What’s New and Important in Pediatric Ophthalmology and Strabismus for 2019
The Complete and Unabridged handout

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1. AMBLYOPIA

Visual Search in Amblyopia: Abnormal Fixational Eye Movements and Suboptimal Sampling Strategies

Microsaccades shift the image on the fovea and counteract visual fading. They are also thought to serve as an optimal sampling strategy while viewing complex visual scenes. This study assessed visual search in amblyopic children. Twenty-one amblyopic children with varying severity of amblyopia and 10 healthy controls were recruited. Eye movements were recorded using infrared video-oculography during amblyopic and fellow eye viewing while the subjects performed (1) visual fixation, (2) exploration of a blank scene, and (3) visual search task (spot the difference between two images). The number of correctly identified picture differences and reaction time were recorded. Microsaccades, saccades, and intersaccadic drifts were analyzed in patients without latent nystagmus (LN). Slow phase velocities were computed for patients with LN. Both patients with and without LN were able to spot the same number of differences but took longer during fellow eye viewing compared to controls. The ability to identify differences was diminished during amblyopic eye viewing particularly in those with LN and severe amblyopia. Reduced frequencies of microsaccades and saccades were found in both amblyopic and fellow eyes during fixation and visual search but not during exploration of blank scene. Across all tasks, amblyopes with LN had increased intersaccadic drifts. These findings suggest that deficient microsaccade and saccadic activity contributes to poorer sampling strategy in amblyopia, which is seen in both amblyopic and fellow eye. These deficits are more notable among subjects who experienced binocular decorrelation earlier in life, with subsequent development of LN. The results of this study are in agreement with other studies demonstrating slower reading in amblyopes related to fellow eye fixation instability. Future research should be directed at determining the influence of attentional deficits on decreased microsaccades frequencies in amblyopes.

Comparison of effect of Cycloplegia on Astigmatism Measurements in a Pediatric Amblyopic Population: A Prospective Study

The purpose of this article was to study the effect of cycloplegia on astigmatism measurements in pediatric patients with amblyopia. This was a prospective com-
parative clinical study. Participants 4 to 17 years old were recruited from the patient population after informed consent was obtained. Autorefractor measurements were used to obtain values of refractive error in amblyopic and non-amblyopic patients before and after cycloplegia. The groups were subdivided into myopia and hyperopia and with and without underlying amblyopia. The refractive error was expressed as sphere, cylinder, axis of astigmatism, and spherical equivalent. The treatment effect was summarized as the mean difference (95% confidence interval) for each outcome. The study showed that there was no statistically significant difference on the axis and power of astigmatism before and after cycloplegia in patients with amblyopia ($p=.28$ and .99, respectively). The authors conclude that non-cycloplegic autorefraction measurements may be considered safe for refining astigmatism power and axis in pediatric patients with amblyopia. The information provided by the current study would benefit pediatric patients by facilitating more accurate spectacle prescriptions with the least amount of diagnostic testing. The study has the obvious limitations of a small sample size and patients not classified according to age or accommodative amplitude. The authors believe further multicenter studies in this area may be beneficial for further utilization of this information with more confidence.

Analysis of Macular Vessel Density and Foveal Avascular Zone Using Spectral-Domain Optical Coherence Tomography Angiography in Children with Amblyopia.

The purpose of this study is to quantify the foveal avascular zone and the whole, parafoveal, and foveal vessel density of superficial and deep capillary plexus in amblyopic eyes and age-matched controls and to compare the measurements. This cross-sectional study involved 49 eyes from 17 patients with amblyopia and 21 healthy children (aged 6 to 16 years). Optical coherence tomography angiography was performed for all participants and superficial capillary plexus, deep capillary plexus, and foveal avascular zone were evaluated. Data from amblyopic eyes, fellow eyes with unilateral amblyopia, and control eyes were compared using the Mann–Whitney $U$ test. The mean patient age was $8.6 \pm 2.5$ years in the amblyopia group and $9.6 \pm 2.9$ years in the control group. The mean foveal avascular zone measurements were $0.251 \pm 0.1 \text{ mm}^2$ in the amblyopia group and $0.291 \pm 0.1 \text{ mm}^2$ in the control group. The whole, foveal, and parafoveal vessel densities of superficial capillary plexus were $48.8\% \pm 3.7\%$, $23.8\% \pm 8.8\%$, and $50.9\% \pm 4.6\%$ in the amblyopia group and $48.4\% \pm 2.5\%$, $19.3\% \pm 5.4\%$, and $51.3\% \pm 2.7\%$ in the control group. The whole, foveal, and parafoveal vessel densities of deep capillary plexus were $51.8\% \pm 4.3\%$, $37.6\% \pm 5.8\%$, and $54.8\% \pm 4.2\%$ in the amblyopia group and $54.4\% \pm 3.2\%$, $34.9\% \pm 7.4\%$, and $56.8\% \pm 3.2\%$ in the control group. No statistically significant difference was detected in all measurements. The study concludes that amblyopic eyes and normal eyes have similar retinal capillary plexus densities and foveal avascular zone. Small sub-
group analysis showed there was no difference between amblyopic eyes and fellow eyes. Based on these results, the authors hypothesize that the amblyopic process does not involve retinal microvasculature because animal models could not detect such evidence. Different levels of the visual pathways might or might not be affected in amblyopia. Also, these alterations might be structural or functional. Studies including histological sections are required to respond to these questions. This study is limited by the relatively small sample size. It is unclear whether our findings would be generalizable to a larger group of patients. However, it is novel that amblyopic eyes and control eyes have analogous retinal microvasculature. Further studies using a larger sample size will clarify our findings.

**The positive predictive value of Smartphone Photoscreening in Pediatric Practices**


The purpose of this study is to compare smartphone photoscreening with other commercial objective screeners for amblyopia screening for young children. Ten pediatricians in four practices employed Nokia 1020 smartphones (Espoo, Finland) with single-axis Gobiquity software (Scottsdale, AZ) during well-child visits. Outcomes of confirmatory pediatric ophthalmology examinations were prospectively compared using American Association for Pediatric Ophthalmology and Strabismus uniform standards. The study showed that five percent of 6,310 in-office screenings were referred: 25% for high anisometropia, 31% for hyperopia, and 15% for myopia. The positive predictive value (PPV) in 217 follow-up examinations was 68% (95% confidence interval: 62% to 74%) by 2013 age-stratified standards and 77% (confidence interval: 71% to 83%) by 2003 American Association for Pediatric Ophthalmology and Strabismus standards. The follow-up rate was 65%.

**Evaluation of retinal structure in unilateral amblyopia using spectral domain optical coherence tomography.**


This cross-sectional study investigated the potential differences in the retinal nerve fiber layer (RNFL) thickness, macular thickness and foveal thickness between amblyopic eyes and normal fellow eyes on spectral domain optical coherence tomography (SD-OCT). The study included patients ≥10 years of age with unilateral amblyopia resulting from anisometropia, strabismus or deprivation. Comprehensive ophthalmic examination was completed and the retinal structures of both eyes were measured using SD-OCT. Twenty-six unilateral amblyopia patients with a mean age of 29.92 ± 14.19 years old participated in the study, of which 17 (65.4%) were classified as anisometropic amblyopia, 7 (26.9%) as
strabismic amblyopia, and 2 (7.7%) as deprivation amblyopia. For the amblyopic eye and fellow normal eye, respectively, the mean RNFL thickness was 95.87 ± 14.56 μm and 97.87 ± 14.56 μm (P = 0.628), the mean macular thickness was 270.87 ± 14.43 μm and 275.60 ± 14.43 μm (P = 0.251) and the mean foveal thickness was 250.59 ± 27.82 μm and 242.91 ± 27.82 μm (P = 0.332). SD-OCT assessments revealed no statistically significant differences between both eyes. The authors concluded that there were no significant changes in the retinal structure of amblyopic eyes on the SD-OCT; Therefore, amblyopia does not seem to have a profound structural effect on the retinal nerve fiber layer, the macula, or the fovea. However, the study has several limitations, including the small sample size and diverse group of patients, including a wide age range (12-59 years) and different types of amblyopia. It seems that deprivation amblyopia wouldn’t affect the visual pathways in a similar way as anisometropic amblyopia would.

### Increased choriocapillaris vessel density in amblyopic children: a case-control study.


In this prospective case-control study the choriocapillaris in children with amblyopia, and age-matched controls was investigated using optical coherence tomography angiography (OCT-A). On OCT-A, the choriocapillaris measures 30 μm starting 31 μm posterior to the retinal pigment epithelium. The section of choriocapillaris under superficial retinal vessels was excluded from analysis to avoid shadowing or projection artifacts. The main outcome measure was choriocapillaris vessel density. Secondary outcome measures were foveal macular thickness and parafoveal macular thickness. A total of 20 eyes of 16 patients with amblyopia and 25 eyes of 25 controls were included. Mean age of amblyopic subjects was 7.6 ± 3.6 years; of controls, 9.3 ± 2.2 years (P = 0.10). Mean refractive error of subjects was 4.3 ± 6.2 D; of controls, 0.0 ± 1.6 D (P = 0.004). Mean choriocapillaris vessel density was 74.8 ± 5.8 in the amblyopic group and 71.1 ± 3.6 in the control group, which was significant even after adjusting for age and refractive error (P = 0.012). There was no difference between groups in foveal macular thickness or parafoveal macular thickness; however, outer parafoveal macular thickness (the inner boundary of the inner nuclear layer to the retinal pigment epithelium outer boundary) was significantly greater in amblyopic eyes than in control eyes, even after adjustment for age and refractive error (203 ± 11 μm and 189 ± 12 μm, resp. [P = 0.014]). The authors concluded that in their cohort, amblyopic eyes were found to have increased choriocapillaris vessel density as well as a greater outer parafoveal macular thickness, which may be due to alterations in outer retinal maturation. Some possible explanations for this finding are offered in the discussion. OCT-A is an exciting new imaging modality; however, its clinical relevance is still under inspection.
OCT angiography findings in children with amblyopia

The purpose of this paper is to compare the microstructure and vascularity of amblyopic eyes in children with their contralateral eye and with eyes from control children using optical coherence tomography angiography (OCT-A). The authors conducted a prospective, cross-sectional evaluation of macular and optic disk vascular density and flow area using OCT-A (Avanti RTVue XR, Optovue Inc, Fremont, CA). Parameters were calculated using automated software. A total of 52 children were included: 26 subjects with amblyopia and 26 nonamblyopic controls. In this study, the amblyopic eye of subjects showed a statistically significant decrease in macular vascular density (P = 0.0171) of the superficial capillary plexus (SCP), in the optic disk flow area (P = 0.0195) and in the average retinal nerve fiber layer thickness (P = 0.0194) as well as a marginally statistically significant decrease in the macular flow area of the SCP (P = 0.0305) and in the optic density (P = 0.0279). Compared with randomly selected eyes of controls, amblyopic eyes showed a statistically significant decrease in the macular flow area of the SCP (P = 0.005) and of the deep capillary plexus (DCP; P = 0.002), in the macula vascular density of the SCP (P = 0.022), in the optic disk flow area (P = 0.004), and a marginally statistical significant increase in the area of foveal avascular zone of the DCP (P = 0.038). The authors also found that the contralateral eyes of amblyopic eyes did not have completely normal vascularization. In this study cohort amblyopic eyes manifested significant differences in macular and optic disk vascularization. The clinical significance of these findings warrants further research. It remains to be determined if the vascularization defect is the cause of amblyopia or the consequence of it, however the findings may provide information for future studies.

Home use of binocular dichoptic video content device for treatment of amblyopia: a pilot study.

The goal of this study was to evaluate the efficacy of the BinoVision home system as measured by improvement of visual acuity in the patient's amblyopic eye. This study was an open-label prospective pilot-trial of the system was conducted with amblyopic children aged 4-8 years at the pediatric ophthalmology unit, Tel-Aviv Medical Center, January 2014 to October 2015. Participants were assigned to the study or sham group for treatment with BinoVision for 8 or 12 weeks. Patients with amblyopia from anisometropia or strabismus were included. Patients were instructed to watch animated television shows and videos at home using the BinoVision device for 60 minutes, 6 days a week. The BinoVision program incorporates elements at different contrast and brightness levels for both eyes,
weak eye tracking training by superimposed screen images, and weak eye flicker stimuli with alerting sound manipulations. Patients were examined at 4, 8, 12, 24, and 36 weeks. A total of 27 children were recruited (14 boys), with 19 in the treatment group. Median age was 5 years (range, 4-8 years). Mean visual acuity improved by 0.26 logMAR lines in the treatment group from baseline to 12 weeks. Visual acuity was improved compared to baseline during all study and follow-up appointments (P < 0.01), with stabilization of visual acuity after cessation of treatment. The sham group completed 4 weeks of sham protocol with no change in visual acuity (P = 0.285). The average compliance rate was 88% ± 16% (50% to 100%) in treatment group. Overall, this pilot trial of 12 weeks of amblyopia treatment with the BinoVision home system demonstrated significant improvement in patients' visual acuity and appeared to be associated with good compliance. The BinoVision home system may provide an option for future treatment of amblyopia and requires further study.


Compliance with patching therapy for amblyopia therapy is limited, thought to be as low as 33-58%. In addition, accurately assessing compliance is difficult. The authors performed a prospective pilot study in 3-7 year old patients with a new diagnosis of amblyopia who were randomized to receive the standard compliance instructions or use the RemindmeRx app. Twenty-four of the 27 enrolled patients completed the study, with 12 in each group. The mean age, gender distributions, socioeconomic characteristics, amblyopia type or mean follow up duration were similar between the groups. The percentage compliance was high and similar in both groups (93 vs 94%), and there were no statistically significant differences in the outcome. The authors address the limitations of the study, which include small sample size, short follow up (6 weeks), and self-reported compliance. Future studies in larger groups and over longer time periods may be helpful in determining the benefit.

Is microtropia a reliable indicator of the presence of amblyopia in anisometropic patients?


It is thought that the type of refractive error and degree of anisometropia are not reliable indicators of the presence or severity of amblyopia. The authors performed a retrospective case series over a 10 year period of 4-5 year old children with unequal visual acuity and no manifest strabismus who were prescribed glasses to correct anisometropic refractive errors. Of the 532 children included in the study, 190 achieved equal vision after 2 months of glasses wear, 134 achieved equal vision after 4-6 months of glasses wear, and 208 persisted with unequal vision after 6 months of glasses wear. In the first two groups, none of the children had a microtropia. Of the 208 with unequal vision that persisted after 6
months of glasses wear, all presented with a microtropia. Of these patients, 30 had unequal vision after 6 months with glasses but the vision in the amblyopic eyes was above the threshold for patching. The remaining 178 children had unequal vision after glasses wear for 6 months and required patching. The authors conclude that the presence of a microtropia appears to be a reliable indicator of amblyopia and possible need for occlusion therapy.

**Multiple-Choice Answer Form Completion Time in Children With Amblyopia and Strabismus**

In this cross-sectional study completed between 2014 and 2017 at a nonprofit eye research institute to assess for a time difference in academic tasks in children with amblyopia and/or strabismus. At the research institute, there were enrollment of 47 children with amblyopia treated for strabismus, anisometropia, or both, 18 children with non-amblyopic strabismus, and 20 normal controls. In particular, children were asked to transfer the correct answers from a standardized reading achievement test booklet to a multiple-choice answer form as quickly as possible without making mistakes or reading the text. Of the 85 included children, 40 (47%) were female, the mean (SD) age was 10.09 (0.91) years, and the last mean (SD) grade completed was 3.42 (0.92). Compared with children in the control group (mean [SD] time to completion, 230 [63] seconds), children with amblyopia (mean [SD] time to completion, 297 [97] seconds; difference, 67 seconds; 95% CI, 24-115; P < .001) and children with non-amblyopic strabismus (mean [SD] time to completion, 293 [53] seconds; difference, 68 seconds; 95% CI, 21-115; P = .002) required approximately 28% (95% CI, 20-37) more time to fill out a multiple-choice answer form. Completion time was not associated with etiology, visual acuity, or stereoacuity. In summary, this study found that longer completion time in children with amblyopia or strabismus may affect a child’s performance on tests using multiple-choice answer forms and may hinder academic success.

**Effectiveness of a Binocular Video Game vs Placebo Video Game for Improving Visual Functions in Older Children, Teenagers, and Adults with Amblyopia**

This multicenter, double-masked, randomized clinical trial was The Binocular Treatment of Amblyopia Using Videogames from 3/2014 through 6/2016. This study reports 115 participants, from ages 7 to 55 years, with unilateral amblyopia (Snellen vision equivalent of 20/40-20/200) due to anisometropia, strabismus, or both. Results indicate no significant difference detected between the binocular video game treatment group and the placebo video game treatment group in the amblyopic eye visual acuity at 6 weeks. Of the participants, 65 (56.5%) were
male and 83 (72.2%) were white and the mean age at randomization was 21.5 years. Compliance with more than 25% of prescribed game play was achieved by 64% of the active group and 83% in the placebo group. At 6 weeks, 36 (64%) participants in the active group achieved fellow eye contrast greater than 0.9 in the binocular video game. Adverse events reported included 3 participants with transient asthenopia, but no reported diplopia. In summary, the authors conclude that this particular dichoptic video game of falling blocks played at home on an iPod Touch for 1 hour a day for 6 weeks did not improve visual outcomes more than the placebo video game despite increases in the fellow eye contrast during the game play. The authors suggest that their results indicate that more engaging video games are needed.

Assessment of an Advanced Vision Screener in the Detection of Amblyopia in the Nebraska Pediatric Population.

The purpose of this cross-sectional study is to determine the validity of the OPTEC 5500 vision screener (Stereo Optical Co., Inc., Chicago, IL) in assessing visual acuity and amblyopia in pediatric patients between the ages of 3 and 17 years by comparing it statistically to gold standard comprehensive ophthalmic examinations. Sixty four patients between the ages of 3 and 17 years underwent a vision screening test at a pediatric ophthalmology office using the OPTEC 5500 vision screener, followed by traditional visual acuity testing via the Snellen or Lea optotypes. After data were collected, the results of the OPTEC 5500 vision screener were compared to the Snellen and Lea visual acuity tests and statistical analysis was subsequently performed for the right and left eyes separately. Patients were considered to have risk factors for amblyopia based on the American Association for Pediatric Ophthalmology and Strabismus referral criteria guidelines. The results of the OPTEC 5500 vision screener for the right eye of participants of all ages were a sensitivity of 77.4%, specificity of 100.0%, positive predictive value of 100.0%, negative predictive value of 50.0%, and accuracy of 81.5%. Results for the left eye were a sensitivity of 81.0%, specificity of 87.0%, positive predictive value of 91.9%, negative predictive value of 71.4%, and accuracy of 83.1%.

Although the specificity and positive predictive value were acceptable, the sensitivity and negative predictive value of the OPTEC 5500 vision screener were below average when compared to other available devices, exhibiting some of the weaknesses of the device. Additional studies of the OPTEC 5500 vision screener with a larger population are necessary to assess the device in the general pediatric population, such as in general pediatric clinics and public schools. Additionally, other options for pediatric vision screening devices should be explored.

Practice Patterns in the Management of Amblyopia: A Survey Study
The purpose of this study is to investigate the practice preferences of pediatric ophthalmologists in the management of amblyopia and whether these are influenced by demographic variables. A 10-question survey was distributed to all pediatric ophthalmologists and fellows attending the Annual Joseph H. Calhoun Pediatric Ophthalmology Forum at Wills Eye Hospital in 2016. The questionnaire consisted of demographic information and clinical management of amblyopia using clinical scenarios commonly encountered in pediatric ophthalmology practice. Of the 133 pediatric ophthalmologists who attended, 74 completed the survey, all of which were included in the data analysis. Seventy-six percent of respondents prescribed refractive correction to a 3 year old with untreated anisometropic amblyopia prior to initiating occlusion therapy. For a child with coexisting exotropia, 57% recommended refractive and occlusion therapy until significant visual improvement, then surgery; however, 30% would perform surgery earlier. Fifty-seven percent stopped occlusion therapy at 10 years of age or older. Sixty-four percent estimated a patient patching compliance rate of 50% to 75%. There was no significant relationship ($P < .05$) between any of the demographic variables, indicating that no group was more or less likely to respond to the question in any way. This study highlights the lack of a united approach to certain aspects of amblyopia management. Physician-related demographic variables did not significantly affect clinical decision-making; however, variation did exist among respondents, a finding that warrants further investigation. Limitations of our study include a small sample size and failure to identify other factors that may play a role in practice patterns (eg, sex or geographic location). In conclusion, this study emphasizes the need to not only identify practice pattern variations among pediatric ophthalmologists in the treatment of amblyopia, but also the need for well-designed prospective randomized controlled trials to establish treatment guidelines and determine whether practice approaches standards of care.

**Improved Binocular Outcomes Following Binocular Treatment for Childhood Amblyopia**


The purpose of this study was to evaluate binocular outcomes in children who had received binocular treatment for childhood amblyopia. Binocular games or movies that rebalance contrast between the eyes are thought to reduce the depth of interocular suppression in children with amblyopia so they can experience binocular vision. While visual acuity gains have been reported following binocular treatment, previous studies rarely reported gains in binocular outcomes (i.e., stereoacuity, suppression) in amblyopic children. Data for amblyopic children enrolled in two ongoing studies were pooled. The sample included 41 amblyopic children (6 strabismic, 21 anisometropic, 14 combined; age 4–10 years; ≤4 prism diopters [PD]) who received binocular treatment (20 game, 21 movies; prescribed 9–10 hours treatment). Mean amblyopic eye visual acuity ($P < 0.001$) and mean
Randot Preschool Stereoacuity improved (P = 0.045), and mean extent (P = 0.005) and depth of suppression (P = 0.003) were reduced from baseline at the 2-week visit (87% game adherence, 100% movie adherence). Depth of suppression was reduced more in children aged <8 years than in those aged ≥8 years (P = 0.004). Worse baseline depth of suppression was correlated with a larger depth of suppression reduction at 2 weeks (P = 0.001). Although not all children had improved binocular outcomes after 2 weeks, the group as a whole did experience improved visual acuity and stereoacuity, as well as a reduction in the extent and depth of suppression. Binocular treatments that rebalance contrast to overcome suppression are a promising additional option for treating amblyopia. This study had a reasonable sample size, but the binocular outcomes will be better elucidated with even larger studies, and it would be interesting to see how binocular treatments fare against traditional patching treatment with regards to binocular outcomes.

**Longitudinal Evaluation of Accommodation During Treatment for Unilateral Amblyopia**


The purpose of this longitudinal observational study was to evaluate the accommodative performance of the amblyopic eye during treatment of children with unilateral amblyopia, with the thought that reduced accommodation would limit visual acuity gains during amblyopia treatment. Twenty-six participants with unilateral amblyopia and 10 participants with typical vision aged 3 to 10 years participated. Accommodative response was measured using modified Nott retinoscopy in monocular and binocular viewing conditions for target distances of 50, 33, and 25 cm, at enrollment and each follow-up visit. Participants with amblyopia accommodated less accurately when viewing with their amblyopic eye in monocular than in binocular conditions. Over the course of amblyopia treatment, accommodative performance improved with amblyopic eye visual acuity (VA) improvement, although this was not consistent across individual participants. A linear mixed model showed that accommodative error worsened with increasing depth of amblyopia for monocular viewing with the amblyopic eye (0.14 diopter [D] per line of acuity loss, P = 0.001), with an interaction between VA and stimulus demand (0.09 D of additional lag per diopter of stimulus, per line of acuity loss, P < 0.001). Participant age, patching duration, length of time in the study, history of strabismus, and stereoacuity were not significant predictors of accommodative performance. Overall, poor monocular accommodative performance of the amblyopic eye was associated with worse amblyopia and improved simultaneously with VA improvement, although there was variability across the study cohort. This is the first study that evaluates changes in accommodation during conventional amblyopia treatment. Further research is needed to determine the causal relationship between amblyopic eye VA and accommodation and its impact on amblyopia treatment, and whether accommodative therapy would be a useful adjunct to amblyopia treatment in certain children.
Home use of binocular dichoptic video content device for treatment of amblyopia: a pilot study.
Mezad-Koursh D., Rosenblatt A., Newman H. and Stolovitch C.

The purpose of this open-label prospective pilot-trial was to evaluate the efficacy of the BinoVision home system as measured by improvement of visual acuity in the patient's amblyopic eye. The study was conducted on amblyopic children aged 4-8 years at the pediatric ophthalmology unit, Tel-Aviv Medical Center, January 2014 to October 2015. Participants were assigned to the study or sham group for treatment with BinoVision for 8 or 12 weeks. Patients were instructed to watch animated television shows and videos at home using the BinoVision device for 60 minutes, 6 days a week. The BinoVision program incorporates elements at different contrast and brightness levels for both eyes, weak eye tracking training by superimposed screen images, and weak eye flicker stimuli with alerting sound manipulations. Patients were examined at 4, 8, 12, 24, and 36 weeks. A total of 27 children were recruited (14 boys), with 19 in the treatment group. Median age was 5 years (range, 4-8 years). Three subjects had refractive amblyopia (16%), 9 had strabismic amblyopia (42%), and 7 had combined mechanism amblyopia (37%). Mean visual acuity improved by 0.26 logMAR lines in the treatment group from baseline to 12 weeks. Visual acuity was improved compared to baseline during all study and follow-up appointments (P < 0.01), with stabilization of visual acuity after cessation of treatment. The sham group completed 4 weeks of sham protocol with no change in visual acuity (P = 0.285). The average compliance rate was 88% ± 16% (50% to 100%) in the treatment group. The authors concluded that in this pilot trial of 12 weeks of amblyopia treatment with the BinoVision home system significant improvement was demonstrated in patients' visual acuity. This is a promising new treatment option for amblyopia in children.

New pediatric risk factors for amblyopia: strabismic versus refractive.

This retrospective case-controlled study evaluates potential perinatal risk factors for the development of strabismic or refractive amblyopia in children born at the Hospital de Braga in Portugal over a 5-year study period. Amongst the 298 children with amblyopia compared with 298 controls, the authors found a significant correlation with 5 minute Apgar score at birth and strabismic amblyopia. Family history of strabismus or amblyopia was significantly associated with amblyopia development particularly in predicting strabismic amblyopia. The authors propose that 5 minute Apgar score be added to the list of amblyopia risk factors in
addition to family history which is a known risk factor. The limitation of the study is establishing the causal link between the five minute Apgar score and strabismic amblyopia particularly when the difference in scores may be statistically significant but perhaps not clinically meaningful (on a scale of 1-10: 9.83 control versus 9.57 strabismic amblyopia). This is not adequately addressed by the study.

**A Randomized Trial of a Binocular iPad Game Versus Part-Time Patching in Children Aged 13 to 16 With amblyopia**

The goal of this randomized prospective trial was to compare the visual acuity improvement in teenagers with amblyopia after treatment with patching to those with a binocular iPad game. The authors studied 100 patients from ages 13 to less than 17 years with a diagnosis of amblyopia and a vision between 20/40 and 20/200. The patients had to have strabismus of 10 prism diopters or less on prism alternate cover test at near to be enrolled in the study. The subjects were randomized to 2 hours/day of patching or 1 hour/day of a binocular iPad game. The main outcome was visual acuity change from baseline to week 16. Patients randomized to the iPad game used red green glasses with the green lens over the amblyopic eye. The contrast of the objects seen by the non amblyopic eye was adjusted based on previous performance. The study was stopped early by the data safety and monitoring committee because the initial data demonstrated that the patching group was doing better and were missing a pre specified stopping boundary. Additionally, there was very poor adherence in the binocular iPad game intervention group where only 13% of patients adhered to 75% or more of the time prescribed. The authors highlight the main limitation, which was the very poor adherence to treatment and they aim to have a more engaging game for the next study, hinting at the main problem, which was that the game was very boring for the participants and expecting 1 hour of play was not realistic.

**Amblyopia in High Accommodative Convergence / Accommodation Ratio Accommodative Esotropia. Influence on Bifocals on Treatment Outcome.**

This is a retrospective comparative case series of 61 children with high ac/a accommodative esotropia between 2011 and 2016. All patients were in single vision glasses for 2 months and were evaluated at that time as a baseline exam. At that time, 46 patients were changed to bifocals. There were 27 patients who had amblyopia at diagnosis, 21 of those still had amblyopia at the 2 month baseline exam in single vision hyperopic spectacles. 13 of amblyopic patients were placed in bifocals. Overall, the decision to add the bifocal was based on the clinician and the family. Most clinicians were in favor of the bifocals, but parents
were given opportunity to opt out of the bifocal after recent studies suggested that this practice was controversial since it is unclear if this provided long term benefit. No patient required surgery for decompensated esotropia during this study. The authors demonstrated that there was faster short term improvement in amblyopia in the group of patients who used the bifocal, but that the acuities in the two groups were similar at 1 year. Similar to previous studies, the patients in the bifocal group of this study did not demonstrate improved stereoacuity compared to the non bifocal group. The conclusion of this paper is that bifocals can provide a transient advantage in the rate of improvement in vision of amblyopic eyes in patients with high ac/a accommodative esotropia. The authors point out that this difference could be due to hypoaccommodation in amblyopic eyes and not because of the alignment at near in these glasses.

The Need for a Unified Protocol for Termination of Amblyopia Treatment
Nassar, MM. and Mitchell, FC *Br Ir Orthopt J* 2018; 14(1): 20-24

The protocols for cessation of amblyopia treatment and duration of post-treatment follow-up remains arbitrary despite the extensive investigation and evidence-based approach on diagnosis and treatment of amblyopia. The studies purpose is to evaluate the stability of visual outcome after amblyopia treatment. 39 patients were included, 72% treated with patching alone and 28% patching and atropine. 92% of patients had improved visual acuity with amblyopia treatment. 80% of patients had tapering of treatment and 20% had abrupt cessation of amblyopia treatment. No patient had a significant recurrence of amblyopia after treatment ended, however 8 patients had an insignificant reduction in their visual acuity. There was no correlation between timing of cessation of treatment or method of cessation in this small retrospective case study. The authors conclude that an end of treatment protocol needs standardization and future research.

Prevalence of amblyopia and its association with refraction in Chinese preschool children age 36-48 months

Previous large studies indicate prevalence rates of amblyopia in preschool children from 1.19% to 1.97%. However, the authors of this study note that this might not apply to the Chinese population. Therefore they conducted a cross-sectional population based study to evaluate the prevalence of amblyopia in Chinese children aged 36-48 months old. Comprehensive eye exams were performed among 1810 preschoolers. 1695 children were included in the analysis after excluding those that did not complete testing. 25 children were identified as amblyopic. 11 of these had bilateral amblyopia. Significant refractive errors were found in 88% of those with amblyopia, and strabismus in 24%. The overall preva-
lence of amblyopia was calculated as 1.47%. There were significant associations with hyperopia, astigmatism, and anisometropia. Note that cycloplegic refraction was only performed in 21% of the tested children, with non-cycloplegic refraction data otherwise used. Also, children who could not perform visual acuity testing (or did not finish) were excluded from analysis. These issues as well as other potential selection biases may have led to underestimation of the true prevalence rate.

**Amblyopia and strabismus: trends in prevalence and risk factors among young adults in Israel**

The authors of this study conducted a large cross-sectional study of adolescents/young adults. They collected data from a database of military conscripts (military conscription is mandatory for 18 year olds in Israel). 107,608 young adults born between 1971 and 1994 were included in the analysis. Overall, amblyopia was detected in just over 1%. Across the age groups, prevalence of amblyopia decreased from 1.2% to 0.8%. Of those with unilateral amblyopia, strabismus was found in 6-12% and anisometropia in 11-20%. Strabismic amblyopia rates remained constant. Overall the decrease in amblyopia prevalence was significant, coinciding with screening implantation and universal healthcare per the authors. They did note that cases of severe amblyopia did not decline, suggesting that these cases may be less amenable to treatment even when detected early.

**Asymmetrical accommodation in hyperopic anisometropic amblyopia**

Accommodation is generally thought to be symmetric in each eye, but some reports suggest asymmetrical accommodation even in normal young adults. Previous studies that have shown reduced accommodation in amblyopic eyes may have not detected asymmetric findings. This study examined 26 children age 4 to 8 with hyperopic anisometropic amblyopia to determine whether asymmetric accommodation was present. The PlusoptiX SO4 photorefractor was used to measure accommodation. Results were compared with 13 age-matched controls. 21/26 (81%) demonstrated asymmetric accommodation. Of these 6 showed “anti-accommodation” or a greater accommodation for distance than for near (with a negative accommodation gain on the machine). However this phenomenon resolved with glasses wear. Overall the results showed greater accommodative lag in amblyopic eyes, along with a relatively high rate of anti-accommodation. The authors suggest that anti-accommodation may be due to a misinterpretation of blur cues in the amblyopic eye, or a result to avoid conflict between the clear im-
age in the sound eye and the less clear image in the amblyopic eye. There may be some mechanism causing independent accommodation that needs further study, and the authors recommend these children wear their full cycloplegic refraction to avoid these accommodation issues.

**Global and regional estimates of prevalence of amblyopia: A systematic review and meta-analysis.**

Amblyopia is an important cause of visual impairment throughout the world. The authors performed a systematic review of the literature to estimate its global and regional prevalence, assess trends in prevalence, and understand the causes. The search returned 1252 articles, which the authors narrowed down to 73 studies after their inclusion and exclusion criteria were applied. There 5653 cases of amblyopia, with a pooled prevalence of 1.75%. The most common causes of amblyopia were anisometropia in 45 studies (62%), strabismus in 7 studies (9.6%), and anisometropia and strabismus in 7 studies (9.59%). Anisometropia was the most common etiology in both children (59.7%) and adults (83.3%). The authors note that there was high heterogeneity between studies (p<0.001), with WHO region (p<0.001) and sample size (p=0.025) having significant effect on the heterogeneity. Overall, the prevalence of amblyopia was higher in the United States and Europe than in Asia and Africa. The authors acknowledge this may be due to level of development or differences in criteria for defining amblyopia, but believe that ethnicity is possibly the most important factor. They also state that a high prevalence of amblyogenic factors like strabismus or anisometropia in these populations may be the reason, or that better detection of amblyopia with higher sensitivity vision testing may also contribute to the difference. Within the limitations, the authors acknowledge a publication bias, as well as lack of including gender-specific differences. Despite the limitations, the authors conclude that the worldwide prevalence of amblyopia is 163-190 in 100,000, which makes it an important cause of visual impairment and may help progress in designing effective screening programs.

**Is microtropia a reliable indicator of the presence of amblyopia in anisometropic patients?**

It is thought that the type of refractive error and degree of anisometropia are not reliable indicators of the presence or severity of amblyopia. The authors performed a retrospective case series over a 10 year period of 4-5 year old children with unequal visual acuity and no manifest strabismus who were prescribed glasses to correct anisometropic refractive errors. Of the 532 children included in the study, 190 achieved equal vision after 2 months of glasses wear, 134 achieved equal vision after 4-6 months of glasses wear, and 208 persisted with
unequal vision after 6 months of glasses wear. In the first two groups, none of the children had a microtropia. Of the 208 with unequal vision that persisted after 6 months of glasses wear, all presented with a microtropia. Of these patients, 30 had unequal vision after 6 months with glasses but the vision in the amblyopic eyes was above the threshold for patching. The remaining 178 children had unequal vision after glasses wear for 6 months and required patching. The authors conclude that the presence of a microtropia appears to be a reliable indicator of amblyopia and possible need for occlusion therapy.

**Effectiveness of a Binocular Video Game vs Placebo Video Game for Improving Visual Functions in Older Children, Teenagers, and Adults with Amblyopia**


This multicenter, double-masked, randomized clinical trial was *The Binocular Treatment of Amblyopia Using Videogames* from 3/2014 through 6/2016. This study reports 115 participants, from ages 7 to 55 years, with unilateral amblyopia (Snellen vision equivalent of 20/40-20/200) due to anisometropia, strabismus, or both. Results indicate no significant difference detected between the binocular video game treatment group and the placebo video game treatment group in the amblyopic eye visual acuity at 6 weeks. Of the participants, 65 (56.5%) were male and 83 (72.2%) were white and the mean age at randomization was 21.5 years. Compliance with more than 25% of prescribed game play was achieved by 64% of the active group and 83% in the placebo group. At 6 weeks, 36 (64%) participants in the active group achieved fellow eye contrast greater than 0.9 in the binocular video game. Adverse events reported included 3 participants with transient asthenopia, but no reported diplopia. In summary, the authors conclude that this particular dichoptic video game of falling blocks played at home on an iPod Touch for 1 hour a day for 6 weeks did not improve visual outcomes more than the placebo video game despite increases in the fellow eye contrast during the game play. The authors suggest that their results indicate that more engaging video games are needed.

**A Randomized Trial of a Binocular iPad Game Versus Part-Time Patching in Children Aged 13 to 16 Years With Amblyopia**


There is emerging evidence that a binocular approach to the treatment of amblyopia can improve amblyopic eye visual acuity in adult patients with strabismic, anisometropic, and mixed-mechanism amblyopia, and possibly at a greater rate than patching treatment. To achieve a binocular precept, dichoptic displays have been used to present high-contrast images to the amblyopic eye and low-contrast images to the fellow eye in order to overcome binocular suppression
commonly found in amblyopia. The purpose of this randomized clinical trial was to compare the improvement in amblyopic eye VA after 16 weeks of home-based treatment with binocular game play on an iPad device prescribed for 1 hour a day vs patching prescribed for 2 hours a day, in teenagers aged 13 to <17 years with amblyopic eye visual acuities of 20/40 to 20/200. One hundred participants aged 13 to <17 years (mean 14.3 years) with amblyopia (20/40 to 20/200, mean 20/63) resulting from strabismus, anisometropia, or both were enrolled into this randomized clinical trial. Participants were randomly assigned to treatment for 16 weeks of either a binocular iPad game prescribed for 1 hour per day (n = 40) or patching of the fellow eye prescribed for 2 hours per day (n = 60). The main outcome measure was change in amblyopic eye VA from baseline to 16 weeks. Mean amblyopic eye VA improved from baseline by 3.5 letters (2-sided 95% confidence interval [CI]: 1.3–5.7 letters) in the binocular group and by 6.5 letters (2-sided 95% CI: 4.4–8.5 letters) in the patching group. After adjusting for baseline VA, the difference between the binocular and patching groups was -2.7 letters (95% CI: -5.7 to 0.3 letters, P = 0.082) or 0.5 lines, favoring patching. In the binocular group, treatment adherence data from the iPad device indicated that only 13% of participants completed >75% of prescribed treatment. The authors concurrently conducted a parallel study of binocular treatment in younger children aged 5–12 years, which showed greater VA improvement than the current study. Although this younger group also had poor adherence to treatment, they had a higher median proportion of treatment hours than the teenager group. The authors conclude that, in teenagers aged 13 to <17 years, improvement in amblyopic eye VA with the binocular iPad game used in this study was not found to be better than patching, and was possibly worse. Nevertheless, it remains unclear whether the minimal treatment response to binocular treatment was owing to poor treatment adherence or lack of treatment effect.

2. VISION SCREENING

A comparison of Three Different Photoscreeners in Children.


The purpose of this study is to compare the results obtained from three non-cycloplegic handheld photorefractometers with cycloplegic autorefractometry (Topcon KR-8100; Topcon Corporation, Tokyo, Japan) measurement in children. The refractive status of 238 eyes in 119 healthy children was assessed. The values acquired using photorefraction with the non-cycloplegic PlusoptiX A12 (Plusoptix GmbH, Nuremberg, Germany), Retinomax K-plus 3 (Righton, Tokyo, Japan), and Spot Vision Screener (Welch Allyn, Skaneateles Falls, NY) devices were compared with those obtained from the cycloplegic Topcon KR-8100. The agreement between the measurements was assessed using the intraclass correlation coefficient. The mean age was 10.1 ± 3.2 years (range: 6 to 17 years). The mean spherical value for the right eyes was 0.38 diopters (D) (range: −4.50 to
6.25 D) for the Plusoptix A12; 0.45 D (range: −4.50 to 6.25 D) for the Spot Vision Screener; −1.15 D (range: −8.75 to 6.50 D) for the Retinomax K-plus 3; and 0.62 D (range: −4.50 to 6.00) for the Topcon KR-8100. The mean spherical equivalent value for the right eyes was 0.41 D (range: −4.50 to 7.90 D) for the Plusoptix A12; 0.18 D (range: −4.75 to 6.13 D) for the Spot Vision Screener; −1.30 D (range: −10.50 to 6.38 D) for the Retinomax K-plus 3; and 0.67 D (range: −4.00 to 6.00 D) for the Topcon KR-8100 (for the right eyes. The authors conclude that the photorefractometer method was found to be beneficial in the measurement of refractive errors of school-aged children. However, its disadvantages are a limited measurable refractive error range and being affected by mydriatic pupils. The PlusoptiX A12 photorefractometer may eliminate the need for cycloplegia in the detection of refractive errors in children. Further studies examining more cases with an extreme range of refractive errors may be needed to confirm the outcomes of this study.

Overestimation of hyperopia with autorefraction compared with retinoscopy under cycloplegia in school-age children

This was a cross-sectional study to compare refraction values using retinoscopy and autorefraction in Iranian children. The Nidek ARK-510A autorefracokeratometer was used. Cycloplegic refraction was performed with the autorefracter and retinoscopy. 5620 children were included with mean age of 9.2 years and 52.5% boys. The results showed that mean sphere and spherical equivalent refraction were significantly higher with autorefraction compared with retinoscopy. Looking at total study population numbers, the mean spherical equivalent by autorefraction was +1.067 compared to +0.994 with retinoscopy. Autorefraction tended to over plus hyperopic and under minus myopic cases. Although the differences obtained were statistically significant, the actual difference was felt to be clinically insignificant (because they were <0.25D), concluding that autorefraction is a suitable substitute for retinoscopy.

Implementing enhanced education to improve the UCLA Preschool Vision Program

The purpose of this paper is to examine whether educational pamphlets and videos for adults can increase follow-up rates for eye examinations among preschool children. The target population was 3- to 5-year-olds attending 144 preschools within Los Angeles County and receiving services from the UCLA Preschool Vision Program (UPVP). Preschools were randomly assigned to standard and enhanced-education groups. The same procedures were followed in each
group, except that preschool personnel and parents of children referred for eye examinations in the enhanced-education group received education materials and watched a 3-minute informational video on the screening day. The outcome measure was the follow-up rate for comprehensive examinations performed by the UPVP on a second date. The follow-up rate for receiving a complete eye examination was 75.3% (438/582) in the enhanced-education group and 65.1% (430/661) in the standard group (P < 0.0001 [Fisher exact test]; OR = 1.63; 95% CI, 1.28-2.09). The authors conclude that educating adults during the screening session can increase follow-up rates. Further studies are recommended to understand barriers to seeking eye care for children and to devise initiatives to help increase targeted awareness.

**Efficacy and outcomes of a summer-based pediatric vision screening program**

This study sought to investigate the prevalence of decreased visual acuity and uncorrected refractive error in school-aged children participating in summer programs. During the summers of 2014-2016, Wills Eye Hospital collaborated with summer programs in Philadelphia to provide vision screenings for underserved children. Fail criteria included children in grades K-1 (ages 5-6) with visual acuity worse than 20/40 in either eye, children in grades 2-6 (ages 7-13) with visual acuity worse than 20/30 in either eye, or children with ≥2 lines of interocular difference. If decreased visual acuity was correctable to ≥20/30 by the onsite optometrist, two pairs of free eyeglasses were provided. Children with other ocular abnormalities were referred to pediatric ophthalmology. Of 1,627 children screened, 360 children (22.1%) did not pass vision screening, and 64 (3.9%) were referred for further evaluation. The prevalence of decreased distance visual was 34.1% in this group of patients. Younger children were more likely to have worse visual acuity than older children (OR = 0.943; P = 0.023; 95% CI, 0.896-0.992). The incidence of refractive error in the group of 303 patients who underwent manifest refraction was: myopia (73%), astigmatism (56.8%), hyperopia (15.5%), spherical anisometropia (12.5%), and cylindrical anisometropia (11.9%). Myopia increased with age (OR = 0.818; P = 0.001; 95% CI, 0.724-0.922), whereas astigmatism decreased (OR = 0.817; P < 0.001; 95% CI, 0.728-0.913) with age. Two pairs of glasses were provided to 301 children. The authors feel that partnership with summer programs and other community initiatives to provide vision screenings facilitates access to eye care ultimately aimed at improving social functioning and academic performance. This vision screening technique yielded a successful and high number of patients who required further evaluation.

**Effect of a Local Vision Care Center on Eyeglasses Use and School Performance in Rural China: A Cluster Randomized Clin-
This was a cluster randomized, investigator-masked, clinical trial from 2014 to 2015 to assess children in rural China with a vision screening program. In particular, a vision center capable of providing refractive services was established in the Hospital of Yongshou County, in rural Shaanxi Province, western China. All 31 rural primary schools in Yongshou County participated; participants were ages 10-12 years with uncorrected visual acuity of Snellen 6/12 or worse in either eye (2613 children). After teacher-led vision screening early in the school year (September-October 2014), schools were randomly assigned to either early referral (December 2014-February 2015) to the vision center for refraction and free eyeglasses if needed or late referral (March-June 2015) for the identical intervention. All 2613 children evaluated were of Han Chinese race/ethnicity, and 1209 (46.3%) were female. Twelve hundred children (45.9%) met the vision criteria. Among these, 543 (45.3%) were randomized to early screening and 657 (54.7%) to late screening; 433 (79.7%) of the early screening group and 516 (78.5%) of the late screening group completed the study. Of eligible children, 120 (27.7%) owned eyeglasses at baseline. The adjusted effect on test scores comparing early and late groups was 0.25 SD (95% CI, 0.01-0.48; 1-sided P = .04), with the point estimate equivalent to half a semester of additional learning. At the end of the study, 347 of the 433 participants in the early group (80%) reported owning eyeglasses and 326 (75%) reported wearing eyeglasses; among the 516 participants in the late group, 371 (61%) reported owning and 286 (55%) reported wearing eyeglasses. In this study, early administration of the free eyeglasses noted an improvement in a child's academic performance and wearing of spectacles. This large county hospital-based vision center is an effective way to improve a child's educational opportunities in rural China.

Clinical Assessment of an Ocular Photoscreener

The purpose of this study is to determine the accuracy of the PlusoptiX A12 photoscreener (PlusoptiX, Inc., Atlanta, GA) in detecting amblyopia or amblyogenic risks factors in pediatric patients in Nebraska. The data were collected from pediatric patients seen at a single pediatric ophthalmology practice. Each patient was screened using the device and also received a comprehensive ophthalmic examination. The results of the PlusoptiX A12 photoscreener were compared to the gold standard, comprehensive ophthalmic examination findings. The assessment of amblyopia or amblyogenic risk factors in the patients was based on the updated American Association for Pediatric Ophthalmology and Strabismus (AAPOS) referral criteria guidelines. Two hundred nineteen consecutive pediatric patients (438 eyes) participated in this study for the 3-month period of time. Among the patients, 87 (40%) children were determined to have amblyopia or amblyogenic risk factors after the comprehensive pediatric ophthalmology exam-
ination based on the AAPOS guidelines. The study showed that the PlusoptiX A12 photoscreener had a sensitivity of 93.02%, specificity of 84.96%, false-positive rate of 9.13%, false-negative rate of 2.74%, positive predictive value of 80.00%, and negative predictive value of 94.96%. The authors concluded that the PlusoptiX A12 photoscreener is viable and comparable to various commercially available devices in the detection of refractive amblyogenic risk factors based on the Nebraska pediatric patient population. Future studies may show increased sensitivity by combining the use of the PlusoptiX A12 photoscreener with an alternate cover test.

Oregon Elks Children's Eye Clinic vision screening results for astigmatism.

In the Elks Preschool Vision Screening program, which uses the plusoptiX S12 to screen children 36-60 months of age, the most common reason for over-referral, using the 1.50 D referral criterion, was found to be astigmatism. The goal of this study was to compare the accuracy of the 2.25 D referral criterion for astigmatism to the 1.50 D referral criterion using screening data from 2013-2014. Vision screenings were conducted on Head Start children 36-72 months of age by Head Start teachers and Elks Preschool Vision Screening staff using the plusoptiX S12. Data on 4,194 vision screenings in 2014 using the 2.25 D cutoff and 4,077 in 2013 using the 1.50 D were analyzed and compared. Area under the curve (AUC) and receiver operating characteristic curve (ROC) analysis were performed to determine the optimal referral criteria. A t-test and scatterplot analysis were performed to compare how many children required treatment using the different criteria. A total of 136 (2.25 D) and 117 children (1.50 D) who were referred by the plusoptiX screening for potential astigmatism and received dilated eye examinations from their local eye doctors were included. Mean subject age was 4 years. Treatment for astigmatism was prescribed to 116 of 136 using the 2.25 D setting compared to 60 of 117 using the 1.50 D setting. The authors concluded that changing the astigmatism setting from 1.5 D to 2.25 D has increased the percentage of referrals requiring treatment to 85%, reducing false positives by 34%. Of note, the negative predictive value of this screening test using the the 2.25 D cutoff is relatively low (64%).

Effectiveness of the GoCheck Kids Vision Screener in Detecting Amblyopia Risk Factors

The authors of this study designed a validity assessment to evaluate the sensitivity and specificity of the GoCheck Kids Vision screener device in a high-risk pe-
diatric population. The goal was to evaluate the accuracy of this device, which is marketed towards pediatricians for the accuracy in evaluating for risk factors for amblyopia. The patients were 6 months to 6 years old and had first a photoscreener and then the “gold standard” eye exam by a pediatric ophthalmologist. The vision screener had a sensitivity of 76.0% and specificity of 67.2% in detecting amblyopia risk factors. There was a positive predictive value of 75% and negative predictive value of 83.0%, though these are in high-risk populations.

Outcome of universal newborn eye screening with wide-field digital retinal image acquisition system: a pilot study.


Universal newborn eye screening is an emerging concept for early intervention of many eye diseases that present at birth. The purpose was to analyze the outcome of this universal newborn eye screening with wide-field digital retinal imaging (WFDRI), assess the cost-benefit margin and compare it with few similar studies reported so far in the literature. Pupillary dilation with a mixture of 2.5% phenylephrine hydrochloride and 0.5% cyclopentolate eye drops. Assessment of red reflex with the help of the illumination from the Ret Cam 130-degree lens; imaging of the external structures of both eyes including eye lids and anterior segments of each eye and entire fundus imaging with five fundus photographs included the posterior pole, including disc and fovea, superior retina-optic disc at the inferior pole of the field of view, inferior retina-optic disc at the superior pole of the field of view, temporal-optic disc at the nasal most part of field of view and nasal retina-optic disc at the temporal most part of the field of view. In addition, the superotemporal, inferotemporal, inferonasal, superonasal quadrant retina were also imaged when required. A total of 1152 babies were examined. Average time to examination was 3.68 days (median: 3.08 days; range 0–21 days). The mean GA and BW were 39.07 weeks (SD: 1.19) and 2.88 kg (SD: 0.46) respectively. Most babies were delivered by lower segment caesarean section (78.4%) Ocular abnormality of any kind was seen in 14.9%, Retinal hemorrhages were the major finding (13.28%); it was of varying severity- superficial, subhyaloid and vitreous hemorrhages. Most were bilateral (77%). Hemorrhages were distributed in all quadrants with varying severity with a tendency to be more around the optic nerve and along the retinal vessels. Retinal hemorrhages were seen in 47.6% of babies born by normal vaginal delivery and 5.2% born by LSCS. The majority of the findings were retinal hemorrhages which usually do not require treatment and the ones that required treatment could have been detected by a routine red reflex test too.
Prevalence and Risk Factors

Environmental Risk Factors Can Reduce Axial Length Elongation and Myopia Incidence in 6- to 9-Year-Old Children


It is becoming increasingly clear that an important cause of the myopia rise in the world is the changing lifestyles of school children. The goal of this study was to identify the risk factors for eye growth at a young age that may help to characterize children at risk for whom lifestyle advice and interventions could be beneficial. This study was embedded in the Generation R Study, population-based prospective cohort study of pregnant women and their children in Rotterdam the Netherlands. Children born between April 2002 and January 2006 were invited at age 6 and 9 years of age for examination which included axial length (AL) and corneal radius (CR) measured with an IOLMaster 500. Corneal radius was obtained from average of K1 and K2 from IOL master. Also, daily life activities and demographic characteristics were obtained by questionnaire. Among 4,734 children who completed examination at age 6 and 9, 3,362 children (71%) were eligible for cycloplegic refractive error measurements. Of these, 2,175 children had ocular biometry data at 9 years of age and cycloplegic refractive error. Linear regression models on AL elongation were used to create a risk score based on the regression coefficients resulting from environmental and ocular factors. The predictive value of the prediction score for myopia (≤0.5 diopter) was estimated using receiver operating characteristic curves. To test if regression coefficients differed for baseline AL-to-CR ratio, interaction terms were calculated with baseline AL-to-CR ratio and environmental factors. The results show that from 6 to 9 years of age, average AL elongation was 0.21±0.009 mm/year and myopia developed in 223 of 2,136 children (10.4%), leading to a myopia prevalence at 9 years of age of 12.0%. Seven parameters were associated independently (P < 0.05) with faster AL elongation: parental myopia, 1 or more books read per week, time spent reading, no participation in sports, non-European ethnicity, less time spent outdoors, and baseline AL-to-CR ratio. Axial length-to-CR ratio at baseline showed statistically significant interaction with number of books read per week (P < 0.01) and parental myopia (P < 0.01). Almost all predictors showed the highest association with AL elongation in the highest quartile of AL-to-CR ratio; incidental myopia in this group was 24% (124/513). The authors concluded that determination of a risk score can help to identify school children at high risk of myopia and suggest that behavioral changes can offer protection particularly in these children. Also notable in this study is that the highest effect of the environmental factors was found for those children with the highest risk of myopia.
Possible Causes of Discordance in Refraction in Monozygotic Twins: Nearwork, Time Outdoors and Stochastic Variation

This study evaluated the impact of differences in nearwork and time spent outdoors on difference in refraction in monozygotic (MZ) twins. Data on MZ twins aged 7 to 18 years from the Guangzhou Twin Eye Study were used. A standard questionnaire was administered by personal interview to estimate time spent on nearwork and time spent outdoors. Spherical equivalent (SE) was measured by cycloplegic autorefraction. The interaction between age and nearwork or time spent outdoors was also estimated. A total of 490 MZ twin pairs (233 male and 257 female) were eligible in this analysis, the mean age was 13.14 ± 2.49. In the mixed-effects model, nearwork difference was a risk factor of discordance in myopic SE (β = -0.11 diopter (D)/h, P = 0.009), the overall association between time outdoors difference and SE discordance was not significant (β = -0.89 (D)/h, P = 0.120) although an interaction between time spent outdoors difference and age was detected (β = 0.07 (D)/h, P = 0.002). Furthermore, difference in nearwork and time outdoors explained about 1.8% and 2.5% of the variation in SE discordance, respectively. Given the very marked genetic similarity of MZ twins, and the small effects of known risk factors on SE discordance, the authors suggest that the SE discordance across MZ twins largely results from stochastic variations at the genomic or epigenetic levels, or from uncollected environmental factors. A limitation of this study is possible recall bias due to the use of a questionnaire to collect myopia-related environmental data in a retrospective fashion.

Distribution and Severity of Myopic Maculopathy Among Highly Myopic Eyes

The purpose of this study was to document the distribution of the severity of myopic maculopathy in a cohort of highly myopic patients and to explore the associated risk factors. A total of 890 Chinese highly myopes aged between 7 and 70 years (median age 19 years) and with spherical refraction -6.00 diopter (D) or worse in both eyes were investigated. All participants underwent detailed ophthalmic examination. Myopic maculopathy was graded into 5 categories according to the International Photographic Classification and Grading System using color fundus photographs: category 0, no myopic retinal lesions, category 1, tessellated fundus only; category 2, diffuse chorioretinal atrophy; category 3, patchy chorioretinal atrophy; category 4, macular atrophy. Category 2 or greater were further classified as clinically significant myopic maculopathy (CSMM). Data from 884 of 890 right eyes were available for analysis. The proportions of category 1, category 2, category 3, and category 4 were 20.0% (177 eyes), 20.2% (178 eyes), 2.6% (23 eyes), and 0.2% (2 eyes), respectively. The proportion of CSMM
increased with more myopic refraction (odds ratio 1.57; 95% confidence interval: 1.46-1.68), longer axial length (odds ratio 2.97; 95% confidence interval: 2.50–3.53), and older age (40–70 years compared to 12–18 years, odds ratio 6.77; 95% confidence interval: 3.61–12.70). However, there was a higher proportion of CSMM in children aged 7 to 11 years than those aged 12 to 18 years (20.9% vs. 11.0%, P = 0.008). Older age, more myopic refraction, and longer axial length were associated with more severe myopic maculopathy. Although CSMM was uncommon among younger participants, children with early-onset high myopia have a disproportionately increased risk. The strengths of this study include large sample size and recruitment from the optometry service rather than retinal clinic, suggesting generalizability. Limitations include cross-sectional study design preventing understanding of causality, lack of assessment of posterior staphyloma due to limited field of photographs, and inclusion of only Chinese participants (generalizability to other races is unknown).

**Dim Light Exposure and Myopia in Children**

Experimental myopia in animal models suggests that bright light can influence refractive error and prevent myopia. Additionally, animal research indicates activation of rod pathways and circadian rhythms may influence eye growth. In children, objective measures of personal light exposure, recorded by wearable light sensors, have been used to examine the effects of bright light exposure on myopia. The effect of time spent in a broad range of light intensities on childhood refractive development is not known. This study evaluated dim light exposure in myopia. The authors reanalyzed previously published data to investigate differences in dim light exposure across myopic and nonmyopic children from the Role of Outdoor Activity in Myopia (ROAM) study in Queensland, Australia. The amount of time children spent in scotopic (<1–1 lux), mesopic (1–30 lux), indoor photopic (>30–1000 lux), and outdoor photopic (>1000 lux) light over both weekdays and weekends was measured with wearable light sensors. Significant differences were found in average daily light exposure between myopic and non-myopic children. On weekends, myopic children received significantly less scotopic light (P = 0.024) and less outdoor photopic light than nonmyopic children (P < 0.001). In myopic children, more myopic refractive errors were correlated with increased time in mesopic light (R = -0.46, P = 0.002). These findings suggest that in addition to bright light exposure, rod pathways stimulated by dim light exposure could be important to human myopia development. Optimal strategies for preventing myopia with environmental light may include both dim and bright light exposure. Limitations of the study include relatively small sample size (102 patients), limited age range of children (10-15 years), and evaluating light exposure only during waking hours. Future studies should include younger children, be designed to determine causation (interventional), and also evaluate light exposure during sleep.
Incidence Of and Factors Associated With Myopia and High Myopia in Chinese Children, Based on Refraction Without Cycloplegia.


This was an observational cohort study to determine the incidence of myopia and high myopia based upon evaluation of non-cycloplegic refraction in 4741 children in primary and junior high school in Guangzhou, China. From 2010 to 2015, children were randomly chosen from the city’s 11 districts, with inclusion at grade 1 (mean age of 7.2 years) and grade 7 (mean age of 13.2 years). The authors defined myopia as the spherical equivalent refraction (SER) of -0.50 diopters or less and high myopia defined as the SER of -6.00 diopters. Baseline mean SER was 0.31 diopter for children in grade 1 and mean SER was -1.60 diopters for children in grade 7. The baseline prevalence of myopia was 12% in grade 1 students and 67.4% in grade 7 students. The authors found that the incidence of myopia was 20% to 30% each year for both cohorts. Moreover, the incidence of high myopia was < 1% in the primary school cohort and was 2.3% in the junior high school cohort. Trends were overall similar in boys and girls, for SER and axial length (AL) measurements. For all measurements, AL measurements were shorter for girls when compared to boys. The authors report mean AL in grade 1 students: girls at 22.48 and boys at 23.5; mean AL in grade 7 students: girls at 23.90 and boys at 24.42. The authors also report a progression of myopia between grades before reaching junior high school. In particular, between grades 1 and 2, 19.1% non-myopic students developed myopia and between grades 5 and 6, 30.2% non-myopic students developed myopia. This report highlights the high incidence of myopia in this cohort of Chinese students, from grade 1 and onward, based upon refraction without cycloplegia. With the increase in myopia as children aged, by grade 9, 79.4% of students were myopic and 7.0% of students were high myopes. The authors acknowledge the the main limitation of their study was the measure only the noncycloplegic refraction, which may overestimate myopia. The authors suggest that if the high incidence and prevalence of myopia at grade 1 is acknowledged with cycloplegic refraction, treatment and prevention of myopic progression should start at the beginning of primary school rather than junior high school. At the very least, the authors of this study reported that myopic progression by junior high school and the high incidence and prevalence of myopia is reason enough to treat and prevent further refractive amblyopia in these students.
The purpose of this paper is to determine whether uncorrected astigmatism in toddlers is associated with poorer performance on the Bayley Scales of Infant and Toddler Development, 3rd edition (BSITD-III). Subjects include were 12- to 35-month-olds who failed an instrument-based vision screening at a well-child check. A cycloplegic eye examination was conducted in all the patients. Full-term children with no known medical or developmental conditions were invited to participate in a BSITD-III assessment conducted by an examiner masked to the child's eye examination results. Independent samples t tests were used to compare Cognitive, Language (Receptive and Expressive), and Motor (Fine and Gross) scores for children with moderate/high astigmatism (>2.00 D) versus children with no/low refractive error (ie, children who had a false-positive vision screening). The sample included 13 children in each group. The groups did not differ on sex or mean age. Children with moderate/high astigmatism had significantly poorer mean scores on the Cognitive and Language scales and the Receptive Communication Language subscale compared to children with no/low refractive error. Children with moderate/high astigmatism had poorer mean scores on the Motor scale, Fine and Gross Motor subscales, and the Expressive Communication subscale, but these differences were not statistically significant. The results suggest that uncorrected astigmatism > 2.00 D in toddlers may be associated with poorer performance on cognitive and language tasks but it does not seem to be associated with poorer performance on gross motor tasks. The results cannot tell whether correcting the astigmatism with spectacles would improve performance. Further studies assessing the effects of uncorrected refractive error on developmental task performance and of spectacle correction of refractive error in toddlers on developmental outcomes are needed to support the development of evidence-based spectacle prescribing guidelines.


This study aimed to determine the prevalence of myopia, proportion of uncorrected myopia and pertinent environmental factors among children in a suburban region in Canada. Myopia was considered at a spherical equivalent refraction (SER) ≤-0.50 D in at least one eye. Parents completed a questionnaire that captured the child’s daily activities. A total of 166 children completed the study (83 aged 6-8 and 83 aged 11-13). Myopia prevalence was 17.5% among the overall group, 6.0% among ages 6-8 and 28.9% among ages 11-13. Mean subjective SER in myopic children was 1.10 D.
(95% CI, -0.34 to -1.86 D) at ages 6-8 and -2.44 D (95% CI, -1.71 to -3.18 D) at ages 11-13. Uncorrected myopia was found in 34.5% of the myopic children (represented 6.0% of the entire group). Axial length (AL) increased by 1.03 mm from ages 6-8 (mean 22.62 mm; 95% CI, 22.45 to 22.79 mm) to ages 11-13 (mean 23.65 mm; 95% CI, 23.45 to 23.84 mm; p < 0.01). The correlation coefficient between AL and SER was -0.618 (p < 0.01). One additional hour of outdoor time per week lowered the odds of a child having myopia by 14.3% (p = 0.007). There is a significantly increase in the prevalence of myopia prevalence from 6% at ages 6-8 to 29% at ages 11-13. Outdoors may be beneficial to protect against myopia onset.

Myopia Prevention and Outdoor Light Intensity in a School-Based Cluster Randomized Trial.


This is a report from Taiwan’s school-based Recess Outside Classroom Trial program to increase the outdoor time for school aged children to reduce myopia progression. The program includes recess outside the classroom, incentive-based outdoor homework and other assignments. The authors investigated the effectiveness of this program and aimed to identify the protective light intensities necessary for such measure. A light meter was used to measure the light intensity. This is a multi-area, cluster-randomized controlled trial including 16 schools in four geographic areas with various weather conditions. A total of 693 students in grade 1 (age 6- to 7- years old) were enrolled. Two hundred sixty-seven schoolchildren were in the intervention group and 426 were in the control group. In the intervention group schoolchildren were encouraged to go outdoors at least 11 hours weekly. The intervention also incorporated near work breaks (10-minute break for every 30 minutes of near work). Data collection included eye examinations, cycloplegic refraction, noncontact axial length measurements, light meter recorders, diary logs, and questionnaires. Of note, the control group already received some intervention to minimize myopia, but not as intensive or deliberate as the intervention group. After 1 year of intervention, the authors found that the intervention group showed significantly less myopic shift and axial elongation compared with the control group (0.35 diopter [D] vs. 0.47 D; 0.28 vs. 0.33 mm; P = 0.002 and P = 0.003) and a 54% lower risk of rapid myopia progression (odds ratio, 0.46; 95% CI, 0.28-0.77; P = 0.003). The myopic protective effects were significant in both nonmyopic and myopic children compared with controls. Regarding spending outdoor time of at least 11 hours weekly with exposure to 1000 lux or more of light, the intervention group had significantly more participants compared with the control group (49.79% vs. 22.73%; P < 0.001). Schoolchildren with longer outdoor time in school (≥200 minutes) showed significantly less myopic shift (measured by light meters; ≥1000 lux: 0.14 D; 95% CI, 0.02-0.27; P = 0.02; ≥3000 lux: 0.16 D; 95% CI, 0.002-0.32; P = 0.048). The school-based outdoor promotion program effectively reduced the myopia change in both nonmyopic and myopic children. Thus, outdoor activities with strong sunlight ex-
posure may not be necessary for myopia prevention. Relatively lower outdoor light intensity activity with longer time outdoors, such as in hallways or under trees, also can be considered. Despite a short duration of follow-up and weakness in gathering light exposure data outside of school, this study suggests that school based interventions can help control myopia and that less than expected light intensity may be necessary to achieve this outcome.

The Effect of Longer-Term and Exclusive Breastfeeding Promotion on Visual Outcome in Adolescence

There is some evidence in the literature that breastfeeding promotes visual development and less susceptibility to ametropia, findings that have been attributed to long-chain n-3 polyunsaturated fatty acids present in breast milk, though more recent survey evidence has been less supportive. The purpose of this study was to determine whether an intervention to promote increased duration and exclusivity of breastfeeding improves visual outcomes of children at 16 years of age. This was a follow-up study of a cluster-randomized trial in 31 Belarusian maternity hospitals/polyclinics randomized to receive a breastfeeding promotion intervention, or usual care, where 46% vs. 3% were exclusively breastfed at 3 months respectively. Low vision in either eye was defined as unaided logMAR vision of ≥0.3 (Snellen 20/40) or worse and was used as the primary outcome. Open-field autorefraction in a subset (n = 963) suggested that 84% of those with low vision were myopic. Primary analysis was based on modified intention-to-treat, accounting for clustering within hospitals/clinics. Observational analyses also examined the effect of breastfeeding duration and exclusivity, as well as other sociodemographic and environmental determinants of low vision. A total of 13,392 of 17,046 (79%) participants were followed up at 16 years. Low vision prevalence was 19.6% (95% confidence interval [CI]: 17.5, 22.0%) in the experimental group versus 21.6% (19.5, 23.8%) in the control group. Cluster-adjusted odds ratio (OR) of low vision associated with the intervention was 0.92 (95% CI: 0.73, 1.16); 0.88 (95% CI: 0.74, 1.05) after adjustment for parental and early life factors. In observational analyses, breastfeeding duration and exclusivity had no significant effect on low vision. However, maternal age at birth (OR: 1.13, 95% CI: 1.07, 1.14/5-year increase) and urban versus rural residence were associated with increased risk of low vision. Lower parental education, number of older siblings was associated with a lower risk of low vision; boys had lower risk compared with girls (0.64, 95% CI: 0.59,0.70). Exclusive breastfeeding promotion had no significant effect on visual outcomes in this study, but other environmental factors showed strong associations. A major strength of the study is that the procedure of randomization occurred early in life without the mother’s choice or knowledge of health outcome, succeeding in achieving two highly comparable groups. This study is limited, however, by considerable overlap in breastfeeding durations. Also, a vision cut-off was used as a proxy for refractive status and cycloplegia was not performed, but this was consistent among both groups, and children were older teenagers.


The purpose of this cross-sectional observational study was to determine the prevalence and severity of uncorrected refractive errors in school-age children attending Philadelphia public schools. The Wills Eye Vision Screening Program for Children is a community-based pediatric vision screening program designed to detect and correct refractive errors and refer those with nonrefractive eye diseases for examination by a pediatric ophthalmologist. Between January 2014 and June 2016 the program screened 18,974 children in grades K-5 in Philadelphia public schools. Children who failed the vision screening were further examined by an on-site ophthalmologist or optometrist; children whose decreased visual acuity was not amenable to spectacle correction were referred to a pediatric ophthalmologist. Eyeglasses were prescribed for hyperopia > +2.00 D, cylinder > +1.00 D, and myopia < -0.50 D. Of the 18,974 children screened, 2,492 (13.1%) exhibited uncorrected refractive errors: 1,776 (9.4%) children had myopia, 459 (2.4%) had hyperopia, 1,484 (7.8%) had astigmatism, and 846 (4.5%) had anisometropia. Of the 2,492 with uncorrected refractive error, 368 children (14.8%) had more than one refractive error diagnosis. In stratifying refractive error diagnoses by severity, mild myopia (spherical equivalent of -0.50 D to < -3.00 D) was the most common diagnosis, present in 1,573 (8.3%) children. The authors conclude that in their urban population 13.1% of school-age children exhibited uncorrected refractive errors. Blurred vision may create challenges for students in the classroom; school-based vision screening programs can provide an avenue to identify and correct refractive errors. The current study applies to screening in low-income schools for children not already in eyeglasses and thus is not comparable to epidemiology of the general pediatric population. However, it does give some indication of the trends of refractive errors among children nowadays.

Environmental factors explain socioeconomic prevalence differences in myopia in 6-year-old children


Risk factors for myopia includes education, ethnicity, and other socioeconomic factors. Higher education has been shown to increase risk, and prevalence rates are high in East Asia. Other lifestyle factors have also been implicated, especially time spent outdoors and certain indoor activities. This study examined whether the differences in myopia prevalence could be explained by lifestyle factors. 5711 six-year old children were included. These children were part of a cohort study called Generation R undertaken in The Netherlands. Visual acuity and refraction
were measured, and questionnaires were analyzed for socioeconomic and behavior factors. Myopia was present in 2.4% of children. These children spent more time indoors, had lower vitamin D, higher BMI, and participated less in sports. Other risk factors included non-European descent, low maternal education, and low family income. The authors conclude that environmental factors are strong risk factors for myopia, even at age 6 years. The difference in prevalence among socioeconomic groups were largely explained by environmental risk factors, which can be modified (more outdoor activity) to decrease risk.

Reducing the Progression of Myopia

Low-Concentration Atropine for Myopia Progression (LAMP) Study: A Randomized, Double-Blinded, Placebo-Controlled Trial of 0.05%, 0.025%, and 0.01% Atropine Eye Drops in Myopia Control

This study aimed at answering the question of efficacy and optimal concentration of low dose atropine in preventing myopia progression and comparing them to placebo. This double-masked, placebo-controlled trial was conducted in Hong Kong. The concentrations of atropine studied were 0.05%, 0.025%, and 0.01% compared with placebo over a 1-year period. A total of 438 children aged 4 to 12 years with myopia of at least -1.0 diopter (D) and astigmatism of -2.5 D or less were included in the study. Participants were randomly assigned in a 1:1:1:1 ratio to receive 0.05%, 0.025%, and 0.01% atropine eye drops, or placebo eye drop (0.9% sodium chloride) once nightly to both eyes for 1 year. Cycloplegic refraction, axial length (AL), accommodation amplitude, pupil diameter, and best-corrected visual acuity were measured at baseline, 2 weeks, 4 months, 8 months, and 12 months. The purpose for the 2 week visit was to determine the hyperopic shift that has been reported in higher concentration of atropine in the ATOM 1 and 2 studies. Visual Function Questionnaire was administered at the 1-year visit. After 1 year, the mean SE change was -0.27±0.61 D, -0.46±0.45 D, -0.59±0.61 D, and -0.81±0.53 D in the 0.05%, 0.025%, and 0.01% atropine groups, and placebo groups, respectively (P < 0.001), with a respective mean increase in AL of 0.20±0.25 mm, 0.29±0.20 mm, 0.36±0.29 mm, and 0.41±0.22 mm (P < 0.001). The accommodation amplitude was reduced by 1.98±2.82 D, 1.61±2.61 D, 0.26±3.04 D, and 0.32±2.91 D, respectively (P < 0.001). The pupil sizes under photopic and mesopic conditions were increased respectively by 1.03±1.02 mm and 0.58±0.63 mm in the 0.05% atropine group, 0.76±0.90 mm and 0.43±0.61 mm in the 0.025% atropine group, 0.49±0.80 mm and 0.23±0.46 mm in the 0.01% atropine group, and 0.13±1.07 mm and 0.02±0.55 mm in the placebo group (P < 0.001). Visual acuity and vision-related quality of life were not affected in each group. The authors concluded that the concentrations studied
did reduce myopia progression along a concentration-dependent response. All concentrations were well tolerated without an adverse effect on vision-related quality of life. Of the 3 concentrations used, 0.05% atropine was most effective in controlling SE progression and AL elongation over a period of 1 year. However, there was no difference in axial length, between the 0.01% and placebo group. There were no treatment-related adverse events. This study is significant as this is the first placebo-controlled trial looking at the effect of atropine.

**Genepin-Crosslinked Donor Sclera for Posterior Scleral Contraction/ Reinforcement to Fight Progressive Myopia**


In East Asia, myopic retinopathy has become one of the leading causes of blindness and visual impairment in the elderly population. This prospective self-controlled interventional case series evaluated the efficacy of posterior scleral contraction/ reinforcement (PSCR) surgery on controlling the progressive elongation of axial length of highly myopic eyes in young patients. Forty young patients (<18-years old) with progressive high myopia received PSCR with a genipin-crosslinked donor scleral strip for one eye and the fellow eye served as concurrent control without surgery. The main outcome measurement was the change of axial length over 2 to 3 years of follow-up. Immediately after the surgery, axial length was shortened and subsequently increased by 0.32 mm over the follow-up period. In contrast, axial length of the fellow eyes increased by 0.82 mm over the same period (P < 0.001, paired t-test). PSCR delayed axial elongation in eyes with or without staphyloma. No significant change of visual acuity, cornea refractive power, or retina thickness was noted between the surgery and fellow eyes. None of the patients lost visual acuity compared with the baseline. The procedure was well tolerated with only temporary corneal refractive axis shifts that recovered by the 6-month postsurgical visit. This study concluded that PSCR with genipin-crosslinked sclera is safe and effective to restrain eye globe elongation in young patients within a 2- to 3-year follow-up period. A larger study sample size with longer follow-up data should shed more light on the safety and efficacy of this PSCR procedure. In this study, the surgery was performed on the more myopic eye in each case at patient’s/ parent’s request, which could introduce bias.

**Miscellaneous**

**Spectacles utilization and its impact on health-related quality of life among rural Chinese adolescents.**

This study measured the magnitude and predictors for spectacles utilization and to quantify its impact on health-related quality of life (HRQOL) among rural Chinese adolescents using a school-based survey of 2346 grade-7 students (mean age: 13.8 years). Criteria to define the need for glasses included an uncorrected visual acuity (VA) of 20/40 or worse correctable to 20/40 or better in the better-seeing eye. Refractive criteria included of myopia of less than 0.5 diopters (D), hyperopia of more than +2.0 D, or astigmatism of more than 0.75D in both eyes. The HRQOL was measured using self-reported versions of 23 item Pediatric Quality of Life Inventory Version 4.0 Generic Core Scales (PedsQL 4.0). A total of 579 (24.7%) adolescents had an uncorrected VA of 20/40 or less. Of those 483 (83.4%) needed vision corrections but only 172 (35.6%) used them. Predictors for glasses included higher parental education levels (OR= 2.73; 95% CI, 1.29-5.77), negative attitude regarding spectacles (OR = 0.49; 95% CI, 0.25-0.97), and poorer uncorrected VA (OR = 31.27; 95% CI, 3.76-260.23). Not use of glasses was associated to lower HRQOL score, psychosocial health (65.91 vs. 70.59; P = 0.028), emotional health (56.85 vs. 63.24; P = 0.012), and social functioning (72.99 vs. 78.60; P = 0.036).

In conclusion in rural China few adolescents meeting the criteria for less than 20/40 vision wear glasses. Despite of the low number there is a negative impact of decrease visual acuity in the quality of life of those individuals.


Anatomic changes associated with axial growth can cause stress on the optic nerve vasculature in a way that makes it more vulnerable to glaucomatous damage. In myopia, retinal vessels are reported be located more temporally suggesting that the central retinal vascular trunk may have shifted from its original location in early development. In this study, the authors investigated the positional change of central retinal vasculature and vascular trunk to deduce the change in the lamina cribrosa (LC) during axial elongation. To capture these changes, the authors measured the angle between the central retinal vascular arcades from the center of the disc (center of the glaucoma progression analysis (GPA) mode, angle ) and from the vascular trunk (angle ) and compared the two angles. Twenty-three otherwise healthy myopic children (46 eyes) were prospectively followed with serial full ophthalmologic examination and axial length measurement every 6 months for 2 years. Using spectral-domain OCT, circle scans centered around the optic disc in the GPA mode, which enabled capturing of the same positions throughout the entire study period, and enhanced depth imaging of the deep optic nerve head complex were performed. Infrared imaging of the circle scans was used to measure the changes in the angles between the first and final
visits. The angle between the major superior and inferior retinal arteries was measured along the circle scan twice: from the center of the circle scan and from the central retinal vascular trunk, respectively. The positional change of the retinal vascular trunk also was measured. Over the study period, the vascular angle measured from the center of the circle scan did not change ($P = 0.247$), whereas the angle measured from the central retinal arterial trunk decreased with axial elongation, indicating that the vascular bundle moved more nasally in the disc ($P < 0.001$). A generalized estimating equation analysis revealed that the factors associated with angle decrease were axial elongation ($P = 0.004$) and vascular trunk dragging ($P < 0.001$). The extent of vascular trunk dragging was associated with axial elongation ($P < 0.001$) and increased border length with marginal significance ($P = 0.053$), but the extent of dragging could not be explained fully by their combination. The major directionality of dragging was mostly to the nasal side of the optic disc, with large variations among participants. Based on their findings, the authors suggested that nasal dragging of the central vasculature may contribute to the vulnerability of the myopic eyes to glaucomatous optic neuropathy.

Longitudinal Changes of Optic Nerve Head and Peripapillary Structure during Childhood Myopia Progression on OCT: Boramae Myopia Cohort Study Report 1

Axial elongation in myopic eyes is accompanied by scleral remodeling of the optic nerve head (ONH) and peripapillary area where glaucomatous changes occur. The authors conducted a prospective study in Korea documenting the longitudinal changes of the ONH and peripapillary tissues during childhood myopia progression using spectral-domain (SD) OCT. The participants underwent fundus photography, SD OCT, and axial length (AXL) measurements every 6 months for 2 years. A total of 23 participants (46 eyes) were recruited, 9 were boys. Mean age was 9.6 yrs. (range 6.7 to 12.5 yrs.). Based on the morphologic features on fundus photographs, masked observers classified each eye into 4 groups based on the ONH shape and the presence of β-zone parapapillary atrophy (PPA): Group A (ONH unchanged without β-zone PPA; 11 eyes), group B (ONH changed without β-zone PPA at baseline; 10 eyes), group C (ONH changed with β-zone PPA at baseline; 15 eyes), and group D (ONH unchanged with β-zone PPA; 10 eyes). The configuration of the border tissue (BT) at the temporal margin of the ONH was assessed, and the ONH parameters, including Bruch’s membrane opening distance (BMOD), border length (BL), and BT angle (BTA), were measured on horizontal SD OCT scans. Group B showed the greatest AXL increase per year (group B > group C > group A = group D; $P < 0.001$). During the follow-up periods, the BT configuration initially was changed from internally oblique to externally oblique (group B) and was stretched, resulting in optic disc ovality and γ-zone PPA development (group C). In group C, BL was increased significantly nasally and BTA was decreased significantly, whereas BMOD re-
mained stable (P < 0.001, P < 0.001, and P = 0.100, respectively). In the multivariate analysis using a generalized linear mixed-effect model, the changes of BL and BTA were associated with axial elongation (P = 0.028 and P = 0.010, respectively). Based on the study findings, the authors concluded that there is development and nasal expansion of γ-zone PPA during myopia progression. During the ONH and peripapillary changes, the BL was increased nasally and the BTA was decreased, whereas the BMOD remained relatively stable. The association of axial elongation with ONH and peripapillary tissue changes may facilitate understanding of the relationship between myopia and glaucoma. This is a much-needed study looking at the childhood myopia progression. However, the groups were not comparable in age or axial length. Group A did not seem to have undergone a significant myopic change and Group D may already have gone through a myopic change. Only group B went through a significant myopic change in the study.

**Lens power in Iranian schoolchildren: a population-based study**

The natural lens is thought to thin and flatten during childhood, which serves as a compensatory factor to increasing axial length to prevent myopic shift (ie emmetropization). Lens powers in infancy can be 43 to 47D, decreasing to 22-23D in young teenagers. Lens thickness does not necessarily help estimate lens power due to changes in the refractive index with growth. This study examined lens power changes in a large cross-sectional study of children. Lens power (LP) was calculated using the Bennett formula which uses cycloplegic refraction, corneal power, anterior chamber depth, lens thickness, and axial length. 4870 children were analyzed with mean age of 9.7 years. Mean LP was 22.86D. In 6 years old mean was 23.48D vs 22.10D in 12 year olds. Mean LP was higher in girls (23.48D vs 22.34D). It was also higher in children with hyperopia (23.25D) compared to myopia (22.64D). Multiple linear regression showed lens thickness, anterior chamber depth, and female associated with increase in LP. Axial length, corneal power, spherical equivalent, and age were associated with lower LP. The slope of reduction in LP decreased between 10 and 12 years of age. Possible environmental exposures/effects were not examined in this study.

**4. VISION IMPAIRMENT**

**Visual impairment and Eye Disease Among Children of Migrant Farmworkers.**
The purpose of this study is to determine the prevalence of reduced visual acuity and ocular disease in the children of migrant farmworkers in Georgia. A retrospective chart review of data acquired by a vision screening was performed on 156 Haitian and Hispanic children of migrant farmworkers attending a summer school in Georgia. Reduced visual acuity at presentation was analyzed and stratified by ethnicity, type of ocular disease, and immediate resolution with refractive correction. The authors found that 20% of migrant farmworker children have a high prevalence of reduced visual acuity in the worse eye. Of those with worse-eye reduced visual acuity, 83% had uncorrected refractive error. The prevalence of uncorrected refractive error from astigmatism and high astigmatism was significantly higher among Hispanics than Haitians. The prevalence of amblyopia suspects among migrant farmworker children was 3%. Of the amblyopia suspects, 80% were anisometropic. The authors concluded that children of migrant farmworkers in Georgia have a higher rate of reduced visual acuity, largely from uncorrected refractive error, when compared to other Hispanic and African American children in the United States with a prevalence more aligned to children in Asian and Latin American countries than school children in the United States. This illustrates the need for improved access to screening and care in this vulnerable population. The study has certain limitations: Due to the retrospective nature of this analysis, the eye charts in each group were not standardized. As such, visual acuity may have been underestimated in 4 to 5 year olds and over estimated in older children using the HOTV charts. Also, there was no additional follow-up to determine the best-corrected visual acuity of patients once they had been wearing their new correction for a few weeks. Furthermore, although the prevalence of uncorrected refractive error was high, this prevalence only accounts for presenting vision; it may not account for children who had but did not bring their spectacles. Finally, because this was a screening measure, amblyopia suspects were referred to follow-up if needed. However, given the transient nature of the population, we were unable to track follow-up visual acuity or response to penalization therapy. Future studies examining long-term visual outcomes in such patients, while logistically difficult, would be worthwhile.

Frequency of Visual Deficits in Children With Developmental Dyslexia.


This was a prospective, uncontrolled observational study from May to October 2016 in an outpatient ophthalmology clinic in 29 children with developmental dyslexia (DD) and 33 typically developing (TD) children. The authors wanted to assess the frequency of visual deficits (vergence, accommodation, and ocular motor tracking) in children with DD compared with a control group. Demographics
included mean age of 10.3 years for the DD children and mean age of 9.4 years for the TD children. The authors report statistically significant accommodation deficits in the DD group compared to the TD group (55% versus 9%, respectively) and statistically significant ocular motor tracking abnormalities in DD group compared to the TD group (62% versus 15%, respectively). Overall, children in the DD group were diagnosed with more than 1 visual deficiency (79%) as compared to children in the TD group (33%) especially abnormalities in ocular motor tracking and accommodation. Reporting statistically significant visual deficiencies in children with DD as compared to TD children, the authors’ suggest that it is important to evaluate visual function in children with dyslexia, including an evaluation of vergence, accommodation, and ocular motor tracking. Limitations of the study is the small sample size and the unmasked examiners. Furthermore, the authors suggest that additional studies should assess if treatment of particular visual deficiencies will help improve visual symptoms for children with DD.

**An Analysis of Parents' Reports on Educational Services for Their Children with Albinism**


The purpose of this study is to gain information from parents in the United States about their children with albinism. The article focuses on information and services related to the education of children with albinism. This article complements a second article in the same journal looking at information and services related to medical care and low vision care. An online questionnaire was used to collect data. Parents had opportunities to submit additional information. One hundred ninety-two families, representing 223 children with albinism from 40 U.S. states, completed surveys. Results revealed that while most children were receiving direct instruction or consultation from teachers of students with visual impairments, many parents were not able to provide information about the level of assessment, reading rates, or the nature of the services. Parents are generally satisfied with services provided as well as their level of involvement in their children’s educational service plans. The article makes recommendations to: 1) provide additional information about educational interventions for infants and children with albinism to physicians who diagnose albinism; 2) provide information to parents about the Individuals with Disabilities Education Act (IDEA) so that they are more aware of which low vision services are available under IDEA’s provisions for medical evaluations and assistive devices; 3) provide support for the social and emotional development of children with albinism; 4) conduct research on educational practices with students with albinism. In addition to other important points, this study highlights the importance of the practitioner partnering with parents of children with autism to ensure parents have a strong foundational understanding of the condition and are aware of services available to them.
Reports from Parents about Medical and Low Vision Services for Their Children with Albinism: An Analysis

The purpose of this study is to gain information from parents in the United States about their children with albinism. The article focuses on information and services related to medical care and low vision care. This article complements a second article in the same journal looking at information and services related to the education of children with autism. An online questionnaire was used to collect data. Parents had opportunities to submit additional information. One hundred ninety-two families, representing 223 children with albinism from 40 U.S. states, completed surveys. The data revealed that the majority of families have no known family history of albinism, and 55.8% of children met criteria for legal blindness. Less than half (48%) of children using optical devices received a clinical low vision evaluation by a specialist. The study highlights the importance of obtaining a medical and clinical low vision evaluation and providing education to families on the value of obtaining both exams. The study also recommends a longitudinal study of the medical services and low vision care provided to these children.

Exploring the Functional Impact of Childhood Vision Impairment: An e-Delphi Study
Susan L. Silveira & Robyn Cantle Moore *Journal of Binocular Vision and Ocular Motility*, 2018; 68:4, 110-121

A new method that assesses both the functional and the clinical impact of childhood vision impairment at various ages, developmental stages, levels of vision loss, and with co-existing disabilities is needed. The purpose of the study is the exploration of the functional impact of childhood vision impairment using the Delphi technique. The Delphi technique uses a series of questionnaires; this study had participants complete three online questionnaires with feedback emailed to them in between the questionnaires. The participants were orthoptists and specialist teachers in vision impairment (STVIs). The outcomes were analyzed for evidence of consensus and stability. The ultimate goal of the study was to develop a visual behavior standard (VBS) that presents an understanding of the child’s current visual function that may not correlate with clinical measurements.

The epidemiology of childhood blindness and severe visual impairment in Indonesia

The magnitude of childhood blindness is unknown in Indonesia, therefore this study aimed to define epidemiological characteristics of childhood blindness in
two parts of Indonesia. A community based program in two areas identified children age 0-15 years. The programs included schools for special education and community based rehabilitation programs. Standard WHO data forms were used, and defined blindness as visual acuity less than 3/60, severe visual impairment as visual acuity 3/60 to less than 6/60, and visual impairment 6/60 to 6/18. Unilateral blindness was excluded. 195 children were assessed, of which 113 had blindness or severe visual impairment. Overall prevalence of blindness/severe visual impairment was 0.25 and 0.23 per 1000 children in the two areas. Prevalence of cataract was 0.07/0.05 per 1000 children (again in the two areas). This suggests there are over 17,000 children with blindness/severe visual impairment in Indonesia, including over 4000 blind from cataracts. This highlights a substantial unmet need for these children including screening programs and access to care.

The Tribal Odisha Eye Disease Study (TOES) 1: prevalence and causes of visual impairment among tribal children in an urban school in Eastern India.

The goal of this study was to estimate the prevalence and causes of visual impairment and other ocular comorbidities among tribal children in an urban school population in eastern India. In this cross-sectional study, vision screening tests were administered to tribal school children. Demographic data, including name, age, sex, home district, height, and weight of each child, and examination data, including unaided and pinhole visual acuity, external eye examination with a flashlight, slit-lamp examination, intraocular pressure (IOP) measurement, and undilated fundus photography, were collected. Children with visual acuity of less than 20/20, abnormal anterior or posterior segment findings, and IOP of >21 mm Hg were referred for further evaluation. Of 10,038 children (5,840 males [58.2%]) screened, 335 (median age, 9 years; range, 6-17 years) were referred. Refractive error was the most common cause of visual impairment (59.52%; 95% CI, 51.97-66.65) followed by amblyopia (17.2%; 95% CI, 12.3-23.6) and posterior segment anomaly (14.88%; 95% CI, 10.2-21.0). The prevalence of best-corrected visual acuity of 20/40 was 0.13%. The prevalence of blindness was 0.03%. Visual impairment among tribal children in this urban residential school in India is an uncommon but important disability.

Emerging trends in childhood blindness and ocular morbidity in India: the Pavagada Pediatric Eye Disease Study 2.
This is population-based cross sectional prevalence survey of children ≤15 years, in South India. One trained medical-social-worker and one field-investigator identified children and brought them to a makeshift clinic in the village school, where they were examined by an ophthalmologist. Children with minor problems were treated on the field and those with major conditions were referred to the pediatric ophthalmologist in the tertiary hospital. The prevalence of childhood ocular morbidity (COM) was 6.54%. The most common problem was refractive error (2.7%). The prevalence of blindness was 0.09%. Main causes of blindness included whole-globe anomalies (25%) and uveal coloboma (25%). Unavoidable causes are still the very common causes of blindness. But there is change in India were cornea used to be the most important cause of blindness.

**Transition from pediatric to adult ophthalmology services: what matters most to young people with visual impairment.**

This is a qualitative study of 17 young people aged 16-19 years with VI (best-corrected acuity logMAR worse than 0.48) and without additional impairments. The study consisted of in-depth, semi structured interviews to elicit their experiences, preferences, and attitudes towards transitioning within health care. Qualitative thematic analysis identified themes related to participants experience of transition. Eight of 17 participants had transitioned out of pediatric ophthalmology services, 7 had not, and 2 were unsure. Two of 8 who had transitioned preferred their prior pediatric service. One patient did not want to transition. Communication and environment were two key components of care associated with greater confidence to self-manage health care in the future as an adult. Emotional attachment to pediatric services/teams was associated with reluctance to transition.

**Visual development During the Second Decade of Life in Albinism.**

The purpose of this retrospective study is to evaluate change in best corrected visual acuity (BCVA) during the second decade of life and the effects of albinism type and extraocular muscle surgery on BCVA in children with albinism. Forty one patients with albinism with clinic visits recording binocular BCVA at least once between the ages of 10 and 13 years (visit A) and again between the ages of 17 and 20 years (visit B) were included. Type of albinism, age at each visit, and interval eye muscle surgeries were recorded for each patient. The study showed that Forty (98%) patients showed BCVA improvement or stability between visits A and B. There was no significant effect of interval extraocular muscle surgery on BCVA. Those carrying either a clinically presumed or molecularly confirmed diagnosis of oculocutaneous albinism types 1B and 2 had the best
visual outcomes, consistent with previous studies. The authors conclude that in
the majority of patients with albinism, significant improvement in BCVA occurs
during the second decade of life. Extraocular muscle surgery was not a signifi-
cant factor in BCVA improvement in albinism. Overall, the assessments support
the finding of improvement of visual acuity in children with albinism at earlier ag-
es and provide new information beneficial in predicting visual outcomes in the
second decade of life. The study is limited by its retrospective nature as well as
the small sample size, which limits the usefulness of data analysis by specific
type of albinism. This is further accentuated by the lack of molecular data on all
patients; knowing the specific causative mutations on all patients would allow
phenotype-genotype correlations. Finally, the patients were not randomly as-
signed to having extraocular muscle surgery in this retrospective study.

Symbol Discrimination Speed in Children With Visual Impair-
ments
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This purpose of this study was to determine whether visual discrimination speed
was slower in children with visual impairments compared to children with normal
vision. Five- to twelve-year-old children with visual impairments due to ocular
dysfunction (VIo; n = 30) or cerebral visual impairment (CVI; n = 17) performed a
speed-acuity test in which they indicated the orientation of Landolt-C symbols as
quickly and accurately as possible. The reaction times for symbols ranging be-
tween -0.3 and 1.2 logMAR relative to acuity threshold were compared with norm-
ative data. To test whether children were already slow in merely detecting
symbols, we also compared their reaction times on a simple visual detection task
(VDT) to normative data. An auditory detection task (ADT) was used to probe for
other, more general deficits. Of the children with visual impairments, 88% had
abnormally long reaction times in the speed-acuity test. This deficit was partly
explained by their reduced acuity, but 40% still needed more time to discriminate
acuity-matched optotypes. Children responded late in the VDT too, especially
those with CVI, but this impairment could not fully account for their slow symbol
discrimination. In children with CVI, reaction times in the ADT were affected as
much as those in the VDT, suggesting more general sensorimotor problems in
CVI. The speed-acuity test offers additional insight in visual impairment. Children
with VIo and CVI are abnormally slow in discerning foveal details. Magnification of
materials is often insufficient to compensate for this deficit, partly because stimu-
lus detection is already hampered. A larger study including multiple children per
ocular diagnoses (retinal abnormalities, nystagmus, strabismus, etc.) would help
elucidate whether certain diagnoses have a higher risk of response delays.

The Tribal Odisha Eye Disease Study (TOES) 1: prevalence and
causes of visual impairment among tribal children in an urban
school in Eastern India.

The purpose of this cross-sectional study was to estimate the prevalence and causes of visual impairment and other ocular comorbidities among tribal children in an urban school population in eastern India. Vision screening tests were administered to tribal school children. Demographic data was collected, and ophthalmic examination performed, including unaided and pinhole visual acuity, external eye examination with a flashlight, slit-lamp examination, intraocular pressure (IOP) measurement, and undilated fundus photography. Children with visual acuity of less than 20/20, abnormal anterior or posterior segment findings, and IOP of >21 mm Hg were referred for further evaluation. Of 10,038 children (5,840 males [58.2%]) screened, 335 (median age, 9 years; range, 6-17 years) were referred. Refractive error was the most common cause of visual impairment (59.52%; 95% CI, 51.97-66.65) followed by amblyopia (17.2%; 95% CI, 12.3-23.6) and posterior segment anomaly (14.88%; 95% CI, 10.2-21.0). The prevalence of best-corrected visual acuity of 20/40 was 0.13%. The prevalence of blindness was 0.03%. The authors concluded that visual impairment among tribal children in their cohort was uncommon. Despite a very low threshold of referral, the overall referral rate was surprisingly small. This may have been related to a selection bias, as children with decreased visual acuity would likely not have enrolled at the school, where the screening tests were performed. This study gives us an insight to some of the trends in visual impairment in different parts of the world.

Low-vision aids improve the visual performance of children with bilateral chorioretinal coloboma.

The purpose of this cross-sectional, interventional case series was to quantify the improvements in visual performance for both distance and near tasks attained by children with bilateral chorioretinal coloboma (CRC) with use of low-vision aids (LVAs). Six children were recruited (median age, 11.5 years; range, 7-17 years), of whom 5 were already using LVAs on a daily basis. Demographic data was collected through a structured questionnaire and review of medical records. Distance and near best-corrected visual acuity, contrast sensitivity, and reading speed were evaluated with refractive correction alone and with the use of LVAs (Keplerian telescopes for distance; handheld magnifiers and a tinted lens [400 nm filter] for near). The use of a Keplerian telescope achieved a significant median improvement in distance best-corrected visual acuity of 0.75 logMAR (95% CI, 0.20-1.20). Contrast sensitivity was also improved across all tested spatial frequencies. Use of near LVAs (hand held magnifiers) resulted in a significant median improvement in near reading acuity of 0.47 logRAD (95% CI, 0.28-0.90), whereas the additional use of 400F provided little benefit (0.04 lo-
gRAD, 95% CI, -0.03 - 0.17). Reading speed at N10 (print size for most school/academic material; equivalent to 0.5 logRAD) also improved, but the results were variable. The authors concluded that LVAs enable meaningful improvements in the visual performance of children with bilateral CRC, allowing noteworthy increases in distance and near visual acuities, as well as good reading speeds at small print sizes. The results regarding reading performance with LVA weren’t as compelling as the improvement in visual acuity. However, this study demonstrates nicely the advantages of low-vision aids in the setting of bilateral visual impairment.

Fitting In or Feeling Excluded: The Experiences of High School Students with Visual Impairments
Glenda Jessup, Anita C. Bundy, Alex Brom, Nicola Hancock

This study compares the experiences of high school students with visual impairments (blind or low vision) in and out of school. The study is part of a larger study examining the social inclusion of high school students with visual impairments. Twelve visually impaired high school students completed the same in-the-moment survey seven times daily for seven consecutive days. The frequencies of their activities, interactions and ratings of internal variables (fitting in, loneliness, enjoyment) were compared in the context of home, school or 'other' (neither home or school). Participants fitted in significantly less and felt significantly less accepted at school than elsewhere. They rated leisure and recreation in 'other' locations as most enjoyable. The authors opine this is due to a greater degree of choice and autonomy in 'other' locations compared to the classroom, where choice and autonomy may be limited for visually impaired students. This article highlights the importance and challenge of social inclusion at school for visually impaired high school students.

5. NEURO-OPHTHALMOLOGY


The authors examined the utility of OKN testing as a bedside tool for quantifying oculomotor dysfunction in the setting of spinocerebellar ataxia in a cohort of 73 genetically confirmed patients. In this prospective study, the authors found that there was a differential response to vertical and horizontal OKN depending on whether the patient had SCA1, 2 or 3. This impairment in response corresponded favorably to the motor disability as evaluated by the International Co-operative
Ataxia Rating Scale and therefore may be a more sensitive measure of determining oculomotor disease in these patients.

**Inclusion of optic nerve involvement in dissemination in space criteria for multiple sclerosis**

The authors examine the inclusion of optic neuritis as a criterion for dissemination in space as part of the revised McDonald criteria for MS using 160 patients with clinically isolated syndrome. Inclusion of symptomatic optic neuritis improved the sensitivity of the McDonald 2017 DIS criteria from 83% to 95% but was less specific from 68% to 57%. When evaluated in patients with clinically isolated syndrome without optic neuritis (of whom there were 31 of the 160), the inclusion of optic neuritis as a criterion did not improve the diagnostic accuracy of the McDonald 2017 criteria. The authors conclude that when considering predilection for development of MS, symptomatic optic neuritis should be included as part of the DIS criteria as it improves the diagnostic accuracy of the McDonald 2017 criteria.

**Detection and characterisation of visual field defects using Saccadic Vector Optokinetic Perimetry in children with brain tumours**

The purpose of this study was to determine the ability of Saccadic Vector Optokinetic Perimetry (SVOP) to detect and characterise visual field defects in children with brain tumours using eye-tracking technology, as current techniques for assessment of visual fields in young children can be subjective and lack useful detail. This was a case-series study of children receiving treatment and follow-up for brain tumours at the Royal Hospital for Sick Children in Edinburgh from April 2008 to August 2013. Patients underwent SVOP testing and the results were compared with clinically expected visual field patterns determined by a consensus panel after review of clinical findings, neuroimaging, and where possible other forms of visual field assessment. Sixteen patients participated in this study (mean age of 7.2 years; range 2.9–15 years; 7 male, 9 female). Twelve children (75%) successfully performed SVOP testing. Of the 4 children in which SVOP failed due to poor eye tracking, one was due to heavy mascara use, one had congenital glaucoma with buphthalmos and cloudy cornea in one eye, one had extremely poor vision and unsteady fixation due to severe optic atrophy, and reason for failure in the fourth patient was not elucidated. SVOP had a sensitivity of 100% and a specificity of 50% (positive predictive value of 80% and negative predictive value of 100%). In the true positive and true negative SVOP results, the characteristics of the SVOP plots showed agreement with the expected visual
field. Six patients were able to perform both SVOP and Goldmann perimetry; these demonstrated similar visual fields in every case. SVOP is a highly sensitive test that may prove to be extremely useful for assessing the visual field in young children with brain tumours, as it is able to characterise the central 30° of visual field in greater detail than previously possible with older techniques. The automated nature of SVOP requires minimal experience to operate the system, children find the test easy with engaging animations and it takes only ~5 minutes to perform. Future studies on longitudinal follow-up of children with visual pathway tumors will help determine repeatability and reliability of the test and demonstrate changes of visual field defects in relation to changes in tumour size over time and response to medical or surgical interventions.

Efficacy and Safety of Low-to –Moderate Dose Oral Corticosteroid Treatment in Ocular myasthenia Gravis.


The purpose of this study is to evaluate the response to corticosteroid treatment as primary therapy for ocular myasthenia gravis. Twenty-nine patients (19 men and 10 women; average age: 49 ± 16.5 years) who were diagnosed with myasthenia gravis were included in the study and started receiving treatment with a corticosteroid. Patients with a blowout fracture, hyperthyroidism, diabetes mellitus, hypertension, cardiovascular disease, or history of strabismus surgery were excluded. Disappearance of diplopia and ptosis were considered a response to treatment. A total of 6 patients were lost to follow-up. Twenty-three of 29 patients (82.6%) were regarded as having presented a response to treatment. The average treatment duration was 3 weeks for patients responding to primary treatment. Eight patients complained of adverse effects from steroid therapy such as heartburn, insomnia, weight gain, and myalgia. The authors conclude that a low-to-moderate dose of an oral corticosteroid may be considered as a primary treatment in ocular myasthenia gravis because the treated patients had a favorable response to the corticosteroid without severe side effects. The study has a lot of limitations: First, the study was retrospective and conducted in a relatively small number of eyes. There was no comparison of the effectiveness and efficacy between corticosteroid treatment and a cholinesterase inhibitor. Second, most patients suffered from diplopia because the study was performed in a neuro-ophthalmology clinic. In ocular myasthenia gravis, ptosis is the most common finding. Thus, there might have been selection bias. However, the study demonstrated the effectiveness of a low-to-moderate dose of a corticosteroid in ocular myasthenia gravis.
Prevalence of Strabismus Among Children With Neurofibromatosis Type 1 Disease With and Without Optic Pathway Glioma.


The purpose of this study is to evaluate the prevalence of strabismus in Neurofibromatosis type 1 (NF-1) by comparing children with normal neuroimaging to those with optic pathway glioma. A retrospective data collection of all children with NF-1 with neuroimaging studies examined at a single medical center between 2000 and 2016. Of the 198 children with NF-1 reviewed, 109 (55%) were male, 121 (61%) had normal neuroimaging, and 77 (39%) had an optic pathway glioma. Mean age at presentation was 6.3 ± 4.7 years and mean follow-up was 4.8 ± 3.1 years. Strabismus was present in 29 (15%) children and was significantly more prevalent in children with NF-1 with optic pathway glioma (21 of 77 [27%]) than in those with normal neuroimaging (8 of 121 [7%], P < .001). Sensory strabismus was only found in children with optic pathway glioma, accounting for most cases (12 of 21 [57%]). A strong association between strabismus and optic pathway glioma is demonstrated by an odds ratio of 5.29 (P < .001). Children with NF-1 with optic pathway glioma have a 4.13 times higher relative risk of developing strabismus than children with NF-1 without it (P = .001). The direction of ocular misalignment in children with NF-1 with optic pathway glioma was not significantly different than that observed in children without optic pathway glioma (P = .197, Fisher's exact test). Only 5 (17%) children with NF-1 with strabismus (3 with optic pathway glioma) underwent corrective surgery to align their eyes. The authors concluded that optic pathway glioma in children with NF-1 is associated with an increased risk of strabismus, especially sensory strabismus. Although exotropia is the most common ocular misalignment associated with optic pathway glioma, the direction of strabismus cannot be used as an accurate predictor for the presence of optic pathway glioma. Many children with NF-1 with strabismus do not undergo corrective surgery. This study's results should be interpreted within the context of its limitations. Because data were collected retrospectively based on chart reviews, it is subject to variability depending on the accuracy and completeness of records. Furthermore, because all children with NF-1 included were examined in a tertiary referral medical center, they may not accurately represent the entire pediatric population of patients with NF-1.

Optic Nerve Head Drusen: An Update
Edward Palmera, Jesse Gale, Jonathan G. Crowstond, and Anthony P. Wellsa, Neuroophth Dec 2018, 42(6), 367–384

Optic nerve head drusen are benign acellular calcium concretions that usually form early in life, just anterior to the lamina cribrosa. Improving imaging using optical coherence tomography suggests they are common and may be present in many clinically normal discs. These drusen may change in appearance in early
life, but are generally stable in adulthood, and may be associated with visual field defects, anterior ischemic optic neuropathy, or rarer complications. Based on long-term clinical data and optical coherence tomography, we propose a refined hypothesis as to the cause of optic disc drusen. Here we summarize recent findings and suggest future studies to better understand the forces involved.

Visual outcomes after chemotherapy for optic pathway glioma in children with and without neurofibromatosis type 1: results of the International Society of Paediatric Oncology (SIOP) Low-Grade Glioma 2004 trial UK cohort

Although survival rates are good, children with optic pathway gliomas (OPG) can experience significant visual impairment. Management decisions are sometimes difficult due to the variable natural history of these tumors. This study aimed to report visual outcomes following chemotherapy for OPG in children with or without neurofibromatosis type 1 (NF1). The authors performed a prospective, multi-center study between 2004 and 2012. 90 children (180 eyes) with complete follow-up and visual acuity outcomes were included. 46 children had NF1 associated OPG and 44 had sporadic OPG. Visual acuity loss was the most frequent indication to initiate therapy in both groups. Average follow-up was 6.5 years. At the start of chemotherapy, 26% and 49% of eyes in NF1 and sporadic groups respectively had VA >= 0.7 logMAR. At completion, in the NF1 group 49% had acuity <=0.2, 23% 0.3-0.6, and 28% had VA>= 0.7 logMAR. In the sporadic group, 32% had <=0.2, 11% 0.3-0.6, and 57% had VA >= 0.7 logMAR. Children with sporadic OPG were significantly less likely to have visual outcomes <= 0.6 logMAR compared to the NF1 group. Overall the two groups had about the same rate of visual acuity improvement, stabilization, or worsening, but the children with sporadic OPG had a poorer visual outcome. Better initial visual acuity, increasing age, absence of post-chiasm tumor, and presence of NF1 were associated with better visual acuity outcomes. Overall timely treatment arrested the decline in VA in most children and some children regained vision.

Ocular Neuromyotonia: Case Reports and Literature Review.

Ocular neuromyotonia is a rare disorder cause by contraction of an extraocular muscle by a damaged nerve leading to delayed muscle relaxation. The authors present 8 patients and review the literature, as well as present an alternative association with low Vitamin D levels. Of the 49 cases in the literature, the patients had an average age of 46 years (range 7-77 years) and were predominantly fe-
male (75%). The most commonly affected nerve was CN 6 (65.3%). The majority of cases were associated with oncological radiation (80%), presenting anywhere from 2 months to 18 years after treatment. In one of the authors’ cases, the ONM complaints disappeared after supplementation with vitamins B12 and D, which suggests that neural conduction along the myelin sheath that results from hypovitaminosis may a possible mechanism. Of the published cases in the literature, 23 of 49 were treated with carbamazepine with an 87.8% success rate. The authors suggest that in the absence of a history of cranial radiation, a neurological cause or thyroid dysfunction should be considered in the workup and that carbamazepine is an effective treatment.

Gene therapy in optic nerve disease


The authors review current gene therapy trials for Leber’s Hereditary Optic Neuropathy as well as other possible modalities for gene therapy. LHON is caused by a point mutation in mitochondrial DNA with 3 common mutations. The 11778 mutation has been the primary focus as it is the most common and the lowest likelihood of spontaneous visual recovery. Adeno-associated viruses type 2 (AAV2) are the vector utilized because of their high efficiency and safety of transduction to inner retinal layers after intravitreal injection. In addition, they have a low risk of tumor formation. Patients (9 eyes) were recruited and given a single dose. No ocular or systemic adverse events were identified as well as no decrease in vision below baseline. However, results showed that there was regression after improvement in the subjects which suggests that gene expression may reduce over time. There are other targets for gene therapy which may help in nerve regeneration such as the mammalian target for rapamycin (mTOR), Rho/Rho associated coiled containing kinase (ROCK), Neuroglobin (Ngb) and the Kruppel-like factor family. The authors summarize that gene therapy is promising. However, in order to be viable the gene expression must persist long enough to have a therapeutic effect, and not succumb to regression. In genetic disorders, the expression would need to have long-term expression. The axons need to be able to take the correct pathway to target neurons in the brain and also because some of these targets are oncogenes and tumor suppressor genes the risk of tumor formation must be addressed.

Retinal and optic nerve changes in microcephaly: An optical coherence tomography study

In this case-controlled prospective study, the authors seek to characterize the optic disc and retinal morphology in 27 patients with microcephaly using handheld OCT. The hypothesis is that given the relationship between ocular and brain development, there may be abnormalities in ocular development in the setting of microcephaly. With respect to the retina, 85% of patients had abnormalities on OCT, 70% with abnormalities of the fovea, and 15% with abnormalities of the retinal periphery. Findings included abnormal foveae, disruption of the ellipsoid zone, and parafoveal thinning. These findings were detectable on funduscopy in only 1/3 of patients. With respect to the optic nerve, 4 patients were noted to have optic nerve hypoplasia both by funduscopy and by OCT. rNFL thinning was also noted. The study highlights the use of OCT to identify ophthalmic changes which may not be readily detectable on clinical exam in patients with microcephaly. However, the etiologies which contributed to microcephaly in these patients were heterogeneous and therefore the utility of applying these OCT findings in differentiating amongst different causes of microcephaly appears to be limited.

Visual stimulation leads to activation of the nociceptive trigeminal nucleus in chronic migraine

Migraine patients may experience photophobia. This prospective evaluation of migraine and control patients evaluated with fMRI for activation of the trigeminal nociceptive pathway in response to visual stimuli. Chronic migraineurs showed enhanced activation of the nociceptive spinal trigeminal nucleus and right superior colliculus when presented with visual stimuli when compared to control patients. Episodic migraineurs complained of aversion to visual stimuli, but the spinal trigeminal nucleus was not activated in the episodic migraine group, only the chronic migraine group. Further confirmation in a larger sample of patients was suggested.

Blood-ocular barrier disruption in patients with acute stroke

The authors serendipitously found that acute stroke patients developed gadolinium leakage into the ocular structures (GLOS), as detected on subsequent MRI. This study retrospectively evaluated acute stroke patients who had been enrolled in the NIH Natural History of Stroke study. These patients had baseline MRI performed with gadolinium, followed by subsequent MRI without contrast (with FLAIR imaging) at 2hrs and 24hrs after the initial MRI. GLOS was present in 76% of patients at the 2hr MRI, and 75% of the patients at the 24hr MRI. Of the patients who had GLOS at the 2hr MRI, 67% of patients had GLOS in the aqueous, 6% in the vitreous, and 27% in both. All patients with GLOS on the 24hr
MRI had vitreous GLOS, and 6% had both aqueous and vitreous GLOS. Patients with vitreous and aqueous GLOS at 2 hours were defined as having "rapid diffuse GLOS" and were found to have larger infarcts, and a higher degree or blood-brain barrier permeability as measured by blood-brain permeability imaging. GLOS was associated with increasing age. Use of tPA had no effect on the presence of GLOS. The authors propose that GLOS suggests disruption of the blood-ocular barrier, and that it may be possible that a common ischemic process triggers blood brain barrier and blood ocular barrier leaks.

Retinal Detachment and Retrobulbar Cysts in a Large Cohort of Optic Nerve Coloboma


This study examined the relationship between retinal detachment and retrobulbar cysts in patients with optic nerve coloboma (ONC) and Morning Glory syndrome (MGS) referred to a specialist children's retina service. 45 patients with ONC and 26 with MGS had an orbital B-scan ultrasound and/or MRI and were assessed independently by two ophthalmologists and a radiologist for the presence of retrobulbar cysts. Retinal detachment was identified clinically with indirect ophthalmoscopy or from fundus photographs. Retinal detachment occurred significantly more often in eyes with MGS than with ONC (53% vs 11%). Retrobulbar cysts were not detected more often in MGS than in ONC (24% vs 27%). Eyes with retrobulbar cysts were more likely to be associated with retinal detachment than those without (39% vs 13%).

This study was limited by its retrospective nature making controlling for confounders difficult, but it does appear that MGS has a higher incidence of both RD and retrobulbar cysts than ONC. The role that retrobulbar cysts play in the development of RD is uncertain.

Handheld Spectral Domain Optical Coherence Tomography Imaging Through the Undilated Pupil in Infants Born Preterm or with Hypoxic Injury or Hydrocephalus


This pilot study investigated the feasibility of undilated SD-OCT imaging of the retina, choroid, and optic nerve in preterm infants and children with neurologic abnormalities. Images were obtained through an undilated pupil of 11 infants/children over 28 imaging sessions, 27 at the bedside without sedation and one under anesthesia. The infants had ROP (n=8), hypoxic ischemic encephalopathy (n=2), or obstructive hydrocephalus (n=1). Pupil sizes ranged from 1.0 to 3.5 mm. The authors captured fovea and optic nerve scans in 25/28 imaging
sessions, with scans of adequate quality to discern prespecified foveal and optic nerve morphology. The choroidal-scleral junction was visible in all but 6 of the 25 sessions. In this study, a highly skilled imager was required to align the handheld imaging system and capture the key structural retinal features through small pupils. Lighter, more compact, and higher speed handheld OCT technology would address this major limitation and hopefully advance the ability to monitor ophthalmic and neurologic microstructural abnormalities, reflecting injury and response to injury in the CNS, in infants with pharmacologically undilated pupils.

**Neuroimaging and endocrine disorders in paediatric optic nerve hypoplasia**


In patients with optic nerve hypoplasia (ONH), early detection of CNS and endocrine disorders is important to prevent severe complications. The incidence of endocrine disorders in patients with ONH varies widely in previous studies. This study aimed to determine the risk factors and association between imaging findings and endocrine disorders. The authors performed a retrospective review of patients between 2006 and 2016 with documented ONH or septo-optic dysplasia. MRI and endocrinology results were reviewed by masked examiners. The MRI protocol used was the same for all patients. 168 patients were identified but 91 of these were excluded due to incomplete data. An abnormal pituitary was seen on MRI in 35.1% and abnormal endocrine results in 37.7%. The incidence of endocrinopathy was 42.1% in bilateral ONH compared to 25.0% in unilateral cases. The sensitivity and specificity of brain MRI as signs of abnormal endocrine status was 67.9% and 83.3%. Agenesis or dysgenesis of the corpus callosum was found in 14.3% and absence of septum pellucidum in 28.6%. The authors conclude that ongoing endocrine evaluations are warranted in children with ONH, whether bilateral or unilateral, and even if MRI findings were normal. However in otherwise normal neurological children with normal endocrine workup, an MRI of the brain could be deferred until later indications arise.

**Natural history of primary paediatric optic nerve sheath meningioma: case series and review**


Optic nerve sheath meningioma (ONSM) is a rare tumor of the optic nerve that is particularly associated with Neurofibromatosis type 2 (NF2). Treatment in the past was commonly surgical resection, but fractionated radiation is more commonly used today. The authors of this paper performed a retrospective case se-
ries of 8 patients with ONSM from 1994-2016 in Switzerland and Australia. There were 6 female and 2 male patients, with mean age of 11. One patient had bilateral tumors. Decrease visual acuity was the most common presenting complaint. 3/9 had acuity less than 20/200. 6/9 had eye movement limitations and 4/9 had proptosis. 2/8 patients had NF2. 6 of the patients were observed while the other 2 received radiotherapy. Two of the observation patients, both presenting with good initial acuity, did not experience tumor growth after long-term follow-up. The other 4 that were observed experienced deterioration of vision. The authors conclude that it is possible that some cases may be observed, but generalized conclusions cannot be made from this small case series.

Relative Afferent Pupillary Defects in Homonymous Visual Field Defects Caused by Stroke of the Occipital Lobe Using Pupillometer

Relative afferent pupillary defects (RAPD) may be detected in patients with occipital lobe lesions. However, no previous report has used an objective technique to record the abnormal pupillary light reflex in such cases. Therefore, we measured the pupillary light reflex objectively in 15 patients with homonymous visual field defects (HVFD) due to occipital stroke using a new pupillometer. This study detected significantly smaller and slower pupillary light reflexes in the contralateral eyes than in the other eyes, which is equivalent to the presence of RAPD in patients with HVFDs caused by retrogenticulate lesions using an objective technique. Our results confirmed those of the previous reports using the swinging flashlight test more objectively.

Cerebellar volume as an imaging marker of development in infants with tuberous sclerosis complex

In this cohort analysis, we studied 1-year-old infants with tuberous sclerosis complex (TSC), correlating volumes of cerebellar structures with neurodevelopmental measures. We analyzed data from a prospective biomarker study in infants with TSC (ClinicalTrials.gov NCT01780441). We included participants aged 12 months with an identified mutation of TSC1 or TSC2. Using MRI segmentation performed with the PSTAPLE algorithm, we measured relative volumes (structure volume divided by intracranial contents volume) of the following structures: right/left cerebellar white matter, right/left cerebellar exterior, vermal lobules I–V, vermal lobules VI–VII, and vermal lobules VIII–X. We correlated relative volumes to Mullen Scales of Early Learning (MSEL) scores. There were 70 participants (mean age 1.03 [0.11] years): n = 11 had a TSC1 mutation; n = 59 had a TSC2
mutation. For patients with TSC2 mutation, for every percentage increase in total cerebellar volume, there was an approximate 10-point increase in MSEL composite score ($\beta = 10.47$ [95% confidence interval 5.67, 15.27], $p < 0.001$). For patients with TSC1 mutation, the relationship between cerebellar volume and MSEL composite score was not statistically significant ($\beta = -10.88$ [95% confidence interval -22.16, 0.41], $p = 0.06$). For patients with TSC2 mutation, there were positive slopes when regressing expressive language and visual reception skills with volumes of nearly all cerebellar structures ($p \leq 0.29$); there were also positive slopes when regressing receptive language skills, gross motor skills, and fine motor skills with volumes of cerebellar right/left exterior ($p \leq 0.014$). Cerebellar volume loss—perhaps reflecting Purkinje cell degeneration—may predict neurodevelopmental severity in patients with TSC2 mutations.

### Spindle activity in young children with autism, developmental delay, or typical development


The aim of the study was to determine whether spindle activity differs in young children with and without autism. The authors investigated differences in spindle density, duration, and oscillatory features in 135 young children with autism, developmental delay without autism (DD), or typical development (TD) and secondarily assessed the dimensional relationship between spindle density and both cognitive ability and social functioning. Compared to TD, both spindle density (Cohen d 0.93, 95% confidence interval [CI] 0.49–1.37) and duration (Cohen d 0.58, 95% CI 0.15–1.01) were significantly decreased in autism. Spindle density was also significantly reduced in autism compared to DD (Cohen d 0.61, 95% CI 0.13–1.09). Decreased spindle frequency in autism compared to both TD (Cohen d 0.47, 95% CI 0.04–0.90) and DD (Cohen d 0.58, 95% CI 0.10–1.06) did not survive correction. The DD group did not differ significantly from the TD group on any spindle parameter. These results, suggesting a relationship between spindle density and autism but not DD, were further illustrated in exploratory analyses, wherein nonverbal ratio IQ (RIQ) and the Vineland Socialization domain standard score were strongly correlated with spindle density in the full sample ($r = 0.33$, $p \leq 0.001$ and $r = 0.41$, $p \leq 0.001$, respectively) but not within group. After nonverbal RIQ was accounted for, the relationship between spindle density and Vineland Socialization remained statistically significant ($r = 0.23$, $p < 0.01$). However, Vineland Socialization scores accounted for the relationship between spindle density and nonverbal RIQ ($r = 0.04$, $p = 0.67$). In a large cohort of young children with autism, spindle density was reduced compared to groups of age-matched children with DD or TD. Alterations in the maturational trajectory of spindles may provide valuable insight into the neurophysiologic differences related to behavior in disorders of neurodevelopment.
Acquired Intermittent Pediatric Horner Syndrome due to Neuroblastoma

This is a case report which involves a 3-month-old male who developed intermittent left upper eyelid ptosis at the age of 1 month that was gradually increasing in frequency and duration. Examination revealed anisocoria and left upper and lower eyelid ptosis, consistent with a left Horner syndrome. Imaging showed a mass in the left superior posterior mediastinum, which was resected, and pathology was consistent with neuroblastoma. Eight months thereafter, the patient underwent left upper eyelid ptosis repair. Cases of infantile acquired Horner syndrome due to neuroblastoma are rare. To the authors’ knowledge, there has only been one case described that presented with intermittent symptoms. The authors report the second case of intermittent acquired Horner syndrome due to neuroblastoma. This case demonstrates the importance of recognizing that Horner syndrome may present with subtle and intermittent symptoms. In a pediatric patient, one should maintain suspicion for neuroblastoma.

Idiopathic Intracranial Hypertension

Perimetry

Detection and characterization of visual field defects using Saccadic Vector Optokinetic Perimetry in children with brain tumors.

This study evaluated the ability of Saccadic Vector Optokinetic Perimetry (SVOP) to detect and characterize visual field defects in children with brain tumors. SVOP testing and results were compared with clinically expected visual field patterns determined by a consensus panel after review of clinical findings, neuroimaging, and where possible other forms of visual field assessment. Sixteen patients participated in this study with a mean age of 7.2 years (2.9-15 years). Twelve children (75%) successfully performed the test with a sensitivity of 100% and a specificity of 50% (positive predictive value of 80% and negative predictive value of 100%). Similar visual fields were found in 6 patients who were able to perform both SVOP and Goldman perimetry. SVOP is a highly sensitive test able to characterize the central 30° of visual field.
Optic Nerve Imaging

Detecting optic nerve head swelling on ultrasound and optical coherence tomography in children and young people: an observational study

Optic nerve elevation can be a sign of intracranial hypertension (IHT), but other causes of pseudopapilledema including high hyperopes, tilted discs, and drusen can confound the diagnoses. In an effort to avoid unnecessary invasive tests, non-invasive imaging modalities such as ultrasound and OCT are routinely being used now to aid in the diagnoses of true versus pseudopapilledema. This retrospective paper looked at children less than 16 years old over a 7-month period in 2016 who underwent evaluation for “suspicous discs”. 61 children were analyzed. Of these 3 were found to have intracranial pathology. One of these three patients were noted to have optic nerve sheath dilation on ultrasound and anterior bowing of Bruch’s membrane on OCT. Increased nerve fiber layer thickness in at least one sector was noted in two cases. The results suggest that ultrasound and OCT can be insufficient to reliably detect all cases of IHT. However, all three cases with intracranial pathology did have significant points in their presenting or medical history. Therefore the authors conclude that the medical history and symptoms are important in suspicious cases and to not rely exclusively on eye test results.

Optic Nerve Head Parameters Measured with Spectral-Domain Optical Coherence Tomography in Healthy Turkish Children: Normal Values, Repeatability, and Interocular Symmetry
Ozge Yabas Kiziloglua, Okan Toygara, Baha Toygara, Ali Murat Hacimustafaoglub, Neuroophth. April 2018, 42(2), 139–145

To determine normal values, repeatability, and interocular symmetry of optic nerve head measurements, three spectral-domain optical coherence tomography (SD-OCT) scans were obtained from 128 healthy Turkish children aged 5–17 years consecutively and prospectively. The mean disc area, rim area, cup volume, cup to disc area ratio, and vertical and horizontal cup to disc ratios were 2.30 ± 0.42 mm2, 1.84 ± 0.45 mm2, 0.09 ± 0.10 mm3, 0.20 ± 0.13, 0.37 ± 0.17, and 0.45 ± 0.20, respectively. The intraclass correlation coefficients were >0.9 for repeatability and >0.75 for interocular correlation. Interocular differences were not statistically significant (p > 0.05). Normal pediatric SD-OCT measurements of the optic nerve head are presented, which showed excellent repeatability and no interocular difference.
Retinal and optic nerve changes in microcephaly: An optical coherence tomography study
Eleni Papageorgiou, Anastasia Pilat, Frank Proudlock, Helena Lee, et al.
Neurology August 2018;91:e571-e585

This was a prospective case-control study to investigate the morphology of the retina and optic nerve (ON) in microcephaly. The study included 27 patients with microcephaly and 27 healthy controls. All participants underwent ophthalmologic examination and handheld optical coherence tomography (OCT) of the macula and ON head. The thickness of individual retinal layers was quantified at the fovea center and the parafovea (1,000 μm nasal and temporal to the fovea). For the ON head, disc diameter, cup diameter, cup-to-disc ratio, cup depth, horizontal rim diameter, rim area, peripapillary retinal thickness, and retinal nerve fiber layer thickness were measured.

Results showed seventy-eight percent of patients had ophthalmologic abnormalities, mainly nystagmus (56%) and strabismus (52%). OCT abnormalities were found in 85% of patients. OCT revealed disruption of the ellipsoid zone, persistent inner retinal layers, and irregular foveal pits. Parafoveal retinal thickness was significantly reduced in patients with microcephaly compared to controls, nasally (307 ± 44 vs 342 ± 19 μm, p = 0.001) and temporally (279 ± 56 vs 325 ± 16 μm, p < 0.001). There was thinning of the ganglion cell layer and the inner segments of the photoreceptors in microcephaly. Total peripapillary retinal thickness was smaller in patients with microcephaly compared to controls for both temporal (275 vs 318 μm, p < 0.001) and nasal sides (239 vs 268 μm, p = 0.013). The authors conclude that retinal and ON anomalies in microcephaly likely reflect retinal cell reduction and lamination alteration due to impaired neurogenic mitosis. OCT allows diagnosis and quantification of retinal and ON changes in microcephaly even if they are not detected on ophthalmoscopy.

Bruch's membrane opening on optical coherence tomography in pediatric papilledema and pseudopapilledema
Thompson AC, Bhatti MT, El-Dairi MA J AAPOS. 2018 Feb;22(1):38-43.e3

This goal of this paper was to determine whether the diameter of Bruch's membrane opening (BMO) can distinguish mild papilledema from pseudopapilledema using optical coherence tomography (OCT). The medical records of pediatric patients with pseudopapilledema due to optic nerve head (ONH) drusen, patients with papilledema, and normal control subjects were retrospectively reviewed. All eyes underwent OCT imaging of the BMO and retinal nerve fiber layer (RNFL). Transverse horizontal diameter of the BMO and papillary height were measured. Mean BMO, papillary height, and RNFL were compared and receiver operating characteristic (ROC) curves were used to calculate the area under the curve (AUC) and determine BMO and RNFL cut-offs for papilledema and pseudopapilledema. A total of 90 eyes of 90 subjects were included: 58 with pseudopapilledema, 19 with papilledema, and 13 controls. In eyes with papilledema, mean BMO, papillary height, and RNFL decreased.
as papilledema resolved (1893.8 vs 1582.2 [P = 0.0003], 193.0 vs 108.9 [P < 0.0001], 893.3 vs 695.5 [P = 0.0007], respectively.). Eyes with mild papilledema had greater mean BMO and RNFL than those with pseudopapilledema and controls (1893.8 vs 1541.9 vs 1628.8 [P < 0.0001, P = 0.0265] and 193.0 vs 108.7 vs 104.1 [P < 0.0001, P < 0.0001], resp.). Papillary height in mild papilledema was similar to pseudopapilledema but greater than controls (893.3 vs 863.2 vs 593.5 [P = 0.47 and P = 0.0001], resp.). ROC showed good diagnostic discrimination for BMO (AUC = 0.81; 95% CI, 0.70-0.92) and RNFL (AUC = 0.96; 95% CI, 0.93-1.0) in distinguishing mild papilledema from pseudopapilledema. The horizontal transverse diameter of BMO is enlarged in eyes with mild papilledema and narrows as papilledema resolves. In conclusion, the authors note that BMO and RNFL can be used together to help distinguish mild papilledema from pseudopapilledema in children.

Myasthenia Gravis

Ocular Myasthenia gravis: an update on diagnosis and treatment

Ocular myasthenia gravis (OMG) typically presents with pupil sparing ptosis and/or diplopia. It can be challenging to make the diagnosis because OMG can overlap with other efferent ophthalmic conditions and it has a lower rate of seropositivity to AChR antibodies compared with the systemic form. Variability in ophthalmoplegia, Cogan’s lid twitch to induce ptosis, and assessment of orbicularis function are some ways to clinically elucidate the diagnosis. Nonpharmacologic testing includes the ice and rest tests. Edrophonium can be used in the clinic and has a sensitivity of 88-97% in the detection of OMG. Serologic testing can include AChR antibodies although they are only present in about half of the patients with OMG. LDL-related receptor-related protein 4 antibodies are found in 1-5% of all patients with MG and patients with positivity tend to have a milder course. Muscle-specific tyrosine kinase antibodies are present in 1-10% of patients and are more prevalent in women. Anti-MuSK positive patients have similar incidence of ophthalmic findings as those with AChR-positive antibodies but the ocular symptoms tend to be milder. 10% of patients with MG will be seronegative for all 3 antibodies. Single fiber EMG is the most useful test for patients with OMG especially when seronegative. Sensitivity for OMG is 80% and is usually performed on the orbicularis. It can also predict the severity of the disease. CT or MRI of chest should be done in all patients to assess for thymoma. In addition, 15% of patients diagnosed with MG will have another autoimmune disorder, most commonly thyroid dis-
ease, followed by SLE and RA. It is more common in patients with early onset disease and thymic hypoplasia. Treatment is commonly with pyridostigmine and in OMG ptosis improves more than motility deficits. Immunosuppressive agents such as prednisone may help to reduce symptoms and in some studies treatment of OMG early on may reduce generalization of the disorder. Azathioprine is most frequently used as an SSA in OMG. Mycophenolate mofetil can be used as an adjunct to steroids in the treatment of OMG. Thymectomy has not been recommended in OMG without thymoma as it has not been shown to prevent generalization or improvement of disease.

The article reviews the diagnostic criteria for OMG and the treatment modalities available.

Optic Neuritis

Pediatric Optic Neuritis
Sharon S. Lehman and Judith B. Lavrich Curr Opin Ophthalmol 2018 29: 419-422 (Sept 2018)

The authors review the challenges faced by clinicians in the diagnosis and management of pediatric optic neuritis. Most treatment has been guided by adult studies that have been performed. However, the clinical presentation differs in children including bilateral optic nerve swelling, preceding viral illness and more significant visual deficit. On OCT evaluation the nerve fiber layer and ganglion cell layer are reduced in thickness. Using OCT, VEP and serologic testing for myelin oligodendrocyte glycoprotein antibodies (MOG-Abs) is associated with demyelinating diseases other than MS in adults and children. Aquaporin 4 (AQP4-IgG or NMO-IgG) is specific for NMO. The serologic markers may delineate which patients will have more relapses and greater disability. In children with NMO aggressive therapy is necessary to prevent damaging relapses as these patients have a higher risk of disability. The paper highlights the challenges and the possible diagnostic and treatment tools that may be important in the future although prospective studies are warranted.

6. NYSTAGMUS

Longitudinal Studies and Eye-Movement-Based Treatments of Infantile Nystagmus Syndrome: Estimated and Measured Therapeutic Improvements in Three Complex Cases

Infantile Nystagmus Syndrome (INS) is difficult to accurately differentiate from fusion maldevelopment nystagmus syndrome clinically. Eye-movement date
Long-Term Follow-up of Spasmus Nutans
Rupin N. Parikh, John W. Simon, Jitka L. Zobal-Ratner & Gerard P. Barry
*Journal of Binocular Vision and Ocular Motility*, 2018; 68:4, 137-139

Spasmus nutans is an acquired asymmetric, fine amplitude, high frequency nystagmus commonly accompanied by head bobbing and torticollis. The majority of cases present within the first year of life with spontaneous resolution by 4 years of age. Rarely spasmus nutans is associated with CNS lesions and patients commonly undergo neuro-imaging. Twenty-two patients with spasmus nutans were included in the study with an equal number of females and males. The series investigated the evolution of clinical findings. The authors found that the nystagmus associated with spasmus nutans does not resolve as quickly as reported in the literature. The authors only encountered the classic triad in 4 of the 22 patients. There was an association with developmental abnormalities and Down syndrome with spasmus nutans. Strabismus occurred in 64% of patients in this study, which has not been defined as a classic characteristic. Despite finding zero incidence of a space occupying lesion on neuro-imaging the authors still recommend scanning all patients with spasmus nutans.

Clinical and ocular motor complications of extraocular muscle extirpation for infantile nystagmus syndrome

In this paper, the authors describe the effects of extraocular muscle extirpation performed after previous eye muscle surgery in a 20-year-old woman with infantile nystagmus syndrome (INS) for whom they have 19 years of follow-up data. In addition to clinical exams, eye movement data analysis was carried out using the eXpanded Nystagmus Acuity Function (NAFX) and longest foveation domain (LFD). The patient re-presented to the authors at age 20, 2 years after bilateral anterior myectomy of the horizontal rectus muscles, bilateral anterior nasal transposition of the inferior oblique muscle, and bilateral superior oblique recessions. Evaluation revealed deterioration in nystagmus at lateral gaze angles, new incomitant strabismus with severe loss of convergence, limited ductions, saccadic hypometria, slow saccades, and hypo-accommodation. Also, there was a pre- to post-extirpation minimal change of 21% in her peak NAFX, a 50% decrease in LFD, plus a predominant, asymmetric, multiplanar oscillation. It appears that in this patient, horizontal extirpation failed to abolish the nystagmus
and caused significant, new, symptomatic deficits interfering with many of the patient's visual functions. The authors suggest that it is premature to consider this technique to treat INS and the procedure may risk inducing symptomatic deficits.

**Visual functioning in adults with Idiopathic Infantile Nystagmus Syndrome (IINS).**


The NEI Visual Function Questionnaire (VFQ-25) has been validated to assess the quality of life for many different ophthalmic conditions. In this manuscript, the authors investigate the impact of infantile nystagmus syndrome (INS) on the quality of life in adults using the VFQ-25. Of the 38 patients recruited, 35 completed the questionnaire. The overall scores were lower than the “normal” score. There was no association of the scores with the level of near or distance visual acuity and the scores for near and distance activities did not differ significantly. The effect of nystagmus on quality of life was similar or worse than other diseases affecting vision, including AMD, diabetes and optic neuritis. The authors postulate that although participants reported reasonable social functioning scores, the substantial effect of IINS in this study was on mental health, role difficulties, and well-being, to a greater extent than would be expected from the documented level of visual acuity.

**The role of Superior oblique Posterior Tenectomy Along With Inferior rectus recessions for the Treatment of Chin-up Head Positioning in Patients With Nystagmus.**


The purpose of this retrospective study is to evaluate the clinical outcomes of bilateral superior oblique posterior 7/8th tenectomy with inferior rectus recession on improving chin-up head positioning in patients with horizontal nystagmus. The medical records were reviewed from 2007 to 2017 for patients with nystagmus and chin-up positioning of 15° or more who underwent combined bilateral superior oblique posterior 7/8th tenectomy with an inferior rectus recession of at least 5 mm. Thirteen patients (9 males and 4 females) were included, with an average age of 7.3 years (range: 1.8 to 15 years). Chin-up positioning ranged from 15° to 45° degrees (average: 30°). Three patients had prior horizontal muscle surgeries, 1 for esotropia and 2 for horizontal null zones causing anomalous face turns. Ten patients underwent other concomitant eye muscle surgery: 3 had esotropia, 1 had exotropia, and 2 had biplanar nystagmus null point requiring a horizontal Anderson procedure. Four patients underwent simultaneous bilateral medial rectus tenotomy and reattachment. All patients had improved chin-up positioning. Eight patients had complete resolution, whereas 5 had minimal residual chin-up positioning. Three patients developed an eccentric horizontal gaze null point with compensatory anomalous face turn with onset 2 weeks, 2 years, and 3 years.
postoperatively. Average follow-up was 42.7 months. No postoperative pattern deviations, cyclodeviations, or inferior oblique overaction were seen. No surgical complications were noted. The authors conclude that bilateral superior oblique posterior 7/8th tenectomy in conjunction with bilateral inferior rectus recession is a safe and effective procedure for improving chin-up head positioning in patients with horizontal nystagmus with a down gaze null point. The study limitations include being a retrospective study without a comparative surgical group. Furthermore, torsion was assessed only by fundoscopic examination.

**Characteristics and Long-term follow-up of Isolated Vertical Nystagmus in Infancy.**


The purpose of this study is to determine the clinical characteristics and long-term outcomes of infants who presented with isolated vertical nystagmus. The medical records of 114 infants who were diagnosed as having nystagmus from 1996 to 2016 were screened. Patients with vertical nystagmus within the first year of life who had unremarkable magnetic resonance imaging of the brain and demonstrated age-appropriate visual behavior were included. The parents of the patients in the final study cohort were contacted by telephone to obtain long-term follow-up information. Eight patients comprised the final cohort. Vertical nystagmus was first observed at a mean age of 1.4 months (range: 1 to 2.5 months) and resolved in 87.5% of patients at a mean age of 3.8 months (range: 2 to 10 months). Vertical nystagmus was intermittent in 62.5%, upbeat in 62.5%, and pendular in 37.5% of patients. One patient's nystagmus did not resolve. Seventy-five percent of patient guardians participated in the telephone questionnaire. The mean age of patients at follow-up was 3.5 years (range: 0.5 to 8.1 years). Isolated iris transillumination was discovered in one patient without other features of albinism. Fifty percent of patients had speech delay requiring intervention. No other developmental delays or general medical conditions were identified. In a cohort of otherwise neurologically intact male infants with vertical nystagmus but age-appropriate visual behavior and unremarkable neuroimaging studies, the authors found a high rate of resolution of nystagmus within the first year of life. There was no emergence of significant ophthalmic or neurologic impairment; however, speech delay was noted in half of the patients who could be reached for follow-up. Further studies that perform longitudinal ophthalmic and neurological assessments will be required to confirm these initial findings.

The current retrospective study has several limitations. Clinical observation of age-appropriate fixation behavior and structural ophthalmic examinations were demonstrated in all patients and excluded significant retinal or optic nerve pathology; therefore, further testing with ERG was not performed universally. Cases of mildly impaired visual acuity from subtle macular or optic nerve pathology that may have been identified with optical coherence tomographic imaging of the retina or optic nerve could have been missed. Although the presence of neurological signs and symptoms was elicited during the neuro-ophthalmologist's history and
clinical examination, formal neurological examinations were not performed. All patients received an MRI of the brain, but an EEG was not performed universally.

Simulation of Oscillopsia in Virtual Reality

Patients with acquired nystagmus commonly have oscillopsia, which can be debilitating for them. The patients with oscillopsia can have associated nausea, vertigo, and loss of balance. Patients feel isolated and neglected. The aim of the study was to create a virtual reality (VR) simulation of oscillopsia to aid in communication with others what a patient with oscillopsia perceives. Eye tracking hardware was used to record different nystagmus eye movements which were then applied to a virtual reality app for smartphones. Users with nystagmus or oscillopsia can then utilize the app to understand and appreciate what others experience day to day. The apps purpose is to raise awareness and aid in communication.

Does eye velocity due to infantile nystagmus deprive visual acuity development?

This paper used eye movement recordings of young children to determine whether eye velocity from infantile nystagmus (IN) deprives the developing visual system of normal visual acuity. The video-oculography recordings and visual acuity measurements (including Teller cards) of 15 children ≤6.0 years of age with IN without visual sensory disease (idiopathic IN) were reviewed retrospectively. Eye velocity that would limit visual acuity development was predicted from both empirical adult data adjusted for age and a temporal limitation model using published photoreceptor density data with age. Foveal alignment onto a target was measured in 5 subjects using confocal retinal imaging. All subjects had periods (85-2440 ms) during which eye velocity was below the limit that would reduce age-appropriate visual acuity. The percentage of time eye velocity was below the limit varied by 4%-54% across all eye movement recordings. Eye movement metrics (eye position variability, average eye velocity, maximum duration of foveation, and the nystagmus optimal foveation fraction) correlated poorly with age or with age-corrected visual acuity ($r^2 < 0.27$ for each metric). Longitudinal visual acuity development overlapped between subjects with different nystagmus waveforms. Eye velocity was not predicted to completely deprive visual acuity development in subjects with idiopathic IN. The authors concluded that nystagmus may decrease visual acuity development in children with idiopathic IN by interfering with visual-cortical development in the context of increased visual noise due to image motion with imprecise foveation.

7. PREMATURITY.
**Ophthalmic Features of Premature Infants**

Comparison of optic disk features in preterm and term infants.


The purpose of this retrospective study was to compare the optic disk features of preterm and term infants. Digital fundus images of preterm infants were compared with those of infants born at term, imaged within 1 week of birth. The optic disk horizontal diameter to vertical diameter ratio, the disk-macula to disk-diameter ratio, and the presence or absence of double ring sign was noted. Images of 649 infants (324 preterm and 325 term) were analyzed. Of the preterm infants, 129 (40%) had a complete double ring sign, compared to 4% in term infants. The double ring was seen more frequently in infants of European descent and was more common with younger gestational age. The mean horizontal to vertical disk diameter in preterm infants on first examination was $0.75 \pm 0.063$, increasing to $0.80 \pm 0.069$ at final examination. Term infants had a horizontal to vertical disk diameter ratio of $0.79 \pm 0.064$. At final examination, the ratio of disk-to-macula distance to the horizontal disk diameter was 3.9 in preterm infants and 3.7 for term infants. This cohort of preterm infants often had a double ring sign around the optic disk in the absence of optic nerve hypoplasia. Preterm disks tend to be more vertically oval, and become less oval closer to term. The mean disk-to-macula to disk-diameter ratio among normal preterm infants was higher than previously reported. Despite its retrospective nature this large-sample study highlights that the mere presence of a double ring does not warrant further investigation in preterm infants unless other features of optic nerve hypoplasia are present.

**Visual Function and Fundus Morphology in Relation to Growth and Cardiovascular Status in 10-Year-Old Moderate-to-Late Preterm Children**


This prospective cohort study from Sweden examined 33 (10 girls) former moderate-to-late preterm (MLP) children at the age of 10 and compared them to 28 age- and sex- matched controls. The goal was to evaluate for any differences visual function and fundus morphology between these groups in relation to growth, metabolic status, and blood pressure. The authors found that the former MLP children were more likely to have myopia, smaller optic disc area, smaller rim area, fewer branching points, and higher index of tortuosity of the retinal vasculature than their full term counterparts. There was some association of refraction and arteriole tortuosity with IGF-1 levels and of leptin/adiponectin ratio to tortuosity of the veins. The authors concluded that MLP is associated with changes
in refraction and fundus structure. The authors point out the main limitations of small sample size and high patient drop out rate. This paper is a reminder that MLP children can also have ocular complications and should be counseled about these risks.

**Relationship between Retinal Thickness Profiles and Visual Outcomes in Young Adults Born Extremely Preterm: The EPI-Cure@19 Study.**


Children born preterm are at increased risk of developing a range of ocular and vision disorders later in life. It is known that foveal reflex is reduced in premature infants and that several spectral-domain (SD) studies have shown abnormal foveal contour, absence of foveal depression and retention of inner retinal layers at the foveal center and macular edema. This is the first study correlating the retinal findings to visual function in adults born extreme preterm (EP), before 26 weeks of gestation. All data for this study was obtained from EPICure study, large well-characterized study on young adults born before 26 weeks of gestation, as part of a long-term follow-up study called the EPICure@19 study. Extreme preterm participants were aged 18 to 20 years and a full-term born age-matched comparison group was recruited for assessment. A total of 354 eyes (226 eyes of former EP infants and 128 age-matched full-term control eyes) from 177 young adults were evaluated. Among EP participants, 50% of eyes (112/226) were not previously diagnosed with retinopathy of prematurity (ROP), 38% of eyes (84) had ROP not deemed to require treatment in the neonatal period, and 13% of eyes (30) had neonatal cryotherapy or laser ablation for ROP.

Subjects underwent eye examinations including best-corrected visual acuity (BCVA) and Heidelberg Spectralis macular SD OCT imaging. Retinal layers were auto-segmented and thickness profiles were computed at the fovea by the instrument software. Compared with control eyes, the inner and outer retinal layers of EP eyes were significantly thicker and BCVA was significantly reduced. Retinal layer thicknesses and BCVA were similar for untreated EP eyes and those without neonatal ROP. In contrast, treated eyes had increased inner and outer retinal layer thickness and decreased vision. Inner retinal layer thickness was moderately correlated with worse BCVA ($r = 0.30$, $P < 0.001$), but outer retinal layer thickness was not ($r = -0.01$, $P = 0.80$). Multivariate regression indicated ganglion cell layer thickness was a significant independent predictor of BCVA. Extremely premature birth influences maturation of the fovea and visual outcomes into early adult life. Increased ganglion cell layer thickness was associated with worse BCVA. Eyes requiring neonatal treatment for ROP had associated worse BCVA at the age of 19 years. Of note, it is interesting that these EPs when compared to full-term controls did not have a significant difference in refractive error.

**Vitreous Bands Identified by Handheld Spectral-Domain Optical**
Coherence Tomography Among Premature Infants

This was a prospective cohort study conducted from 2015, to 2017 at 2 university-based neonatal intensive care units. Seventy-three premature infants who required routine ROP screening examination were recruited. Of note, associations between the presence of vitreous bands in premature infants with ROP diagnoses and the presence of other vitreoretinal SD-OCT findings were investigated. Of the 73 infants recruited, 6 infants' parents withdrew their children from the study, and 2 infants were too hemodynamically unstable for imaging, leaving a total of 65 participants. Of these, 32 (49%) were female, 36 (55%) were white, 10 (15%) were Hispanic, 3 (5%) were Native American, 4 (6%) were African American, 4 (7%) were Asian/Pacific Islander, and 8 (12%) were other. The mean (SD) gestational age was 28 (2.7) weeks, the mean (SD) birth weight was 997 g (286 g), and the mean (SD) postmenstrual age at imaging was 34 (3) weeks (mean [SD] total of 3 [2] imaging sessions). Comparing the 24 infants (37%) who had a right eye vitreous band at any time with the 41 (63%) who did not, no difference in mean birth weight, gestational age, postmenstrual age at imaging, sex, or race/ethnicity was identified. No associations with ROP stage (eg, in 6 [25%] infants with vitreous bands vs 4 [9.8%] in those without; P = .23), presence of plus disease (2 [8%] vs 2 [5%]; P = .84), or type 1 ROP (3 [12%] vs 3 [7%]; P = .66) were identified. Vitreous bands were associated with epiretinal membrane detected on SD-OCT (P = .001) with an odds ratio of 9.4 (95% CI, 2.8-31.3) in 15 [62%] infants with vitreous bands vs 6 [15%] in those without. Vitreous bands were also associated with cystoid macular edema (in 15 [62%] infants with vitreous bands vs 1 [27%] in those without; P = .005) with an odds ratio of 4.5 (95% CI, 1.5-13.3). In summary, the development of vitreous bands was associated with both cystoid macular edema and epiretinal membrane and suggests a tractional pathogenesis to these entities among premature infants. There was not a direct association between vitreous bands and severe ROP. The authors noted that additional studies are needed to determine whether vitreous bands represent subclinical hyaloidal organization leading to retinal detachment in advanced ROP.

Visual and Hearing Impairments After Preterm Birth
Mikko Hirvonen, Riitta Ojala, Paivi Korhonen, et al. Pediatrics August 2018; 142 (2) e:20173888

Pre-term birth is associated with significant hearing loss and visual impairment. The aim of the study was to determine the incidence of sensory impairments in a large national birth cohort and to establish prenatal and neonatal risk factors predictive of these disabilities. The authors used the medical birth registry in Finland between 1991 and 2008 which contains information about the gestational age (GA) of the baby at birth as well as weight. The children were divided into 3 GA
subgroups: 1) VP which is less than 32 wks gestation; 2) MP which is 32 through 33 wks gestation; 3) LP 34 wks up to 37 wks gestation and 4) term which is 37 wks or greater of gestational age. Diagnoses of sensory disturbances were obtained through ICD coding in the hospital discharge register and Social Insurance Institution. The incidence of sensory impairments decreased with advancing GA at birth ($p<0.001$). The most prominent risk factors for impairment were intracranial hemorrhage and convulsions. VP and LP were associated with increased risk of hearing loss, while VP (OR = 1.94), MP (OR=1.42), and LP (OR = 1.31) predicted an increased risk of visual impairment. Other factors associated with visual impairment included maternal smoking and mother being over the age of 40. Strabismus and refractive disorders decreased with increasing GA at birth. The strength of the study derives from the large study population, duration of the study period, quality of data reported in the Finish medical system, and the ability to link different databases within the national medical system. Weaknesses of the study include the unknown number of undiagnosed disabilities, accuracy of the coding, and the time delay between the registry data and the publication of the study. Overall, the study provides valuable predictive information for medical providers and families with pre-term babies and suggests that physicians should have a low threshold to refer children born prematurely to evaluate for sensory disabilities.

**Handheld Spectral Domain Optical Coherence Tomography Imaging Through the Undilated Pupil in Infants Born Preterm or with Hypoxic Injury or Hydrocephalus**


This pilot study investigated the feasibility of undilated SD-OCT imaging of the retina, choroid, and optic nerve in preterm infants and children with neurologic abnormalities. Images were obtained through an undilated pupil of 11 infants/children over 28 imaging sessions, 27 at the bedside without sedation and one under anesthesia. The infants had ROP (n=8), hypoxic ischemic encephalopathy (n=2), or obstructive hydrocephalus (n=1). Pupil sizes ranged from 1.0 to 3.5 mm. The authors captured fovea and optic nerve scans in 25/28 imaging sessions, with scans of adequate quality to discern prespecified foveal and optic nerve morphology. The choroidal-scleral junction was visible in all but 6 of the 25 sessions. In this study, a highly skilled imager was required to align the handheld imaging system and capture the key structural retinal features through small pupils. Lighter, more compact, and higher speed handheld OCT technology would address this major limitation and hopefully advance the ability to monitor ophthalmic and neurologic microstructural abnormalities, reflecting injury and response to injury in the CNS, in infants with pharmacologically undilated pupils.
Little comprehensive data exists on visual outcomes in adult former very preterm or very low birthweight (VLBW) infants. This study looked at visual outcomes of VLBW infants born in 1986 in New Zealand, before ROP treatment was available, and compared them with healthy term born controls. 229 patients (ages 27-29 years) were assessed over a 2 day period along with 100 controls. Data included visual acuity, glasses prescriptions, contrast sensitivity, autorefraction, retinal photographs, and a questionnaire of vision-related activities. 45 of the patients had a history of ROP, and these subjects had a reduced visual acuity compared to both those without ROP and controls. There were no significant differences in myopia except for cases of high myopia (>5D) which was heavily weight towards those with history of ROP or <1000g birth weight. Results were compared to data collected when the patients were 7-8 years old and found the rates of poor visual acuity were stable. Also the rates of mild myopia increased regardless of whether there was a history of ROP. The VLBW cohort did report more difficulties with everyday activities due to eyesight and less frequently were drivers.

**Prematurity and Outcomes**

**8. ROP**

**ROP and Telemedicine/Screening**

Implementation of a Critical Prediction Model Using Postnatal Weight Gain, birth Weight, and gestational Age to Risk Stratify ROP.


The purpose of this study is to develop a simple prognostic model using postnatal weight gain, birth weight, and gestational age to identify infants at risk for developing severe retinopathy of prematurity (ROP). The medical records from two tertiary referral centers with the diagnosis code "Retinopathy of Prematurity" were evaluated. Those with a birth weight of 1,500 g or less, gestational age of 30
weeks or younger, and unstable clinical courses were included. Multivariate regression analysis was applied to transform three independent variables into a growth rate algorithm. Seventeen of 191 neonates had severe ROP. Weight gain of at least 23 g/d was determined as a protective cut-off value against development of severe ROP. This value maintained 100% sensitivity with 62% specificity to ensure all neonates who require treatment would be captured. Overall, the Omaha (OMA)-ROP model calculated a 58% reduction in eye examinations within the cohort. The authors concluded that inclusion of postnatal growth rate in risk stratification will minimize the number of eye examinations performed without increasing adverse visual outcomes. The OMA-ROP model predicts neonates who gain less than 23 g/d are at higher risk for developing severe ROP. Although promising, larger cohort studies may be necessary to validate and implement new screening practices among preterm infants. This study is not without limitations. Similar to previously proposed models, the OMA-ROP model was developed from tertiary academic hospitals where infants have a higher ROP risk profile. Therefore, this cohort may not represent the average demographic of the national at-risk neonatal population. Furthermore, our findings are not applicable to infants in developing nations where differences exist in health care systems, patient demographics, and a cohort of older and larger infants who develop ROP and who may represent a different ROP risk profile. Accurate assessment of gestational age may not even be possible in some regions. Both the CO-ROP model and the OMA-ROP model screen based on lower-than-predicted weight gain. Therefore, an infant with higher-than-average weight gain due to non-physiologic reasons (edema, sepsis, or hydrocephalus) could theoretically be missed. Of the current proposed postnatal weight gain models, the WINROP is unique in its identification of such infants. Similarly, clinical factors that cause weight gain but are not associated with increased IGF-1 may generate false-negative signals and should be further assessed.

Development of Modified Screening Criteria for Retinopathy of Prematurity: Primary Results From the Postnatal Growth and Retinopathy of Prematurity Study.


This is a retrospective multi center cohort study of the incidence and early course of retinopathy of prematurity (ROP) from infants having ROP screening from 29 hospitals in the United States and Canada from 2006 to 2012. The authors performed a secondary analysis of the G-ROP study data. Of note, the data collection was standardized with a rigorous certification process for interpretation of medical records. To be enrolled in the study, the infant had to meet 1 of 2 conditions: (1) either eye met criteria for the ETROP type 1 or type 2 ROP or under-
went treatment for ROP or (2) both eyes had mature retinal vasculature, immature vasculature in zone III with no prior ROP, or a regression of ROP of less than type 1 or type 2 ROP. Among the 7,483 infants included, 947 (12.7%) had birth weight (BW) of 1500g or more and 1440 (19.2%) had a gestational age (GA) of older than 30 weeks. Regarding the demographics, almost half the infants were white and more than 30% were African American. The authors reported that 43.1% (3224 infants) developed ROP, 6.1% (459 infants) developed type 1 ROP and 6.3% (472 infants) developed type 2 ROP. Furthermore, only 514 infants (6.9%) underwent treatment in 1 or both eyes and 147 infants (2%) had zone 1 disease. In infants with BW of less than 1251g, most had type 1 or 2 ROP (98.1%) and only approximately half of the eyes (49.4%) had retinal vasculature into zone III by 37 weeks postmenstrual age. One critical finding in this study is that these multi center cohort study involved ROP screenings of all eligible infants and not only high-risk infants. The authors remind us that for infants with BW less than 1251g, there is a higher risk of developing severe ROP and they reported 12.5% of severe ROP from low BW infants. Limitations of the study include the retrospective analysis and retinal photography was not used to confirm ROP zone or the presence of plus disease. However, study strengths include the large sample size from ROP screening programs from 29 hospitals with a rigorous data abstraction procedure. The authors suggest that this study is helpful for ophthalmologist, neonatologists, and care coordinators by providing ROP risk profiles across GA and BW groups for these infants.

**Screening Examination of Premature Infants for Retinopathy of Prematurity**

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*Pediatrics.* December 2018; 142(6): e20183061.

This policy statement provides an updated outline of evidence-based screening and treatment for infants with retinopathy of prematurity (ROP). From the multicenter trials of Cryotherapy for Retinopathy of Prematurity and Early Treatment of Retinopathy of Prematurity Randomized Trial, researchers confirmed the efficacy of treatment in reducing visual loss with high risk disease. From the information gleaned from these and other studies, the following guidelines have been developed to maximally detect ROP before it becomes severe enough to result in retinal detachment while minimizing the frequency of potentially traumatic examinations. Examinations should be performed by experienced ophthalmologists with binocular indirect ophthalmoscopy or, the authors suggest, an expert ophthalmologist reviewing wide angle retinal photographic images of pre-term infants. All infants less than or equal to 30 weeks or 1500 kg should be screened. The schedule of the screening is based on the gestational age at birth and post-menstrual age beginning at 31 weeks of post-menstrual age for 22-27 week
premature infants and 32-34 weeks of post-menstrual age for 28-30 week premature infants. Depending on the stage and aggressiveness of ROP, the babies are re-examined in 1 to 3 week intervals. Termination of examinations occurs with full retinal vascularization, zone III retinal vascularization attained without prior zone I or zone II ROP, postmenstrual age of 45 weeks and no type 1 ROP, regression of retinopathy of prematurity without any change of reactivation or progression, or if anti-VEGF. Treatment with either laser photocoagulation or anti-VEGF injections. Treatment must be initiated if there is plus disease in zones I or II, Zone I ROP of any stage with plus disease, Zone I ROP with stage 3 without plus disease, and Zone II with Stage 2 or 3 with plus disease. Treatment should generally be accomplished as soon as possible at least within 72 hours of diagnosis and the infant should be re-examined in 3-7 days after treatment. The authors discuss the pros and cons of retinal photocoagulation and anti-VEGF injections. Photocoagulation has been proven to be effective in treatment of ROP but will cause mild visual field loss, risk of increased myopia, and significant structural changes. Anti-VEGF injections show promise in stopping ROP with limited structural changes but more prolonged follow up is needed due to reactivation of the ROP and there is uncertainty regarding systemic side effects and developmental delays. Communication with parents about the examinations, findings, and treatment plan is crucial. Systemic approaches to follow up and transitions to outpatient care are very important to follow screening and treatment guidelines and ensure appropriate care for these vulnerable infants. Regardless of whether infants at risk develop treatment requiring ROP, physicians should be aware that these infants are at increased risk for other visual disorders such as strabismus, amblyopia, high refractive errors, cataracts, and glaucoma.

A national telemedicine network for retinopathy of prematurity screening.

The goal of this study was to report the results of retinopathy of prematurity (ROP) screening by a telemedicine system in Chile and evaluate its usefulness for referring patients who require treatment. Premature infants at risk of developing ROP from 11 neonatal intensive care units were included in this study. Screening was performed on all infants born at a gestational age of <32 weeks and/or birth weight of <1500 g. A trained nonphysician operator used an imaging system to capture retinal images, which were reviewed by two independent ROP experts. All infants that required treatment were referred for further evaluation. The study included 2,048 eyes of 1,024 premature infants. Mean gestational age was 28.8 ± 2.2 weeks, and mean birth weight was 1128 ± 279 g. A total of 5,263 telemedicine examinations were performed and reported. The average number of image sets per patient was 2.6 ± 2.5. Of the 5,263 images, 4,903 (93%) were recorded to at least the end of zone II; 5,172 (98%) were graded as having good quality, allowing for staging of ROP disease. Forty-two infants (4%) were referred for treatment. Discharged patients with ROP type 2 that regressed did not pre-
sent with any complications or adverse effects during 6 months' follow-up. This study demonstrates the utility of telemedicine screening for ROP using non physician operators with ophthalmologist readers in a developing country. Telemedicine screening was able to detect treatment-requiring ROP. Most of the images had good quality and showed the end of zone II, two variables sufficient to discharge patients. Telemedicine appears to be of utility for ROP screening in developing countries.

**Diagnostic Accuracy of Ophthalmoscopy vs Telemedicine in Examinations for Retinopathy of Prematurity**

H Biten, TK Redd, C Molenta et al. *JAMA Ophthalmol.* May 2018; 136(5); 498-504.

This multicenter prospective study conducted between 2011 and 2014 at 7 neonatal intensive care units and academic ophthalmology departments in the United States and Mexico included 281 premature infants who met the screening criteria for retinopathy of prematurity (ROP). Of note, each examination consisted of 1 eye undergoing binocular indirect ophthalmoscopy by an experienced clinician followed by remote image review of wide-angle fundus photographs by 3 independent telemedicine graders. Results of both examination methods were combined into a consensus reference standard diagnosis. The agreement of both ophthalmoscopy and telemedicine was compared with this standard, using percentage agreement and weighted $\kappa$ statistics. Among the 281 infants in the study (127 girls and 154 boys; mean [SD] gestational age, 27.1 [2.4] weeks), a total of 1553 eye examinations were classified using both ophthalmoscopy and telemedicine. Ophthalmoscopy and telemedicine each had similar sensitivity for zone I disease (78% [95% CI, 71%-84%] vs 78% [95% CI, 73%-83%]; $P > .99$ [n = 165]), plus disease (74% [95% CI, 61%-87%] vs 79% [95% CI, 72%-86%]; $P = .41$ [n = 50]), and type 2 ROP (stage 3, zone I, or plus disease: 86% [95% CI, 80%-92%] vs 79% [95% CI, 75%-83%]; $P = .10$ [n = 251]), but ophthalmoscopy was slightly more sensitive in identifying stage 3 disease (85% [95% CI, 79%-91%] vs 73% [95% CI, 67%-78%]; $P = .004$ [n = 136]). In summary, there was no difference was found in overall accuracy between ophthalmoscopy and telemedicine for the detection of clinically significant ROP. On average, ophthalmoscopy had slightly higher accuracy for the diagnosis of zone III and stage 3 ROP. These results support the use of telemedicine for the diagnosis of clinically significant ROP.

**Validation of the Colorado Retinopathy of Prematurity Screening Model**


The Colorado Retinopathy of Prematurity (CO-ROP) is a secondary analysis of data from the Postnatal Growth and Retinopathy of Prematurity (G-ROP) Study,
a retrospective multicenter cohort study conducted in 29 hospitals in the United States and Canada between January 2006 and June 2012 of 6351 premature infants who received ROP examinations. Of the 7438 infants in the G-ROP study, 3575 (48.1%) were girls, and maternal race/ethnicity was 2310 (31.1%) African American, 3615 (48.6%) white, 233 (3.1%) Asian, 40 (0.52%) American Indian/Alaskan Native, and 93 (1.3%) Pacific Islander. In the study cohort, 747 infants (11.8%) had type 1 or 2 ROP, 2068 (32.6%) had lower-grade ROP, and 3536 (55.6%) had no ROP. The CO-ROP model had a sensitivity of 96.9% (95% CI, 95.4%-97.9%) and a specificity of 40.9% (95% CI, 39.3%-42.5%). It missed 23 (3.1%) infants who developed severe ROP. In summary, the CO-ROP model demonstrated high but not 100% sensitivity for severe ROP and missed infants who might require treatment in this large validation cohort. The model requires all 3 criteria to be met to signal a need for examinations, but some infants with a birth weight or gestational age above the thresholds developed severe ROP. Most of these infants who were not detected by the CO-ROP model had obvious deviation in expected weight trajectories or non-physiologic weight gain. These findings suggest that the CO-ROP model needs to be revised before considering implementation into clinical practice.


The purpose of this study is to evaluate an alternative retinopathy of prematurity (ROP) screening system that identifies infants meriting examination by an ophthalmologist in a middle-income country. The authors hypothesized that grading posterior pole images for the presence of pre-plus or plus disease has high sensitivity to identify infants with type 1 ROP that requires treatment. Part 1 of the study evaluated the feasibility of having a non-ophthalmologist health care worker obtain retinal images of prematurely born infants using a non-contact retinal camera (Pictor; Volk Optical, Inc., Mentor, OH) that were of sufficient quality to grade for pre-plus or plus disease. Part 2 investigated the accuracy of grading these images to identify infants with type 1 ROP. The authors prospectively recruited infants at Chulalongkorn University Hospital (Bangkok, Thailand). On days infants underwent routine ROP screening, a trained health care worker imaged their retinas with Pictor. Two ROP experts graded these serial images from a remote location for image gradability and posterior pole disease. Fifty-six infants were included. The study showed that overall, 69.4% of infant imaging sessions were gradable. Among gradable images, the sensitivity of both graders for identifying an infant with type 1 ROP by grading for the presence of pre-plus or plus disease was 1.0 (95% confidence interval [CI]: 0.31 to 1.0) for grader 1 and 1.0 (95% CI: 0.40 to 1.0) for grader 2. The specificity was 0.93 (95% CI: 0.76 to 0.99) for grader 1 and 0.74 (95% CI: 0.53 to 0.88) for grader 2. The authors concluded that it was feasible for a trained non-ophthalmologist health care
worker to obtain retinal images of infants using the Pictor that were of sufficient quality to identify infants with type 1 ROP. The results of this study should be considered in light of several limitations. First, the results may not be generalizable to other countries because ROP screening guidelines are region specific. Second, there was a single imager in this study who had a background in ophthalmic photography. Third, although both graders have extensive experience screening and treating ROP, they were not given any specific training before grading these images and the variability of their grading underscores the need for standardized training for image grading, which has been shown to be effective in other ROP screening studies.

A national telemedicine network for retinopathy of prematurity screening.

The purpose of this cross-sectional observational study was to report the results of retinopathy of prematurity (ROP) screening by a telemedicine system in Chile and evaluate its usefulness for referring patients who require treatment. A total of 2,048 eyes of 1,024 premature infants at risk of developing ROP from 11 neonatal intensive care units were included. Screening was performed on all infants born at a gestational age of <32 weeks and/or birth weight of <1500 g. A trained nonphysician operator used an imaging system to capture retinal images, which were reviewed by two independent ROP experts. All infants that required treatment were referred for further evaluation. Mean gestational age was 28.8 ± 2.2 weeks, and mean birth weight was 1128 ± 279 g. A total of 5,263 telemedicine examinations were performed and reported. The average number of image sets per patient was 2.6 ± 2.5. Of the 5,263 images, 4,903 (93%) were recorded to at least the end of zone II; 5,172 (98%) were graded as having good quality, allowing for staging of ROP disease. Forty-two infants (4%) were referred for treatment. Discharged patients with ROP type 2 that regressed did not present with any complications or adverse effects during 6 months’ follow-up. The authors conclude that study demonstrates the utility of telemedicine screening for ROP with ophthalmologist readers in a developing country. Telemedicine screening was able to detect treatment-requiring ROP. The system described in the article relies solely on telemedicine for assessment unlike referral-warranted ROP-based networks, which combine imaging and regular examination of children with more advanced disease is implemented. An ophthalmological assessment using indirect ophthalmoscope was only performed prior to treatment.

Cost analysis of remote telemedicine screening for retinopathy of prematurity
This Canadian study compared the costs of two ROP screening modalities: telemedicine (remote interpretation of digital fundus images) versus in-person binocular indirect ophthalmoscopy (BIO). A total of 174 patients were screened from two sites. Children in the telemedicine group were transferred for BIO for referral-warranted ROP, defined as any ROP in zone I, plus disease, or stage 3 or worse. Note that the control group was hypothetical – this was a hypothetical group of only BIO examinations for the same group of patients if there was no telemedicine screening. Cost analysis was determined using the funding calculated and allocated by the Ontario Ministry of Health and Long-Term Care. The average total cost per infant for the telemedicine group was $4855 and $4540 for the two sites, compared to $19,834 and $2429 for the control group. This indicated that telemedicine appears to be a viable economically good option for ROP screening. As indicated above, however, the control group was 'hypothetical' based on expert opinion, and while they used a conservative approach in estimating costs, a direct cost comparison would be favorable for a study of this type.

**Single grading vs double grading with adjudication in the telemedicine approaches to evaluating acute-phase retinopathy of prematurity (e-ROP) study**

This study evaluated the sensitivity and specificity of single, independent, non-physician trained reader (TR) gradings in the Telemedicine Approaches to Evaluating Acute-phase Retinopathy of Prematurity (e-ROP) study. The study evaluated secondary analyses of image grading results from 1,235 infants of birth weights <1251 g. Two of three TRs independently graded image sets and discrepancies were adjudicated by the reading center director (an ophthalmologist) to reach final grading. Sensitivity and specificity of each TR grading and final grading was calculated by comparing gradings to clinical examination results. Of 7,808 double graded image sets, TR1 graded 5,165; TR2, 3,787; and TR3, 6,664. Compared to final grading for referral warranted retinopathy of prematurity (RW-ROP), two TRs had relatively lower sensitivity (TR1, 75% vs 79% [P = 0.03]; TR2, 73% vs 77% [P = 0.02]) and specificity (TR1, 80% vs 83% [P < 0.001]; TR2, 82% vs 83% [P = 0.09]). TR3 had similar sensitivity (83% vs 83% [P = 0.78]) and specificity (83% vs 84% [P = 0.02]). Compared to final grading, TR1 had lower sensitivity for zone I ROP (47% vs 56% [P = 0.04]) and stage ≥3 ROP (71% vs 77% [P = 0.002]); TR2 had lower sensitivity for stage ≥3 ROP (69% vs 77% [P < 0.001]) and lower specificity for all three components (P < 0.001); TR3 had lower sensitivity for detecting plus disease (23% vs 35% [P < 0.001]) and similar sensitivity for zone I ROP and stage ≥3 ROP. There is a
small but significant decrease in the sensitivity and specificity for RW-ROP when single-reader grading is compared to double adjudicated grading. In summary, the authors conclude into whether just one well-trained nonphysician grader can achieve comparable or better results in identifying RW-ROP than double grading with adjudication by an ophthalmologist is encouraging. One major component of the e-ROP grading protocol that they did not investigate is the necessity of an ophthalmologist adjudicator, because this would have required regrading the entire data set. They feel that, at present, the option of combining TR assessment with ophthalmologist confirmation of results within an ROP teledicine system that has robust quality assurance is a reasonable approach.

ROP and imaging

Optical Coherence Tomography Angiography of the Foveal Avascular Zone in Children with a History of Treatment-Requiring Retinopathy of Prematurity


Ten patients with history of laser photocoagulation or cryopexy treatment for Stage 3 (Zone >=II) ROP and 10 normal control subjects were included in this retrospective case-control study to examine the characteristics of the foveal vascular structure by OCT angiography. Foveal avascular zone, vessel density, vessel length, and vascular diameter index were measured by OCT angiography using the 3x3-mm ETDRS sectors. The median foveal avascular zone values of the patients with ROP and controls were 0.103 mm² and 0.260 mm² respectively (p=0.0025). The medians of the vessel density, vessel length, and vascular diameter index of the patients with ROP were 0.218 mm²/mm², 11.75 mm/mm², and 18.0 um, respectively, in ETDRS Sector 1 and did not significantly differ from those of the controls. For the average of ETDRS Sectors 2 to 5, the medians of the vessel density, vessel length, and vascular diameter index for the patients with ROP were 0.347 mm²/mm², 18.95 mm/mm², and 18.28 um, respectively; vessel density and vessel length were significantly smaller than those of the controls, but there was no difference in vascular diameter index.

This study population was small. Gestational age was not accurately recorded in some patients and therefore a correlation between FAZ formation and gestational age could not be made. In addition, although not statistically significant, there was an age difference at the time of testing between the ROP and control groups. Because this study compared children with history of treatment for ROP to control subjects without any treatment, it is possible that the treatment itself may have caused changes. Also, FAZ data from children with spontaneously regressed ROP was not compared to these groups. Despite these limitations, OCT angiography appears to be useful for non-invasively visualizing retinal vascular construction in children. OCT angiography-guided FAZ was significantly smaller.
in patients treated for ROP than in controls, indicating that foveal vascular development may be altered in patients with a history of treatment-requiring ROP.

**ROP and Anti-Vascular Endothelial Growth Factor Treatment**

**A Dosing Study of Bevacizumab for Retinopathy of Prematurity: Late Recurrences and Additional Treatments**

Intravitreal bevacizumab (IVB) is increasingly used to treat severe retinopathy of prematurity (ROP), but it enters the bloodstream, and there is concern that it may alter development of other organs. Previously, this study group reported short-term outcomes of 61 infants enrolled in a dose de-escalation study, where one eye was injected with 0.25 mg, 0.125 mg, 0.063 mg or 0.031 mg of IVB. The lowest dosage of 0.031 mg was effective after 4 weeks in 9 out of 9 infants. There was a concern that these low doses, however, will lead to higher recurrence of the disease. Here, the authors report the late recurrences and additional treatments and structural outcomes for infants receiving lower doses of IVB. This was a masked, multicenter, dose de-escalation study including 61 premature infants with type 1 ROP. If type 1 ROP was bilateral at enrollment, then the study eye was randomly selected. In the study eye, bevacizumab intravitreal injections were given at de-escalating doses of 0.25 mg, 0.125 mg, 0.063 mg, or 0.031 mg; if needed, fellow eyes received 1 dose level higher: 0.625 mg, 0.25 mg, 0.125 mg, or 0.063 mg, respectively. After 4 weeks, additional treatment was at the discretion of the investigator. Of 61 study eyes, 25 (41%; 95% confidence interval [CI], 29%–54%) received additional treatment: 3 (5%; 95% CI, 1%–14%) for early failure (within 4 weeks), 11 (18%; 95% CI, 9%–30%) for late recurrence of ROP (after 4 weeks), and 11 (18%; 95% CI, 9%–30%) for persistent avascular retina. Re-treatment for early failure or late recurrence occurred in 2 of 11 eyes (18%; 95% CI, 2%–52%) treated with 0.25 mg, 4 of 16 eyes (25%; 95% CI, 7%–52%) treated with 0.125 mg, 8 of 24 eyes (33%; 95% CI, 16%–55%) treated with 0.063 mg, and 0 (0%; 95% CI, 0%–31%) of 10 eyes treated with 0.031 mg. By 6 months corrected age, 56 of 61 study eyes had regression of ROP with normal posterior poles, 1 study eye had developed a Stage 5 retinal detachment, and 4 infants had died of preexisting medical conditions. The fellow eyes treated with IVB had similar outcome. Due to small sample size, the study was not powered to address the relationship between the dose and recurrence rate. The authors concluded that retinal structural outcomes are very good after low-dose, as low as 0.031 mg, bevacizumab treatment for ROP, although many eyes received additional treatment. This is the first study aimed at determining the ideal anti-VEGF dosing in infants with ROP.
Ocular complications following treatment in the Postnatal Growth and Retinopathy of Prematurity (G-ROP) Study.

The purpose of this study was to determine the prevalence of treatment-related ocular complications and disease progression following treatment for retinopathy of prematurity (ROP). This was a secondary analysis of a retrospective cohort study of eyes treated for ROP at 29 North American neonatal intensive care units in the Postnatal Growth and ROP (G-ROP) Study. Data from the time of treatment through 15 months were abstracted from medical records by certified data collectors. Treatment-related complication (cataract, hyphema, glaucoma, corneal abrasion/opacity), and disease-progression (retinal fold, dragging, or stage 4 or 5 detachment) were calculated by treatment modality. Vitreous hemorrhage was classified separately, because it can relate to treatment or disease progression. Of 7,483 infants included in the study, 1,004 eyes (512 infants) underwent ROP treatment: 970 eyes received laser as initial therapy; 34 eyes received intravitreal bevacizumab (IVB). Median follow-up after treatment was 18 weeks. Overall, one or more complications occurred in 2.6% (95% CI, 1.8%-3.8%) laser treated eyes and no (0%; 95% CI, 0.0%-10.1%) IVB eyes. Disease-progression occurred in 9.2% (95% CI, 7.6%-11.2%) laser treated eyes, no (0%; 95% CI, 0.0-12.9%) IVB-only eyes. Vitreous hemorrhage occurred in 5.4% (95% CI: 4.1% - 7.0%) laser treated eyes, no IVB-only eyes. Of laser-treated eyes, 9% experienced disease progression despite treatment. Overall, the rates of complications are very low following ROP treatment with either laser or IVB.


This longitudinal national surveillance study done in the UK evaluated retreatment rates, anatomical, visual and refractive outcomes at 1-year follow-up in infants treated for ROP. The study was able to follow up 168 (51.4%) of 327 original patients. A higher retreatment rate was found in patients after initial injection of anti-vascular endothelial growth factor (VEGF) antibody (35.7%) compared to 11.1% after initial diode laser (11.1%). Out of 131 children who had sight impairment certification eligibility 3.8% were classified as severely sightly impaired. There was a trend towards early emmetropia and myopia following diode laser, particularly in more severe ROP.

Foveal Development in Infants Treated with Bevacizumab or Laser Photocoagulation for Retinopathy of Prematurity
This study uses OCT to study the early foveal development in preterm infants and to compare this development between eyes treated with intravitreal bevacizumab or laser photocoagulation (LPC), and untreated eyes. This is an observational case series of 131 preterm infants undergoing retinopathy of prematurity (ROP) screenings, while they were inpatient. Using a handheld OCT, thickness measurements of the inner and outer retinal layers were obtained at the foveal center and the nasal and temporal foveal rims. Comparisons between treated and untreated eyes were adjusted for age and other confounding variables. They also measured weekly changes in inner and outer retinal thickness and presence of inner retinal layers, ellipsoid zone (EZ), and cystoid macular changes (CMCs). The authors found that the outer retinal thickness at the foveal center increased by 3.1 μm/week in untreated eyes and 7.2 μm/week in bevacizumab-treated eyes (P = 0.038). Eyes treated with LPC had a lower probability of having all inner retinal layers present at the foveal center (OR, 0.04; P = 0.001) and a lower probability of having the EZ present at the foveal center (OR, 0.07; P = 0.024) compared with untreated eyes. Cystoid macular changes were found in 53% of patients and 22% of imaging sessions. However, the age-adjusted incidence of CMCs was not significantly different for bevacizumab or LPC-treated eyes. The authors concluded that intravitreal bevacizumab therapy for ROP is associated with more rapid outer retinal thickening at the foveal center, whereas LPC is associated with earlier extrusion of the inner retinal layers and delayed development of the EZ at the foveal center. Limitations of the study include the fact that infants undergoing inpatient ROP screenings were included in the study hence those with more severe ROP or a more unstable clinical course were represented in the cohort. Long-term follow-up is needed to determine the visual significance of these findings.

Ocular complications following treatment in the Postnatal Growth and Retinopathy of Prematurity (G-ROP) Study.
Morrison D., Shaffer J., Ying G. S. and Binenbaum G. J AAPOS April 2018; 22(2): 128-133.

The purpose of this retrospective study was to determine the prevalence of treatment-related ocular complications and disease progression following treatment for retinopathy of prematurity (ROP). The study included eyes treated for ROP at 29 North American neonatal intensive care units in the Postnatal Growth and ROP (G-ROP) Study. Data from the time of treatment through 15 months were abstracted from medical records by certified data collectors. Treatment-related complications (cataract, hyphema, glaucoma, corneal abrasion/opacity), and disease-progression (retinal fold, dragging, or stage 4 or 5 detachment) were calculated by treatment modality. Vitreous hemorrhage was classified separately, because it can relate to treatment or disease progression. Of 7,483 infants included in the study, 1,004 eyes (512 infants) underwent ROP treatment: 970 eyes received laser as initial therapy; 34 eyes received intravitreal bevacizumab (IVB). Median follow-up after treatment was 18 weeks. Overall, one or more complications oc-
curred in 2.6% (95% CI, 1.8%-3.8%) laser treated eyes and no (0%; 95% CI, 0.0%-10.1%) IVB eyes. Disease-progression occurred in 9.2% (95% CI, 7.6%-11.2%) laser treated eyes, no (0%; 95% CI, 0.0-12.9%) IVB-only eyes. Vitreous hemorrhage occurred in 5.4% (95% CI: 4.1% - 7.0%) laser treated eyes, no IVB-only eyes. The authors concluded that rates of complications are very low following ROP treatment with either laser or IVB. Of laser-treated eyes, 9% experienced disease progression despite treatment. The use of IVB for ROP was not widespread during the time period of the study, as demonstrated by the small number of eyes treated with IVB. Therefore, there was inadequate statistical power to know whether there is a difference in complication rates for laser and IVB. Despite the issues that were raised by the authors regarding the study’s methodology, this is a very well-written report that voices several concerns regarding the treatment options for ROP and yet offers an encouraging result with an overall low complication rate.

Macular Structures, Optical Components, and Visual Acuity in preschool Children after Intravitreal Bevacizumab or Laser Treatment

This is a comparative interventional case series of 80 eyes of 42 patients who had type I ROP treated either by intravitreal Bevacizumab (IVB) or laser. The patients had spectral domain OCT of their macula between the ages of 4 and 6 to determine if treatment modality would affect the macular structures at preschool age. The authors also looked at refraction and biometry metrics to compare the two groups. Thirty-three eyes of 17 patients had IVB only, 24 eyes of 13 children had laser only, and 23 eyes of 12 children had both laser and IVB. Baseline characteristics were evaluated and there was a difference in the gestational age at birth with the Laser +IVB group having younger GA and a trend towards a lower BW. Patients treated with IVB had less myopia, deeper anterior chambers, but similar axial lengths and corneal curvatures. The IVB treated eyes had thinner retinal thicknesses in the fovea, parafovea, and perifovea. There was a higher incidence of having a foveal depression in the the IVB group. The IVB group had better uncorrected visual acuities but did not have improved best corrected visual acuities. Interestingly, there were clear structural differences in the eyes in the two groups, but no differences in the BCVA suggesting that the development of the foveal depression does not affect BCVA. Some of the limitations of this study included small sample size, lack of randomization, selection for patients who could cooperate with OCT testing and visual acuity testing, and the baseline differences between the two groups. However, this is an important study since it is the first to describe the visual acuity, morphology of the retina, and the biometry of the eyes in IVB and laser treated eyes in the preschool years with a large cohort of patients.
Progressive Retinal Detachment in Infants with Retinopathy of Prematurity Treated with Intravitreal Bevacizumab or Ranibizumab


Fibrovascular contraction and tractional retinal detachment (TRD) are recognized complications associated with the use of anti-VEGF agents in vasoproliferative vitreoretinopathies. This international, multicenter, retrospective case series sought to characterize TRDs that developed after intravitreal bevacizumab or ranibizumab therapy for ROP. The study included 35 eyes from 23 infants that were treated with anti-VEGF therapy for Type 1 ROP with progression to TRD. Mean gestational age was 26 weeks, and mean birth weight was 873 grams. Mean postmenstrual age on the day of injection was 35 weeks; retinal detachment was noted a mean of 70 days after injection. 11% detached within 1 week, 23% within 2 weeks, and 49% within 4 weeks. The highest stage of ROP noted was 4A in 29%, 4B in 37%, and 5 in 34% of eyes. Time to RD negatively correlated with postmenstrual age at the time of injection. Three TRD configurations were observed: 1) conventional peripheral elevated ridge or volcano-shaped Stage 5 detachment, 2) midperipheral detachment with tight circumferential vectors, and 3) very posterior detachment with prepapillary contraction. Full or partial reattachment was achieved with surgical intervention in 86% of eyes.

The authors of this study note that they do not routinely use anti-VEGF to treat ROP, and almost all of the cases in the study were referred from other institutions for surgical intervention. Therefore, the total number of infants treated with anti-VEGF injections is unknown. Also, eyes that received anti-VEGF injections for vascularly active Stage 4/5, either for attempted monotherapy or a surgical adjunct, were excluded. Theoretically these eyes have a higher risk for progressive TRD because of the preexisting fibrosis that can contract.

This study demonstrates that progression to RD can occur after anti-VEGF treatment of ROP, and progression can occur in atypical circumferential or prepapillary configurations. Further studies are needed to determine the incidence and risk factors for failure of anti-VEGF treatment.

Short-term Outcomes After Intravitreal Injections of Conbercept versus Ranibizumab for the Treatment of Retinopathy of Prematurity


This study investigated intravitreal injection of conbercept (IVC) as a treatment for ROP, comparing the structural outcomes and recurrence of ROP among patients treated with IVC or intravitreal ranibizumab (IVR). The primary outcome was treatment success, defined as regression of plus disease; secondary outcomes included recurrence of plus disease, times of injection, and final disease
regression. 48 eyes (24 patients) with ROP were included in the study. 20 eyes (10 patients) received IVC, and 28 eyes (14 patients) received IVR. In the IVC group, 17 (85%) of 20 eyes received only one injection, and the regression of plus disease occurred 4.3 weeks later. 3 eyes (15%) received a second IVC injection, and plus disease regression occurred within 3 weeks. For the IVR group, 15/28 (53.6%) eyes received a second IVR injection. No retinal detachment was observed in either group.

Infants in this Chinese study who developed severe ROP were more mature and heavier than infants who were similarly affected in other studies, including ETROP, potentially limiting the generalizability of the results. Another limitation is the study’s retrospective nature and lack of matched laser-treated group. The number of included patients is small and the follow-up somewhat limited (mean 52.6 weeks in IVC group and 42.9 weeks in IVR group), and long-term safety and efficacy studies are needed. However, with a structure different than ranibizumab and bevacizumab, conbercept may represent a new choice of anti-VEGF treatment for ROP.

Prophylactic Peripheral Laser and Fluorescein Angiography after Bevacizumab for Retinopathy of Prematurity


This paper reports the reactivation rate after bevacizumab treatment for ROP in eyes with classic ROP (CROP) versus aggressive posterior ROP (APROP). Peripheral fluorescein angiography findings are also reported, along with ocular outcomes after bevacizumab with subsequent prophylactic treatment completion with laser for persistent avascular retina after 60 weeks post-menstrual age. 64 eyes of 33 patients were included, with mean gestational age 25 weeks and mean birth weight 674 grams. Reactivation requiring treatment after initial bevacizumab was more common in eyes with APROP (8/16) than with CROP (2/48). At mean 73 weeks post-menstrual age, eyes with APROP had more avascular retina (mean 4.4 versus 2.6 disc diameters) and higher percentage of leakage (11/11 eyes versus 22/38 eyes) on FA than in eyes with CROP. Unfavorable outcome occurred in 1/16 eyes with APROP and in no eyes with CROP. No eye that underwent prophylactic laser after bevacizumab (45 of the 64 study eyes) had a poor structural outcome. This retrospective study included relatively few eyes. In addition, there was no comparison treatment group, so the study does not necessarily support the use of bevacizumab over laser photocoagulation, particularly for CROP. Also, there was no control group without planned treatment completion laser. One must also consider the difficulty in diagnosing APROP and its current somewhat imprecise definition which could make the results of this study difficult to generalize. Strengths include a relatively long follow-up period (mean 125 weeks) and FA studies of most eyes that received bevacizumab, affording robust characterization of the periphery.
Medical and developmental outcomes of bevacizumab versus laser for retinopathy of prematurity
Kennedy KA, Mintz-Hittner HA; BEAT-ROP Cooperative Group

Infants with stage 3+ retinopathy of prematurity (ROP) in zone I or zone II posterior were randomized to initial treatment with bevacizumab or laser in a multicenter trial (BEAT-ROP). The purpose of this study was to assess the effects of bevacizumab on medical and neurodevelopmental outcomes of infants enrolled in the BEAT-ROP trial at one Houston site, where very preterm (<27 weeks gestation at birth) inborn infants are routinely seen at 18-22 months’ corrected age for medical and neurodevelopmental evaluations. Inborn infants of <27 weeks' gestational age underwent medical and standardized neurologic and developmental assessments at 18-22 months' corrected age (age after expected date of full-term delivery). Of the 18 infants enrolled at our site, 16 (7 bevacizumab, 9 laser) were evaluated for medical and neurodevelopmental outcomes at 18-28 months' corrected age. For each of the groups, the medians and ranges of growth percentiles were low compared with norms for healthy infants. The ranges for Bayley III developmental scores were also low relative to expected norms for healthy infants. There were no significant differences between the bevacizumab and laser therapy groups in weight (median percentile: bevacizumab, 18; laser, 7), length, head circumference, cerebral palsy, or Bayley scores (median Cognitive Composite Score: bevacizumab, 85; laser, 65). There was a significant difference in length of hospital stay (median days, 98 vs 140 days) favoring the bevacizumab group. In this patient cohort 2-year follow-up evaluation of infants treated with bevacizumab versus laser therapy for retinopathy of prematurity showed no adverse effects on medical or neurodevelopmental outcomes. Further randomized trials are being conducted and a 5-year developmental follow-up is planned for the one of these trials; the authors also point out that there is increasing recognition that neurodevelopmental testing at 18-24 months can overestimate severe disability and cannot detect limitations in more sophisticated domains, such as executive functioning.

Follow-up to Age 4 Years of Treatment of Type 1 Retinopathy of Prematurity Intravitreal Bevacizumab Injection versus Laser: Fluorescein Angiographic Findings.

This is a single-center, randomized controlled trial looking at the structural outcome at age 4 years of eyes treated with intravitreal injection of bevacizumab (IVB) with fellow eyes treated with conventional laser photoablation in type 1
ROP. The study was conducted at the Catholic University in Rome, from September 1, 2009, to March 31, 2012. Structural outcome at age 4 years was assessed using fluorescein angiography (FA). In each of 21 infants (42 eyes), 1 eye was randomized to receive an intravitreal injection of 0.5 mg bevacizumab; the fellow eye underwent conventional laser photoablation. Digital retinal imaging and FA were performed at an average of 4 years after treatment in follow-up after these studies performed at treatment and 9 months. FAs were examined by 2 experts to document retinal and choroidal findings. Among the 20 IVB-treated eyes available at 4 years of age, all showed abnormalities at the periphery (avascular area, vessel leakage, shunts, abnormal vessel branching, and tangles) or the posterior pole (hyperfluorescent lesions, absence of foveal avascular zone). These lesions were not observed in the majority of the laser-treated eyes. Among the 19 laser-treated eyes, leakage was noted in 1 eye, shunts and tangles were noted in 3 eyes, and macular abnormalities were noted in 3 eyes. The authors concluded that FA has shown potentially serious and long-term ocular effects that are present more commonly after treatment with bevacizumab for acute-phase ROP than after laser.

Ultra-low-dose intravitreal bevacizumab for the treatment of retinopathy of prematurity: a case series

There are significant concerns about the effect of VEGF suppression in early human development, particularly on neurological development. Lower doses of anti-VEGF are being studied to lessen the systemic concerns when treating retinopathy of prematurity. The authors of this study performed a retrospective review of infants receiving 0.16mg in 0.025ml of bevacizumab for ROP in England. 29 eyes (15 infants) were included. Mean GA was 23.9 weeks, and mean BW was 596.3g. Mean postmenstrual age at treatment was 34.1 weeks. Follow-up was for a mean of 9.4 months. All cases showed early improvement in plus disease and retinopathy within 48 hours of injection. Success was defined as complete regression of retinopathy and vascularization into or laser treatment of zone 3. Initial success was achieved in 23/29 eyes, and secondary success (additional treatment required) in 27/29 eyes. 6/29 eyes underwent additional treatment at a mean of 9.8 weeks after first injection (mean 44 weeks PMA). There were no recorded ocular adverse events. Two infants died during follow-up, both due to respiratory disease. While this study was not designed to address systemic effects, overall the authors conclude this low dose of bevacizumab is effective for ROP without adverse ocular outcomes.

ROP Epidemiology and Outcomes
Implementation of a Critical Prediction Model Using Postnatal Weight Gain, birth Weight, and gestational Age to Risk Stratify ROP.


The purpose of this study is to develop a simple prognostic model using postnatal weight gain, birth weight, and gestational age to identify infants at risk for developing severe retinopathy of prematurity (ROP). The medical records from two tertiary referral centers with the diagnosis code “Retinopathy of Prematurity” were evaluated. Those with a birth weight of 1,500 g or less, gestational age of 30 weeks or younger, and unstable clinical courses were included. Multivariate regression analysis was applied to transform three independent variables into a growth rate algorithm. Seventeen of 191 neonates had severe ROP. Weight gain of at least 23 g/d was determined as a protective cut-off value against development of severe ROP. This value maintained 100% sensitivity with 62% specificity to ensure all neonates who require treatment would be captured. Overall, the Omaha (OMA)-ROP model calculated a 58% reduction in eye examinations within the cohort. The authors concluded that inclusion of postnatal growth rate in risk stratification will minimize the number of eye examinations performed without increasing adverse visual outcomes. The OMA-ROP model predicts neonates who gain less than 23 g/d are at higher risk for developing severe ROP. Although promising, larger cohort studies may be necessary to validate and implement new screening practices among preterm infants. This study is not without limitations. Similar to previously proposed models, the OMA-ROP model was developed from tertiary academic hospitals where infants have a higher ROP risk profile. Therefore, this cohort may not represent the average demographic of the national at-risk neonatal population. Furthermore, our findings are not applicable to infants in developing nations where differences exist in health care systems, patient demographics, and a cohort of older and larger infants who develop ROP and who may represent a different ROP risk profile. Accurate assessment of gestational age may not even be possible in some regions. Both the CO-ROP model and the OMA-ROP model screen based on lower-than-predicted weight gain. Therefore, an infant with higher-than-average weight gain due to non-physiologic reasons (edema, sepsis, or hydrocephalus) could theoretically be missed. Of the current proposed postnatal weight gain models, the WINROP is unique in its identification of such infants. Similarly, clinical factors that cause weight gain but are not associated with increased IGF-1 may generate false-negative signals and should be further assessed.

Refractive Trend of Stage 3 Retinopathy of Prematurity.


The purpose of this retrospective review was to analyze the refractive trend in patient with Stage 3 Retinopathy of Prematurity (ROP) over a 7-year time period.
Of the 70 eyes that were included in the study, 46 received laser ablation and 24 did not. There was a similar distribution between zone II and zone III disease in both groups ($P = .87$). The average final refraction in the laser group was $-0.83$ diopters (D) in comparison to $+1.61$ D in the no laser group. The final refractive change was $-3.55$ D in the laser group and $-0.25$ D in the no laser group. A greater myopic shift was observed in the first 2 years of life than between years 2 and 7 in both groups. The authors conclude that infants who underwent laser treatment for stage 3 ROP tended to have higher myopia than those with stage 3 ROP who did not require treatment. This study has several limitations. First, it was a retrospective study without a randomized control group. Although the laser and no laser groups with a similar disease extent were analyzed, it was still difficult to account for disease severity because the laser group had more patients with plus disease. All of the patients in the bevacizumab group had plus disease. Additionally, most of the patients in this study were Hispanic and these findings may not be as widely reproducible in another population.

**Incidence and Early Course of Retinopathy of Prematurity: Secondary Analysis of the Postnatal Growth and Retinopathy of Prematurity (G-ROP) Study.**


This was a large retrospective cohort study of 7483 infants who had serial retinopathy of prematurity (ROP) examinations in 29 hospitals in the United States and Canada between 2006 and 2011. Of note, this article has some overlap of findings and data points and collection in the earlier article from *JAMA Ophthalmology* September 2018. The authors sought to establish the incidence, onset, and early ROP course in infants undergoing ROP screening. Of note, this study includes all eligible infants for ROP screening, not only high-risk infants for ROP. Demographics for the children undergoing ROP examinations included a mean birth weight (BW) of 1099g and a mean gestational age (GA) of 28 weeks. The authors reported that 3224 (43.1%) infants developed ROP, 459 (6.1%) developed type 1 ROP and 472 (6.3%) developed type 2 ROP. Regarding treatment, 514 (6.9%) infants underwent ROP treatment in 1 or both eyes and 147 (2.0%) had zone 1 disease. The authors report that secondary analysis shows that more than 40% of at-risk premature infants develop some stage of ROP and most ROP regresses without treatment. Of note, severe ROP was noted in 12.5% infants, especially with BW of less than 1251g. The authors suggest, similar to their earlier manuscript, that these stratified ROP results provide ROP risk profiles across BW and GA categories. Finally, the authors suggest that more specific guidelines are needed for low-risk infants with older GA and larger BW regarding the current criteria for ROP screening.
In this multicenter cohort study, the authors developed a database of 197 wide-angle retinal images from 141 preterm infants from neonatal intensive care units at 9 academic institutions (enrolled from July 2011 to December 2016). Each image was assigned a reference standard diagnosis based on consensus image-based and clinical diagnosis. Data analysis was performed from February to September 2017. In particular, six graders independently diagnosed each of the 4 quadrants (cropped images) of the 197 eyes (quadrant-based diagnosis) as well as the entire image (eye-based diagnosis). Images were displayed individually, in random order. Quadrant-based diagnosis of plus disease was made when 2 or more quadrants were diagnosed as indicating plus disease by combining grades of individual quadrants post hoc.

Of the 141 included preterm infants, 65 (46.1%) were female and 116 (82.3%) white, and the mean (SD) gestational age was 27.0 (2.6) weeks. Findings included that there was variable agreement between eye-based and quadrant-based diagnosis among the 6 graders (Cohen $\kappa$ range, 0.32-0.75). Four graders showed underdiagnosis of plus disease with quadrant-based diagnosis compared with eye-based diagnosis (by McNemar test). Intergrader agreement of quadrant-based diagnosis was lower than that of eye-based diagnosis ($\kappa$, 0.75 [95%
The accuracy of eye-based diagnosis compared with the reference standard diagnosis was substantial to near-perfect, whereas that of quadrant-based plus disease diagnosis was only moderate to substantial for each grader. In summary, graders had lower reliability and accuracy using quadrant-based diagnosis combining grades of individual quadrants than with eye-based diagnosis, suggesting that eye-based diagnosis has advantages over quadrant-based diagnosis. This multicenter cohort study has implications for more precise definitions of plus disease regarding the criterion of 2 or more quadrants.

### Longitudinal study of the association between thrombocytopenia and retinopathy of prematurity.


An association between thrombocytopenia and retinopathy of prematurity (ROP) has been suggested, but not been studied longitudinally. The authors’ aim in this retrospective case-control study was to identify the time period in postnatal development during which thrombocytopenia and the subsequent development of severe ROP are associated. A total of 100 subjects who received laser photocoagulation for type 1 ROP between 2005 and 2009 and 100 controls with no ROP or only stage 1 ROP were included. The proportions of infants with thrombocytopenia, defined as a serum platelet level of <150,000/μL, among cases versus controls were compared on a weekly basis from birth through the time of laser during early (postmenstrual age [PMA] weeks 24-28), middle (PMA weeks 29-34), and late (PMA weeks 35-38) time periods. Main outcome measures were odds ratios for the association between thrombocytopenia and type 1 ROP from multivariate logistic regression models adjusted for gestational age, birth weight, culture-proven sepsis, and necrotizing enterocolitis. Thrombocytopenia was significantly associated with severe ROP during PMA weeks 24-28 (adjusted OR, 4.7; 95% CI, 2.0-1.1; P = 0.001) and 29-34 (adjusted OR, 2.8; 95% CI, 1.4-5.6; P = 0.006), but not during weeks 35-38 (adjusted OR, 2.0; 95% CI, 0.9-4.3; P = 0.10). Thrombocytopenia from birth through 34 weeks' PMA was associated with subsequent severe ROP. The authors concluded that this time period corresponds to a period of poor retinal vascular growth, suggesting a possible proangiogenic effect of platelets in normal retinal vascular development in infants at risk for ROP. The authors acknowledged that there were statistically significant differences in mean gestational age (about 1 week earlier) and BW (about 50 g lower) for cases versus controls, but they controlled for these differences in their analysis. There were several typos in the text that caught the eye, including confidence interval values that did not make sense.

### Top five legal pitfalls in retinopathy of prematurity
The author reviews the common areas of medicolegal risk during ROP screening. RO accounts for a significant number of legal cases that result in high awards. The author elucidates five major areas that if properly addressed can decrease the risk of legal action and lead to better care of the patient. The screening ophthalmologist has a fiduciary duty to the infant to try and give the highest likelihood of vision. Failure to engage the family in educating them on the importance of ROP screening both in the NICU and after discharge is key. Assigning one person in your office to be the point person for ROP addresses the failure to engage your front office. Issues such as follow-up and phone care were the single largest category resulting in the highest indemnity payments from the malpractice carrier. Another area responsible for a large portion of litigation is failure to coordinate care and transfer properly between specialists. Failure of situational awareness leading to improper staging of ROP and incorrect follow up intervals is a significant issue. Screeners should be sure that they are up to date on screening guidelines and that they adhere to them. Lastly, failure to be diligent in following up with those babies that are especially sick, and to be proactive in dealing with all interested parties to ensure proper care and follow-up is essential. This paper is designed to aid the ROP screener in providing safe and effective care to the infant while protecting their own medicolegal interests.


This is a literature review that reviews and summarizes the evolving concepts in the clinical management of retinopathy of prematurity while also providing a personal perspective on its management today and future directions of treatment. The authors perform a literature review on studies that evaluate the use of anti-VEGF treatment for ROP. Although initial treatment strategies focused on ablative therapy for threshold ROP, earlier treatment for type 1 or pre-threshold disease has been found to decrease unfavorable visual and structural outcomes. Vascular endothelial growth factor has emerged as a significant contributor to retinal-vascular diseases in the previous 2 decades. The potential role of anti-VEGF treatment for type 1 ROP has become a focus in recent years, but the protracted recurrence of disease and unknown adverse ocular and systemic effects have caused concern from some clinicians. In addition, the use of telemedicine technologies may provide the ability to screen remote areas with a shortage of ROP providers, thereby reducing the burden of disease. The authors conclude that the diagnosis and management of ROP has changed over the past 40 years; the role of anti-VEGF therapy remains to be established in current treatment strategies. Screening for initial disease and progression will likely be impacted by the increasing prevalence of telemedicine and relative shortage of clinicians.
Heart rate variability changes and its association with the development of severe retinopathy of prematurity.


The purpose of this retrospective case-control study was to evaluate for differences in autonomic nervous system (ANS) activity of premature infants with advanced retinopathy of prematurity (ROP). Heart rate variability (HRV) was used as an indicator of ANS activity. It was calculated in two groups of premature infants: (1) a treatment group of 15 infants who developed type 1 ROP and underwent treatment and (2) an age-matched control group of 8 infants, who did not develop ROP or only developed stage 1 ROP. The control group was also matched to the treatment group by weight and risk factors. No normative values are available for these indices in premature infants; Therefore, differences between the control and the study groups were assessed by comparing changes in HRV over time. HRV was analyzed during the first 5 days of life, within 5 days of initial ROP examination, and within 5 days of ROP treatment for the treatment group or, for controls, on the day of last electrocardiogram data prior to discharge. Calculations were performed for the high frequency, low frequency, and low frequency-high frequency values of the HRV components. Between the initial ophthalmologic evaluation and the final evaluation, there was a tendency for reduction in both the low- and high-frequency components of the HRV indices in the treatment group, whereas there was a tendency for an increase in both components of the HRV indices in the control group. None of which were statistically significant. The difference in the rate of change of the high frequency between groups was statistically significant (P = 0.021). The authors concluded that disruption in ANS activity may play an important role in the development and severity of ROP. This idea is very interesting, however the data presented was not very compelling, possibly due to study limitations including small sample size.

Effect of Patients’ Clinical Information on the Diagnosis of and Decision to Treat Retinopathy of Prematurity


This prospective cross-sectional study evaluated the effect of patients' clinical information on experts' diagnoses of ROP and decisions to treat. 7 experts assessed wide-field fundus photographs of eyes of 52 premature infants for ROP diagnosis and the necessity for treatment for 2 days. On Day 1, they were masked to all patient data. On Day 2, they were given information on gestational
age and birth weight. After receipt of patients’ clinical information, there was a significant shift in the experts’ ratings towards a less aggressive ROP grading stage and less frequent decision for intervention. This was truer for heavier/less premature infants (gestational age \( \geq 28 \) weeks or BW \( \geq 900 \) grams) than those with very low BW/high prematurity (GA \( < 24 \) weeks or BW \( < 600 \) grams).

The results of this study suggest that knowledge of patients’ clinical information influences the grading of ROP disease and decision for treatment, as ROP staging seemed to be set at a lower level and the decision for treatment at a higher threshold for heavier/less premature babies. The authors raise an important point that the key issue to be addressed is the problem of subjectivity in ROP assessment. Despite the lack of objective metrics of disease severity and the fact that various examination methods exist, examiners ultimately make decisions based on their own interpretations of results. Although inherent subjectivity is a problem, individual decisions are triggered or reinforced by external confounding factors that merit further study.

**Longitudinal study of the association between thrombocytopenia and retinopathy of prematurity.**
Jensen AK, Ying G, Huang J, Quinn GE, et al. JAPOS. April 2018;22(2)119-123

An association between thrombocytopenia and retinopathy of prematurity (ROP) has been suggested but not been studied longitudinally. The authors sought to identify the time period in postnatal development during which thrombocytopenia and the subsequent development of severe ROP are associated. This was a retrospective case–control study of 100 subjects who received laser photocoagulation for type 1 ROP between 2005 and 2009 and 100 controls with no ROP or only stage 1 ROP. The proportions of infants with thrombocytopenia, defined as a serum platelet level of \(<150,000/\mu L\), among cases versus controls were compared on a weekly basis from birth through the time of laser during early (postmenstrual age [PMA] weeks 24-28), middle (PMA weeks 29-34), and late (PMA weeks 35-38) time periods. Main outcome measures were odds ratios for the association between thrombocytopenia and type 1 ROP from multivariate logistic regression models adjusted for gestational age, birth weight, culture-proven sepsis, and necrotizing enterocolitis. Thrombocytopenia was significantly associated with severe ROP during PMA weeks 24-28 (adjusted OR, 4.7; 95% CI, 2.0-1.1; \( P = 0.001 \)) and 29-34 (adjusted OR, 2.8; 95% CI, 1.4-5.6; \( P = 0.006 \)), but not during weeks 35-38 (adjusted OR, 2.0; 95% CI, 0.9-4.3; \( P = 0.10 \)). The authors conclude that thrombocytopenia from birth through 34 weeks’ PMA was associated with subsequent severe ROP. This time period corresponds to a period of poor retinal vascular growth, suggesting a possible proangiogenic effect of platelets in normal retinal vascular development in infants at risk for ROP. This information may be useful in the management or prediction of risk for ROP in the future.
Parents’ Knowledge and Education of Retinopathy of Prematurity in Four California Neonatal Intensive Care Units

The purpose of this study was to evaluate the lack of parental knowledge about Retinopathy of Prematurity (ROP) in order to better understand gaps in screening and treatment. To do this the authors performed a cross sectional study in four NICUs in California with 194 parents of very low birth weight infants between 2013 and 2015 completing phone surveys. They called parents 4 weeks after discharge asked parents what they knew about ROP and how they were educated about this disease. The goal was to talk to parents after the first outpatient ROP visit. They then used multivariate analysis to determine if parental understanding of ROP was associated with English proficiency and literacy, method of education, and infant transfer status. There was a 68% rate of returned survey and of those, half of the parents reported receiving information about ROP status at the patient’s discharge. Parents reported treatments for ROP including steroid injections, eye drops, lights, oxygen, and blood transfusions demonstrating a clear lack of understanding. Patients with limited English proficiency had lower odds of knowing that low birth weight and prematurity were risk factors for ROP. The authors did not survey the health care providers on what education was actually provided, and highlighted this as a limitation. The authors concluded that patients with limited English proficiency had less knowledge about ROP.

The inner retinal structures of the eyes of children with a history of retinopathy of prematurity

The eyes of preterm children have more highly curved corneas, shallower anterior chambers, thicker lenses, and shorter axial lengths (ALs) than those of full-term children; these differences become more significant as the severity of ROP increases. Preterm children with or without a history of ROP have a thinner retinal nerve fiber layer (RNFL) than full-term children. Glaucoma is a progressive optic neuropathy characterized by RNFL thinning and it is recognized as an important cause of visual decline in children with severe ROP after surgery. Myopia, especially high is strongly associated with glaucoma. The mechanical stretching of the ocular structure alone or insufficient ocular perfusion in people with myopia can lead to RNFL damage. An analysis of the ganglion cell layer (GCL) might be a powerful predictor to diagnose and monitor glaucoma. The present study performed detailed measurements of the optic nerve head (ONH) and inner retinal structures (including the peripapillary RNFL and mGCC). This study recruited two cohorts of children: children with a history of treatment-requiring ROP. The second cohort consisted of age-matched healthy controls born at > 37 weeks; Birth weight > 2500 g and they did not present with any ocular
disease except refractive errors. ROP grade was categorized by the maximal severity in the acute stage. Patients were excluded if they had stage 4 or 5 ROP and had undergone vitrectomy or scleral buckling. Patients with residual retinal sequelae of ROP, including retinal detachment or macular dragging or fold, were also excluded. To measure the ONH, RNFL, and mGCC, the standard glaucoma module was used. The peripapillary RNFL thickness was measured at a diameter of 3.45 mm around the center of the optic disc. The mGCC consists of three layers: the RNFL, the GCL, and the IPL. The mGCC scan covered a 7 × 7 mm area in the macula and was centered 1 mm temporal to the fovea to improve coverage of the temporal macula. Four types of data (average, superior, inferior thicknesses, and superior- inferior difference) were used to analyze the mGCC. The mGCC global loss volume (GLV) and focal loss volume (FLV) metrics are designed to detect patterns of loss. The GLV detects diffuse loss, and the FLV detects localized loss over the mGCC map. A total of 41 eyes of 21 preterm children and 34 control eyes of 17 full-term children were included in this study. The mean GA of children in the ROP group was 26.2 ± 2.1 weeks (range, 23–36 weeks) and 39.0 ± 1.7 weeks (range, 37–41 weeks) in the control group (P0.001). The mean BW of the children in the ROP group was 919.4 ± 260.8 g (range, 552–1530 g) and 3195.9 ± 384.3 g (range, 2500–3878 g) in the control group (P0.001). The mean age (years) at examination was 9.6 ± 2.5 in the ROP group and 8.4 ± 1.7 in control group (P = 0.14). In the ROP group, all of the eyes (100%) were zone 2 ROP. Six eyes (14.6%) were stage 2 ROP plus disease, and 35 eyes (85.4%) were stage 3 ROP plus disease. A total of 37 (90.2%) eyes were treated with diode laser photocoagulation, and 4 eyes (9.8%) were treated with diode laser photocoagulation and IVB. A significant greater spherical equivalent was seen in the ROP cohort. (Myopia 4.6 vs 0.4 D). Other analysis revealed similarity in average AL between the two cohorts, significantly shallower ACDs and thicker LTs in the ROP cohort, and no differences in the vitreous depth, baseline intraocular pressure, central corneal thickness. The average RNFL thickness of children with ROP did not significantly differ from that of full-term children (108.4 ± 16.0 μm and 109.5 ± 12.1 μm, respectively, P = 0.91). The peaks near the superior and inferior sectors showed a temporal deviation in the ROP group, which means that the superotemporal and inferotemporal sectors were thicker, and the superonasal and inferonasal sectors were thinner. The average, superior, and inferior mGCC thicknesses were all thicker in children with a history of ROP than healthy children. mGCC difference between the superior and inferior areas was similar across these two groups (P = 0.20). The spherical powers, cylindrical powers, and spherical equivalent in all patients were positively correlated with RNFL thickness. The AL in all patients was negatively correlated with RNFL thickness. The ACD in all patients was not correlated with RNFL thickness. there was no significant correlation between mGCC thickness and spherical powers, cylindrical powers, spherical equivalent, AL, or ACD among all patients. Preterm children with a history of ROP have poorer best-corrected visual acuity, shallower ACD, greater LT, changes in peripapillary RNFL distribution, and greater mGCC thickness with increased mGCC-FLV compared with full-term children. Inner retina in children with a history of ROP
was thicker and had a different distribution pattern than those of full-term children. The temporal RNFL thickening in children with a history of ROP was related to the disrupted development of the inner retina rather than the temporal shift of RNFL peaks in axial myopia observed in full-term children.

**An international comparison of retinopathy of prematurity grading performance within the Benefits of Oxygen Saturation Targeting II trials.**


Variation in the rates of severe ROP between clinical centers have been attributed in part to observer bias. A number of studies have demonstrated inter-observer variation when grading ROP using retina images. This study aimed to determine whether international variation in the interpretation of images and subsequent treatment decisions was present. Nine readers from Australia, two from New Zealand, and seven from UK who participated in the BOOST II trials were used. The median (range) number of years’ experience of the readers in performing clinical ROP screening examinations was 25 (14–26) for the UK group, 15 (3.5–40) for ANZ, and 21 (10–38) for the international reference group. Each reader assessed 48 eye examinations. Seventeen of the 42 (40.5%) image sets were obtained at the time when a decision to treat was made, or immediately prior to treatment. Thirteen of the 42 (31.0%) image sets were from infants who did not require treatment at the time of imaging, but who were subsequently treated. Twelve of the 42 (28.6%) image sets were from infants who were not treated for ROP at any time. Of the 42 eye examinations reviewed the mean (SD) number of examinations per reader judged as ‘plus’ disease was 14.1 (6.23) for UK readers, 8.5 (3.24) for ANZ readers, and 13.2 (6.31) for the international readers (Table 1). The difference between UK and ANZ readers was significant (t-test P = 0.021, mean difference = 5.69, 95% CI = 0.98–10.40). Examinations per reader classified as stage 2 was higher in the ANZ group than in the UK group (t-test, P = 0.026, mean difference = 7.47, 95% CI = 1.00–13.94). For stage 3 there were no significant differences between the groups. The proportion of eye examinations read as each zone was not significantly different between any pair of groups. Agreement was highest within the ANZ group for all measures, with ‘moderate’ agreement for treatment decisions and for plus disease categories. Agreement was ‘fair’ for treatment decisions within the UK group. Agreement was poor for most measures within the INT group. UK ophthalmologists demonstrated a lower threshold to treat than Australian and New Zealand ophthalmologists. UK ophthalmologists graded more images as plus disease, and more images as treatment-requiring. There were no significant differences in grading stage 3 disease or ROP zone. The UK ophthalmologists had more inter-observer variation than the Australian and New Zealand ophthalmologists. Intra-observer consistency
appeared to be good among all ophthalmologists. The international reference ophthalmologists graded in a similar way to the UK ophthalmologists. It is likely that variation in treatment rates between countries was due to international variation in ROP grading and treatment decisions.

9. STRABISMUS

Strabismus – double vision, binocular vision and visual perception

Comparison of a new digital KM screen test with conventional Hess and Lees screen tests in the mapping of ocular deviations


This paper's goal is to evaluate the digital KM screen computerized ocular motility test and to compare it with conventional nondigital techniques using the Hess and Lees screens. Patients with known ocular deviations and a visual acuity of at least 20/100 underwent testing using the digital KM screen and the Hess and Lees screen tests. The examination duration, the subjectively perceived difficulty, and the patient's method of choice were compared for the three different tests. The accuracy of the test results was compared using Bland-Altman plots between testing methods. A total of 19 patients were included in this study. Examination with the digital KM screen test was less time-consuming than tests with the Hess and Lees screens (P < 0.001 and P = 0.003, respectively, compared with the digital KM screen). Patients found the test with the digital KM screen easier to perform than the Lees screen test (P = 0.009) but of similar difficulty to the Hess screen test (P = 0.203). The majority of the patients (83%) preferred the digital KM screen test to both of the other screen methods (P = 0.008). Bland-Altman plots showed that the results obtained with all three tests were similar. The authors conclude that the digital KM screen is accurate and time saving and provides similar results to Lees and Hess screen testing. It also has the advantage of a digital data analysis and registration. From this study digital KM screen should be considered over the nondigital Lees and Hess screen testing.

Differences in the Stimulus Accommodative Convergence/Accommodation Ratio using Various Techniques and Accommodative Stimuli.

The AC/A ratio may differ greatly, even in normal eyes. The authors sought to define a method for determining the stimulus AC/A ratio by looking at the relationship between ocular deviation and accommodation with spherical lenses to create an accommodative stimulus and the amblyoscope. They enrolled 81 orthoptic students (mean 21 years, range 20-23 years; 66 female) without any ocular abnormalities apart from refractive error. They found that there was a significant difference between measurement methods in the median stimulus AC/A ratio with low accommodation (1.0 Δ/D for method 1 at distance, 2.0 Δ/D for method 1 at near, and 2.7 Δ/D for method 2). Additionally, they found differences caused by measurement technique can be reduced with a high accommodative stimulus during measurements (4.0 Δ/D for method 1 at distance, 3.7 Δ/D for method 1 at near, and 4.7 Δ/D for method 2). The authors conclude that values and variation of the stimulus AC/A ratios in the same subjects differ depending on the measurement and calculation methods used.

**Anatomy**

**Magnetic Resonance Imaging of the Globe-Tendon Interface for Extrocular Muscles: Is There an “Arc of Contact”?**

Clark RA and Demer AJO 2018 October; 194: 170-181.

The authors of this paper performed MRIs in 18 normal patients and 14 strabismic patients in order to test the “arc of contact” biomechanical model of extraocular muscle force transfer to the globe. Each extraocular muscle leaves its insertion and wraps around the globe for a contact arc, and then leaves the globe and heads towards its insertion and this “arc of contact” model is what has historically used to understand the angle at which the muscles are acting upon the globe. However this model, mathematically, assumes that the tendon is infinitely thin at that portion where it touches the globe, and that the muscle leaves at a perfectly straight line towards its insertion. The authors sought to test this mathematical model by evaluating the angle at the insertion of the muscles compared to the angle predicted by the “arc of contact” model. Using MRI, the angle measured at the insertion during large ipsiversive ductions and the angle predicted on the “arc of contact” model were compared. The authors found that for the normal extraocular muscles, the measured angle was larger than predicted by the traditional “arc of contact” method. In strabismic patients, the authors found that the measured angle was also greater than predicted for the medial rectus in abducens palsy, after medial rectus resection, but not after lateral rectus recession. The authors make a case that the “arc of contact” model needs updating with information that we obtain from modern imaging techniques. Of note, there is a (strong) letter to the editor highlighting a few extra limitations of the paper, namely the technique of using extreme ipsiversive gaze and suggests an overstatement of their conclusions.

**Optical Coherence Tomography in Children With Microtropia.**
The purpose of this retrospective, observational, and transversal study is to assess whether optical coherence tomography (OCT) could be useful for detecting and documenting fixation in patients with microtropia. A total of 25 patients were included: 15 with microtropia (study group) and 10 without tropia and with foveal fixation and stereopsis (control group). Retinal fixation observation was performed using spectral-domain OCT on amblyopic children with microtropia. The position between the retinal fixation point and the anatomical fovea was measured, in microns, using the system software tools. Only patients with a high level of cooperation, OCT scan quality signal of 7 or better, and visual acuity of 0.70 logarithm of the minimum angle of resolution (logMAR) or worse in the amblyopic eye were included. The study showed that in the study group, microtropia was previously diagnosed in 67% of cases through the cover test, and was predominantly in the left eye (73%). The average visual acuity of the sound eye was 0.03 decimal and 0.18 logMAR in the amblyopic eye. The microtropia was $3.73 \pm 3.34$ prism dipters and eccentric fixation ($387 \pm 199 \mu m$) with OCT was observed in all cases except one. Eccentricity was predominantly in the superonasal quadrant (57%). Both eyes in the control group and the contralateral eyes of the study group showed foveal fixation. The authors conclude that OCT can aid in the detection of eccentric fixation and provide a relative degree of location of the retinal fixation point. Therefore, OCT can play an important role in the detection and measurement of eccentric fixation in eyes with microtropia, providing a high sensitivity compared to other methods. The small experimental sample size and the study design (observational and retrospective) limit the results. Furthermore, comparison with a gold standard or reference test, such as microperimetry, would be of value. Furthermore, the instability of fixation in amblyopic or strabismic eyes is another important bias factor to be considered.

Neuroanatomical Structures in Human Extraocular Muscles and Their Potential Implication in the Development of Oculomotor Disorders.
Ala Paduca, Jan Richard Bruenech JPOS. 2018;55(1):14-22

The potential role of sensory feedback from human extraocular muscles has been subjected to considerable speculation in the ophthalmic literature. Extraocular muscles pull against a fairly even load and do not initiate a stretch reflex, even when the eyes are directed toward the boundaries of their respective field of action. These unique working conditions and physiological properties have led to the notion that the sensory signal arising from receptors in extraocular muscles differs from the conventional proprioceptive signal arising from their somatic counterparts. The interest in the receptors at the myotendinous junction of human extraocular muscles has been renewed due to their alleged role in the development of binocular vision and their potential implication in the etiology of binocular vision anomalies. The idea that extraocular muscles provide knowledge of
eye position and whether this function can be affected by surgical intervention has initiated several clinical and neuroanatomical studies. Many of these studies support this concept and suggest that surgical procedures that impose only minimal interference with the proprioceptive signal will give a better postoperative result. However, other studies contradict this view because the afferent capacity of the receptors can be questioned and some uncertainties remain. The purpose of this study was to review the related literature and discuss the possible role of ocular proprioceptors in relation to binocular vision and the development of eye motility disorders.

**Strabismus – Cranial Nerve palsy**

**Strabismus – Childhood XT and ET**

Clinical and surgical risk factors for consecutive exotropia.

This study retrospectively examined 74 patients with consecutive exotropia to determine risk factors for this surgical outcome. The majority of patients had preoperative amblyopia. Amongst all of the risk factors which were analyzed including age of strabismus onset, oblique dysfunction, anisometropia and stereopsis abnormalities, preoperative amblyopia was the strongest predictor of postoperative exotropia. The authors emphasize that this should be considered during surgical planning for an esotropia and will be useful for counseling families regarding potential complications from surgery.

**Congenital monocular Strabismus fixus**

The purpose of this retrospective observational case series is to investigate the clinical characteristics and magnetic resonance imaging (MRI) findings of the extraocular muscle and ocular motor nerves in congenital monocular strabismus fixus. Three patients presented with unilateral non-progressive strabismus fixus with marked limitations of movement in all directions since birth. Of the three patients, one presented with esotropia, one with a large degree of exotropia and hypertropia, and one with an almost normal primary position. All three patients had normal ocular motor nerves, but adherences among the extraocular muscles, posterior Tenon's capsule, and the globe within the muscle cone on MRI. Two patients underwent strabismus surgery, but there were no postoperative im-
provements in the primary position and eye movements. The authors conclude that extensive adherences among the extraocular muscles, posterior Tenon’s capsule, and globe may partially explain the cause of congenital monocular strabismus fixus and why strabismus surgery was ineffective. The findings further highlight the importance of MRI in detecting and characterizing atypical forms of strabismus. There are some limitations to this study. This is a retrospective study with a relatively small sample size. However, this disease is rare, and it will hopefully be of benefit to have a better understanding of the clinical characteristics to offer a tailored treatment plan and have an informed prognosis.

**Decompensated Esophoria as a Benign Cause of Acquired Esotropia**


This is a retrospective, interventional case series aimed at determining clinical and magnetic resonance imaging (MRI) characteristics of patients with adult, acquired, comitant esotropia due to decompensated esophoria. The authors looked retrospectively at 8 patients with a mean age of 29 years. These patients had a history of gradually progressive intermittent binocular diplopia and on exam had $31 \pm 12$ prism diopters of esotropia at distance and $29 \pm 12$ prism diopters at near. All patients had a neurologic exam and MRI, which were normal. For all patients, orthoptropia and resolution of the double vision was achieved with bilateral medial rectus recession, though some patients continued to have esophoria. The authors concluded that decompensated esophoria is a cause of acquired esotropia in adults and proposed that patients with acute acquired comitant esotropia and no other neurologic signs or symptoms should be considered to have this benign condition. While this is an important entity to describe, the authors fail to point out the small sample size and that neurologic causes, in the absence of clear history of esophoria, should still remain in the differential.

**Long-Term Follow-Up of Cyclic Esotropia**


A retrospective review of 7 patients with cyclic esotropia who underwent bilateral medial rectus recessions to describe the development and treatment of cyclic esotropia. Cyclic esotropia is extremely rare, it typically manifests on alternate days with the esotropia being present one day for 24 hours followed by 24 hours of no deviation. Some patients may have a 3, 4, or 5-day cycle. The deviation is typically between 30 and 40 prism diopters. Cyclic esotropia may be associated with seizure disorders, hyperkinesia, behavioral problems, menstrual cycles, etc. It can be present for many years, may disappear spontaneously, or may become constant. The mainstay of treatment is surgical, surgical dose is determined by the deviation present on the esotropic days.
The Role of Dynamic Retinoscopy in Predicting Infantile Accommodative Esotropia and Influencing Emmetropization

The goal of the study was to determine the role of dynamic retinoscopy in reducing the occurrence of infantile accommodative esotropia and facilitating emmetropization. Infants with greater than 5 diopters of hyperopia in their more hyperopic eye were assessed with cycloplegic refraction and their accommodation was tested with dynamic retinoscopy at 33cm. Infants with normal accommodation were followed without spectacle correction, patients with subnormal accommodation were prescribed partial hyperopic correction to neutralize the with-motion on dynamic retinoscopy. Patients were followed regularly monitoring for the development of esotropia. None of the patients with neutral dynamic retinoscopic responses indicating normal accommodation developed strabismus. Of the patients placed in spectacles to partially correct their hyperopia due to their subnormal dynamic retinoscopy accommodation 53% did not develop strabismus and 47% developed strabismus. The authors found a direct correlation between the degree of hyperopia and the development of esotropia amongst the groups. The emmetropization rate between the groups was not statistically significant. The authors conclude that dynamic retinoscopy can predict which orthotropic hyperopic infants can be observed without spectacles and are not at risk of developing esotropia, and which are at risk.

Esodeviation without correction for tapering hyperopia in refractive accommodative esotropia

Full hyperopic correction is typically used to treat refractive accommodative esotropia. There are no standardized protocols for reducing hyperopic correction as children age. The purpose of this study was to investigate the clinical features of children whose hyperopic correction was tapered while maintaining visual acuity and stereoacuity. 106 patients were enrolled with mean follow-up period of 3.1 years. Only those patients with esodeviation within 8 PD in hyperopic correction were included. The medial amount of tapered hyperopia at each visit was 0.5D, with tapering intervals of 4-6 months. Baseline refraction was 7.6 +/- 1.5D. The patients had to maintain alignment within 8PD esodeviation without correction at distance and near at the time of tapering. At the final visit, there was no significant changes in visual acuity, esodeviation with correction, or near stereoacuity. They found a correlation with the amount of tapering with a reduced esodeviation without correction, suggesting that this could be used as a clinical indicator for tapering hyperopia. The authors do note that this was not a controlled study, so caution should be exercised when interpreting results.
Stereoacuity outcomes following surgical correction of the non-accommodative component in partially accommodative esotropia

Kurup SP, Barto HW, Myung G, Mets MB. JAAPOS. April 2018;22(2):92-96.

Previous studies of partially accommodative esotropia (PAET) have assessed factors requiring surgery and alignment outcomes. The purpose of this study was to additionally evaluate stereoacuity in patients who required surgery for their nonaccommodative component. The medical records of consecutive patients with PAET who underwent bilateral medial rectus recession from April 1990 to July 2010 to treat the nonaccommodative component were reviewed retrospectively. Preoperative data included visual acuity, stereoacuity, cycloplegic refraction, deviation at distance and near, and age at surgery. The primary outcomes were stereoacuity and alignment. A total of 84 patients were included in this study. Stereopsis by the Titmus StereoTest was demonstrated in 51 (61%) by the final visit. The average follow-up time was 4.4 ± 2.8 years (range, 0.8-11.0 years). Fine stereopsis (100 arcsec or better) was appreciated in 29 patients (35%, 57% of those with stereopsis). Of those with residual esotropia, 11 (50%) demonstrated stereopsis, and 7 (32%) appreciated fine stereoacuity. No exotropic patient had stereopsis. There was a statistically significant correlation between age at time of surgery and stereopsis at 1 year ($\rho = 0.233; P = 0.033$) but not at the final visit ($\rho = 0.106, P = 0.34$). Of the 84 patients, 56 (67%) had a favorable alignment (within 10 Δ of orthotropia) at the final visit; 22 (26%) had residual esotropia; and 6 (7%) had consecutive exotropia. The authors found that in their subset of esotropic patients who required surgery for their nonaccommodative component, favorable sensory outcomes can be achieved. Overall, favorable stereoacuity can be found in PAET even when there is a residual esodeviation larger than desired postoperative alignment.

The Effect of Prism Adaptation on the Angle of Deviation in Convergence Excess Esotropia and Possible Consequences for Surgical Planning.


Previous studies by the author demonstrate a poor success rate of strabismus surgery in children with convergence excess esotropia. The author postulates that this is due to a distance deviation that is not revealed by cover testing. Furthermore, monocular occlusion has been found to change the measurement by up to 20 PD at both distance and near. The authors performed a prospective study of 49 children (mean age 7.2 years old, range 4-10 years) with convergence excess who underwent prism adaptation prior to strabismus surgery. The median angle of deviation at near was 25 PD (12-50) and at distance was 6 PD (1-20). This increased to 50 PD (30-70) and 30 PD (8-50) at distance. Twenty-eight (47%) required a change in prism strength during the adaptation period. An
increase of 10PD or more was seen in 39 of 49 children at near and 41 of 49 at distance. Forty-six (83.6%) were full binocular post-operatively. The authors conclude that prism adaptation frequently reveals an otherwise masked larger angle of deviation in convergence excess esotropia. They also suggest that convergence excess esotropia can further be divided into two categories: true and simulated, in which the simulated cases will have a distance deviation that approaches the size of the near angle following a period of prism adaptation. This in turn may influence surgical decision-making, as the risk of over-correction is lower.

**Spontaneous consecutive esotropia**

Authors report 10 cases of infants examined by pediatric neuro-ophthalmology clinic of a tertiary ophthalmology in a period of 6 years having presented an early large-angle exotropia that spontaneously converted into an esotropia or orthophoria. Median age at first exotropia assessment was 3.8+/-6.3 months. Median age at spontaneous conversion to esotropia or orthophoria was 7.2+/-14.7 months. Six patients (60%) had other significant medical problems including severe neurologic or metabolic diseases, 3 (30%) had history of neonatal respiratory distress syndrome. Only one patient was healthy.

**Infantile exotropia and Developmental delay.**
Gregg T. Lueder, Marlo Galli *J of Ped Ophth & Strabismus.* 2018; 55(4):225-228

The purpose of this interventional case series was to determine the long-term outcome of surgery in children with infantile exotropia and developmental delay and to assess the need for neurologic evaluations. The records of infants who underwent surgery for the treatment of exotropia with onset during the first year of life were reviewed. The preoperative ophthalmic and systemic findings, treatment, and developmental and ophthalmic outcomes were reviewed. Surgery was considered successful if the horizontal deviation was less than 10 prism diopters (PD). Developmental assessments were obtained at each visit. Twenty-six patients presented between age 2 and 10 months with exotropia ranging from 20 to 95 PD. Ten (38%) patients had a developmental delay that was recognized at the first visit, 9 of whom had a systemic diagnosis at that time; the other patients remained developmentally normal during a mean follow-up of 7 years. Age at surgery ranged from 4 to 18 months. Surgery was successful in 10 (38%) of 26 patients after 1 surgery and in an additional 13 (50%) of 26 patients after a second surgery. More than half of patients required more than one surgery, but the overall success rate with one or two surgeries was 88%.

The authors concluded that the need for more than 1 surgery was higher in infantile exotropia when compared to other forms of childhood strabismus, but most children achieved good alignment with one or two surgeries. Developmental de-
lay is common in patients with infantile exotropia, but this was usually recognized at the time of the initial evaluation. In the current patients, routine neurologic screening or imaging of these otherwise developmentally normal infants was not required. A limitation of this study is that it included only those patients with early onset exotropia who underwent surgery. Surgery was performed for patients with constant or poorly controlled exotropia. This group would presumably be at greater risk for developmental problems than those with milder forms of intermittent exotropia.

Time and Factors Affecting the Direction of Re-drift in Essential Infantile Esotropia.

The purpose of this study is to investigate the development pattern of postoperative re-drift in patients with infantile esotropia and identify factors associated with the re-drift. A total of 112 patients with infantile esotropia who underwent surgery before the age of 3 years were included. Surgical outcomes were divided into (1) consecutive exotropia: more than 8 prism diopters (PD) of exodeviation; (2) recurrent esotropia: more than 8 PD of esodeviation; and (3) monofixation syndrome: maintenance of deviations within 8 PD. The occurrence rate, time of onset and associated factors of the re-drift were evaluated. At a mean follow-up of 9.5 years, consecutive exotropia developed in 37 patients (33.0%) and recurrent esotropia in 43 patients (38.4%). Whereas 76.7% of total recurrent esotropia cases were identified within postoperative 1 year, consecutive exotropia occurred constantly over 10 years postoperatively. The mean time to consecutive exotropia development from surgery was 78.6 months, greater than that of recurrent esotropia development (8.9 months) (P < 0.001). In multinomial logistic regression using monofixation syndrome as the reference category, fixation preference before surgery (odds ratio [OR]: 6.64, 95% confidence interval [CI]: 2.07 to 21.32) and the rate of myopic progression (OR: 15.07 per −1.00 D/year, 95% CI: 1.23 to 184.86) were associated with consecutive exotropia, whereas increase in the angle of esodeviation on postoperative day 1 (OR: 1.15, 95% CI: 1.04 to 1.26) was correlated with recurrent esotropia. The study showed that re-drift after surgery occurred in more than 70% of patients with infantile esotropia during a long-term observation period. There was a clear difference in the development pattern between exotropic and esotropic drift; most recurrent esotropia cases appeared within postoperative 1 year, whereas consecutive exotropia occurred constantly over a long period of time. Detailed evaluation before surgery and close observation of postoperative deviations and changes in refractive status will help to determine the surgical prognosis in patients with infantile esotropia. The study has several limitations such as retrospective nature and small number of cases. Also there was an interval between the onset of infantile esotropia and the time of operation.
Strabismus – Convergence / Divergence insufficiency

Postural Patterns of the Subjects with Vergence Disorders: Impact of Orthoptic Re-education, a Pilot Study


Eye movements are essential for body control and equilibrium in addition to vision. The studies goal is to characterize the influence of vergence and orthoptic exercises on postural control. Postural control quality was measured by the Romberg test and was evaluated before and after orthoptic therapy for vergence disorders. Orthoptic therapy decreased the amount of body sway with eyes open and at near fixation. There was no change in monocular versus binocular viewing conditions. But there was a small advantage in ocular dominance post-therapy. The authors conclude that orthoptic education and therapy can improve postural control in patients with vergence disorders.

Current Concepts in convergence insufficiency


The prevalence of convergence insufficiency (CI) is between 2-17% in the general population, and up to 49% in those suffering from traumatic brain injury. While there is no standardized measurement, using near-point convergence (NPC) and symptomatology is an appropriate screening measure that should be performed by all eye care professionals and those dealing with TBI patients. The most effective treatment for the condition is orthoptic exercises. Office based therapy is the most proven method for treatment. Home based computer therapy can be a good alternative based on some researchers and may be useful in those patients to whom office based therapy is either not practical or not available. Base-in prism glasses were not shown to be more effective than placebo in improving NPC, convergence amplitudes or symptoms. Patients with asymptomatic CI do not require treatment.

The article discussed the screening and diagnostic criteria currently in use for CI as well as the proven treatment methods. It is important given the degree to which vision therapy advances the cause of prism glasses and other unproven treatment techniques.

Near Point of Convergence in Iranian Schoolchildren: Normative Values and Associated Factors.

The near point of convergence (NPC) is an important diagnostic value, as it can identify conditions such as convergence insufficiency which causes impaired visual performance at near. The authors performed a cross-sectional study evaluating the NPC of 5444 children age 6-12 years in northern Iran. The mean NPC was 8.08 cm, without differences based on gender or geographic location. However they did find that each year increase in age was associated with a 0.18 cm recession in NPC (p<0.001). Myopes had the least remote NPC and hyperopes had the most remote NPC. They note that the NPC is more remote in their population than what is commonly cited in the literature (2.80-3.90 cm), which the authors feel may be attributable to the type of fixation target, racial differences, and age.

**The Discrepancy between Subjective and Objective Measures of Convergence Insufficiency in Whiplash-Associated Disorder versus Control Participants**


Whiplash-associated disorders (WADs) after MVAs are associated commonly with disability claims, many of which are related to vision. Convergence insufficiency (CI) leads to visual disability associated with symptoms of ocular discomfort. The authors examined the incidence of symptoms and findings consistent with CI in a cohort of patients after MVA-related WAD compared with age-matched control participants. Patients with WAD after MVA were recruited from the Orthopedic Emergency Department between July 2014 and March 2017 in Rabin Medical Center in Israel. Control participants were recruited among hospital personnel and relatives of WAD patients. Each participant completed the Convergence Insufficiency Symptom Survey (CISS) questionnaire followed by a detailed visual examination including measurements of distance and near best-corrected Snellen visual acuity, distance and near cover test, Randot stereopsis, Maddox distance and Maddox-Thorington near heterophoria, near point of convergence, base-out step fusional reserves, and amplitude of accommodation using the push-away method. A pathologic CISS score of 16 or more occurred in 26 of 57 WAD patients (45.6%) compared with 6 of 39 controls (15.4%; P = 0.002). Absolute CISS score was higher in the WAD group compared with the control group (15.3±10.0 vs. 7.7±7.7; P < 0.001). Findings consistent with CI occurred in 7.0% of WAD patients and 7.7% of control participants (P = 0.90). The authors concluded that although the visual symptoms suggestive of CI were reported more frequently among WAD patients, objective testing of CI did not correlate. This discrepancy between subjective and objective measures of CI in WAD patients versus control participants stresses the importance of training healthcare personnel to assess disability using objective, validated standards of examination.
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Strabismus – Acquired

Spasm of the Near Reflex: Literature Review and Proposed Management Strategy
Hyndman Journal of Binocular Vision and Ocular Motility, 2018; 68:3, 78-86

The purpose of the article is to identify, explain, and manage spasm of the near reflex (SNR) by reviewing the literature. SNR includes excessive accommodation leading to pseudomyopia and blurred vision, convergence spasm leading to esotropia and diplopia, and pupil miosis. Other symptoms include headache, eye pain/strain, micropsia, macropsia, and dizziness. A literature review was performed and 44 articles were included. Patients don’t always present with all three components at the same time and the condition may be missed because of this. A cycloplegic refraction is essential in the diagnosis to detect pseudomyopia. The presumed etiologies for SNR are most commonly secondary to head trauma, functional/psychogenic, organic/neurologic, or other. Proposed treatments include treating the underlying condition if found, psychiatric evaluation and medication, prolonged cycloplegia and plus lenses to break the cycle, overminusing, orthoptic exercises, miotics, and medial rectus botox. Prognosis is variable, SNR due to psychogenic causes often resolves with therapy and head trauma cases have the poorest prognosis. The authors proposed a treatment algorithm. The authors conclude that SNR has highly variable in presentation, from various causes, and response to treatment is unpredictable.

Double vision in adults
Travis Peck & David Goldberg Journal of Binocular Vision and Ocular Motility, 2018; 68:3, 63-69
A retrospective chart review of 125 patients to determine the patient characteristics, presentation patterns and incidences of the various etiologies in adult patients presenting with a chief complaint of double vision. Approximately 4% of adults are diagnosed with new onset strabismus. The majority of patients presented in the 8th and 9th decades of life. The most common type of strabismus was a small angle HT (21%), followed by ET (20%), XT (14%), palsies not including trochlear palsy (12%), and trochlear palsy (8%). Of patients with non-paralytic ET 80% had divergence insufficiency. The etiologies of strabismus leading to diplopia were vast, including neurovascular compromise, narcotic use, Lyme disease, dementia, myasthenia gravis, thyroid eye disease, orbital inflammation/mass, neurologic disease, idiopathic, etc. 11% of subjects complaining of diplopia were found not to have strabismus. The author discusses the age-related changes in the EOM pulleys as a cause of ET greater at distance than near in patients over the age of 75.

**Long-term evolution of age-related distance esotropia.**

The goal of this study was to evaluate the long term progression and evolution of horizontal deviation and fusional amplitudes both at distance and at near in patients with age-related distance esotropia (ARDET), a condition which seems to have increased in incidence over the last 10 years. The medical records of consecutive patients diagnosed with ARDET between January 2008 and March 2016 were reviewed retrospectively. Patients with at least 60 months’ follow-up were eligible for inclusion. Horizontal deviation, fusional convergence amplitude, and fusional divergence amplitude both at distance and at near were compared. Of 131 cases reviewed, 31 patients were identified for inclusion. Median age at diagnosis was 73 years. Median distance esodeviation was $6^\Delta$ esotropia at initial examination (range, $2^\Delta$-12$^\Delta$ esotropia) and $8^\Delta$ eostropia at final examination (range, $2^\Delta$-$25^\Delta$ esotropia). Median near deviation was orthophoria at initial examination (range, $10^\Delta$exophoria to $8^\Delta$ esophoria) and $4^\Delta$ esophoria at final examination (range, $4^\Delta$ exophoria to $14^\Delta$ esophoria). Median fusional divergence amplitude at distance was $4^\Delta$ at initial and at final examinations. At near, median fusional divergence amplitude was $8^\Delta$ at initial and at final examinations. Median fusional convergence amplitude at distance was $14^\Delta$ at initial examination and $12^\Delta$ at final examination. At near, median fusional convergence amplitude was $26^\Delta$ at initial and at final examinations. Base-out prisms were prescribed in all patients. In 23 patients the prism correction gradually increased. Strabismus surgery was performed in 3 patients. Clinicians can expect that patients with ARDET are likely to experience a slight increase in distance esodeviation ($P < 0.001$), whereas no significant change in fusional amplitudes may be observed over time ($P \geq 0.05$).

**Adult-onset nonparalytic, small-angle hypertropia**
The purpose of this paper is to describe the prevalence and clinical features of a common but underrecognized disorder of adult vertical strabismus. The medical records of all adult (≥19 years of age) residents of Olmsted County, Minnesota, diagnosed with nonparalytic, small-angle hypertropia (NPSAH) from January 1, 1985, through December 31, 2004, were retrospectively reviewed for demographic and clinical features. Of 753 patients diagnosed with adult-onset strabismus, 99 (13.1%) were found to have NPSAH, yielding an annual incidence of 7.50 per 100,000 patients >18 years of age and a cumulative incidence of 1.28%. The median age at diagnosis was 71 years (range, 27-98 years); 63 (64%) of the patients were women. Diplopia was reported at the initial diagnosis in 91 patients (93.8%), with 90 (92.8%) having the diplopia in primary or reading position. The median initial angle of hypertropia was $2^\Delta$ (range, $1^\Delta$-$22^\Delta$) at near and $2^\Delta$ (range, $0^\Delta$-$12^\Delta$) at distance. Only 3 patients had an initial deviation of at least $11^\Delta$. After a median follow-up of 10.8 years (range, 6.2 months to 23.7 years), the final median angle of vertical deviation was $4^\Delta$ (range, $0^\Delta$-$20^\Delta$) at near and $4^\Delta$ (range, $0^\Delta$-$16^\Delta$) at distance for all 99 patients. 84.8% of the patients received prisms during the follow up period and only one underwent surgery. NPSAH is a relatively common but infrequently recognized disorder among adults. NPSAH was more prevalent among elderly and female patients in this study cohort and the vast majority presented with diplopia and a hypertropia of $\leq 10^\Delta$ that progressed over time.

Long-term evolution of age-related distance esotropia.

Age-related distance esotropia (ARDET) is a small, acquired, comitant esodeviation with intermittent or constant horizontal diplopia occurring only at distance fixation. The purpose of this retrospective study was to evaluate the evolution of horizontal deviation and fusional amplitudes both at distance and at near in patients with age-related distance esotropia (ARDET). The medical records of consecutive patients diagnosed with ARDET between January 2008 and March 2016 were reviewed. Patients with at least 60 months' follow-up were eligible for inclusion. Horizontal deviation, fusional convergence amplitude, and fusional divergence amplitude both at distance and at near were compared. Of 131 cases reviewed, 31 patients were identified by the authors for inclusion in the study. Median age at diagnosis was 73 years. A significant increase in distance esodeviation ($P < 0.001$) was noted from a median distance esodeviation of 6 prism diopters (PD) esotropia at initial examination (range, 2-12 PD esotropia) to 8 PD esotropia at final examination (range, 2-25 PD esotropia). A similar increase in esodeviation was also noted for near with a median near deviation at orthophoria at initial examination (range, 10 PD exophoria to 8 PD esophoria) and 4 PD esophoria at final examination (range, 4 PD exophoria to 14 PD esophoria) ($P=0.004$). However, no significant change in fusional diver-
gence amplitudes and fusional convergence amplitudes were noted at both distance and near fixation. No vertical deviations developed during follow-up. Base-out prisms were prescribed in all patients. In 23 patients the prism correction gradually increased. Strabismus surgery was performed in 3 patients. The authors conclude that in their cohort of patients with ARDET, an increase in distance esodeviation was noted over time with no significant change in fusional amplitudes. Despite some inherent limitations of this retrospective study, it provides the reader with a better understanding of the natural history of this condition. The study had very strict inclusion criteria, making its sample size small.


Ocular neuromyotonia is a rare disorder cause by contraction of an extraocular muscle by a damaged nerve leading to delayed muscle relaxation. The authors present 8 patients and review the literature, as well as present an alternative association with low Vitamin D levels. Of the 49 cases in the literature, the patients had an average age of 46 years (range 7-77 years) and were predominantly female (75%). The most commonly affected nerve was CN 6 (65.3%). The majority of cases were associated with oncological radiation (80%), presenting anywhere from 2 months to 18 years after treatment. In one of the authors’ cases, the ONM complaints disappeared after supplementation with vitamins B12 and D, which suggests that neural conduction along the myelin sheath that results from hypovitaminosis may a possible mechanism. Of the published cases in the literature, 23 of 49 were treated with carbamazepine with an 87.8% success rate. The authors suggest that in the absence of a history of cranial radiation, a neurological cause or thyroid dysfunction should be considered in the workup and that carbamazepine is an effective treatment.

**Strabismus – Misc**


The purpose of this study is to examine the stereopsis in patients with comitant horizontal strabismus who had normal vision and were stereoblind following the strabismus surgery. Twenty patients with primary comitant horizontal strabismus and normal corrected visual acuity were included in this study. The stereoacuity was quantitatively measured by the random dot butterfly stereotest, the Randot Preschool Stereoacuity Test (Stereo Optical, Inc., Chicago, IL), and synoptophore. The average prism deviation was 63.55 ± 18.52 prism diopters (PD) (range: 30 to 90 PD). The mean duration of strabismus was 17.93 ± 7.0 years (range: 5 to 30 years). At 3 days postoperatively, 22.2% (4 of 18) of the patients
had improved stereopsis and the mean stereoacuity was 60 ± 28.28 seconds of arc by random dot butterfly stereotest and 150 ± 57.74 seconds of arc by Randot Preschool Stereoacuity Test (P < .05). For the fusion and stereopsis at far measured by the synoptophore, 11.1% (2 of 18) of the patients demonstrated recovery of fusion and substantial recovery of stereopsis. The mean stereoacuity (at far) was 200 seconds of arc. At the last follow-up visit (3 to 12 months, average 6.55 ± 3.46 months), 45% (9 of 20) of the patients demonstrated substantial near stereopsis recovery and the median stereoacuity was 53.33 ± 33.17 seconds of arc by random dot butterfly stereotest and 95.56 ± 63.07 seconds of arc by the Randot Preschool Stereoacuity Test (P < .01). A total of 25% (5 of 20) of the patients demonstrated recovery of fusion and 15% (3 of 20) of the patients showed substantial recovery of stereopsis at far. The median stereoacuity (at far) was 193.33 ± 179.26 seconds of arc. The study demonstrates that adult patients with comitant strabismus with good vision who are stereoblind benefit from strabismus surgery and the stereopsis significantly recovers in these patients. Strabismus surgery for these patients with comitant strabismus and good vision should not be considered only a cosmetic surgery.

The effect of oral statin therapy on strabismus in patients with thyroid eye disease.


Statins, known to possess anti-inflammatory characteristics, have recently been identified as potentially reducing the risk of developing thyroid eye disease (TED) in Graves disease patients. The purpose of this retrospective review was to investigate the effect of oral statin therapy on strabismus related to TED. A total of 30 patients with TED and restrictive strabismus (average age, 63.9 years; 50% male; 59% current/former smokers) were included; 12 statin users and 18 nonusers. Both groups were characterized by the following parameters: smoking status, previous radioactive iodine, thyroidectomy, number of decompressions, motility restriction, amount of strabismus, number of surgeries, surgical dose, and number of muscles involved on radiography. Statin users averaged fewer decompressions (1.3 in users vs 2.4 in nonusers [P = 0.04]). Statin users on average had 15 mm of total strabismus surgery compared with 21.4 mm in the nonuser group (P = 0.09) and had fewer muscles involved radiographically (4.3 vs 5.1 [P = 0.08]) The authors concluded that statin users tended to have fewer decompressions, less restriction, fewer surgeries, and fewer muscles involved despite having more current smokers (36% vs 5%), more males, more RAI, and fewer thyroidectomies, all of which are associated with worse TED. In their cohort of patients with TED and strabismus, statin therapy significantly reduced the number of orbital decompressions. Oral statin therapy also trended toward reducing the number and amount of strabismus surgeries as well as radiographic indication of muscle involvement, although these did not meet statistical significance. The study’s main
limitation is its small sample size; a slightly increased cohort size may have been more conclusive.

Anomalous Vertical Deviations in Attempted Abduction Occur in the Majority of Patients with Esotropic Duane Syndrome

This is a retrospective, observational case series of patient diagnosed with esotropic Duane syndrome over 13 years. The authors used clinical photographs of the patient's motility to describe the vertical eye position in attempted abduction; they grouped the patients into midline, depression or elevation based on these photos. Three separate ophthalmologists evaluated the photos. Of patients with unilateral esotropic duane syndrome 74/133 patients (66%) had depression in attempted abduction. 18/42 (43%) of the eyes with bilateral esotropic Duane syndrome were also found to have depression on attempted abduction. In the midline group, the limitation in abduction was found to be less severe. In the elevation group, the vertical deviation was more severe. The authors concluded that depression in attempted abduction is present in the majority of patients with esotropic Duane syndrome, yet the description of this is lacking. They speculate that this is likely another form of dysinnervation and that looking for this is important in surgical planning. This paper nicely describes a clinical finding we see often in pediatric ophthalmology practice, but one that has not been described in detail in the literature.

Binocular stereo acuity affects monocular three-dimensional shape perception in patients with strabismus

This study aimed to examine the difference in 3D shape perception between normal subjects and those with strabismus. They did this by enrolling 20 patients with strabismus (mean age 22.3 years) compared to 25 age-matched subjects without strabismus (mean age 21.0 years). The strabismus subjects were further broken down into those with stereo and those without stereo. All participants had normal acuity in both eyes. They were asked to identify certain features of a 3D shape based on shading, texture, or motion cues. Differences in discrimination of texture, motion and luminance did not differ among the groups. Subjects with strabismus without stereo could not discriminate one-dimensional features of binocular disparity. Overall the results showed that patients with strabismus without stereo perceived monocularly defined 3D shapes poorly. This suggest a perceptual benefit of binocular stereopsis in patients with strabismus.

Nonsurgical treatment of diplopia
Michael J. Bartiss *Curr Opin Ophthalmol* 2018, 29:381-384
The author writes about the approach to treatment of diplopia. Monocular diplopia can often be related to improper refractive correction particularly astigmatism. To determine if this is the case a patient should be asked to view the chart through a pinhole. If the diplopia resolves then it is likely an issue in the visual pathway from the cornea to the retina. If a refractive cause is suspected, careful refraction and trial frame evaluation should be undertaken. If there is an anatomic abnormality such as cataract or PCO it should be addressed. The retina should be carefully assessed as well with diagnostic testing. If there is no treatable anatomic abnormality treating the symptoms with various methods of blurring is recommended. In the case where a patient does not wear distance correction inexpensive spectacles can be made to be the “carrier” for the occlusion device used. Binocular diplopia can be treated with many of the same methods as monocular cases such as occlusion or image blur. If the diplopia is not very bothersome and the patient can compensate with a head position no treatment may be an option. Fusional exercises work best when increased fusional convergence amplitudes are required. Prism therapy is the best nonsurgical option in patients with small angle horizontal or vertical deviations. This should be done by careful sensorimotor examination with ductions and versions as well as measuring fusional ranges and vergences after the associated phoria is determined. Once the optimal amount of prism is determined, a press-on prism can be used as initial treatment which is helpful to see if the amount of prism suggested is useful in the patient’s functional needs. If the amount is small enough it can be ground into spectacles. Horror fusion is continues to be difficult to treat.

The paper discusses options for nonsurgical management of monocular and binocular diplopia.

Parent attitudes toward resident involvement in their child’s strabismus surgery

This paper sought to explore patterns in parents’ understanding and preferences related to ophthalmology resident participation in their child's strabismus surgery. Over a 4-week period, a survey was distributed at a suburban, academic eye center to English-speaking parents of children with strabismus who have not previously undergone, or were not being scheduled for, strabismus surgery. All of the 64 eligible parents participated in the survey. 80% and 97% of parents, respectively, indicated it was important or extremely important to be asked permission beforehand if a resident was going to assist or perform the surgery; 69% of the patients also indicated the attending surgeon should ask permission for the resident to perform the surgery, whereas only 11% believed a standard written consent was sufficient. Of the 64 respondents, 77% of the patients indicated that they would agree to a resident assisting with their child’s operation while 36% of the patients stated they would agree to a resident performing the surgery. Nearly all parents in this study indicated that they would want to be informed of resident
involvement by the attending surgeon. The vast majority would consent to having an ophthalmology resident assist in their child's strabismus surgery, and more than one-third would consent to having the resident perform their child's strabismus surgery. The study was small and completed at a single site but emphasizes the importance of communication with the patient regarding resident involvement. Surgeons should keep in mind that obtaining informed consent prior to resident involvement increases transparency and highlights the importance of ophthalmology residency education.

**Horizontal deviations in Congenital Brown syndrome.**
Gad Dotan, Maya Eiger-Moscovich, Moshe Snir, Miriam Ehrenberg, et al
*J of Ped Ophth & Strabismus.* 2018; 55(2): 113-116

The purpose of this retrospective study is to report the incidence of horizontal deviations requiring surgical correction in patients with congenital Brown syndrome. Nineteen eyes of sixteen patients were included in this study. Fourteen patients (88%) had surgery for correction of a compensatory head position, including 8 patients (50%) with a head tilt and 6 patients (38%) with a chin-up position, and 2 patients had surgery for primary position hypotropia. All of them underwent a weakening procedure of the superior oblique tendon, by either Z-tenectomy (81%, n = 13) or suture elongation of the superior oblique tendon (19%, n = 3). Fifty-six percent of patients (n = 9) had primary position horizontal deviation before surgery, including 50% (n = 8) exodeviations, ranging from exophoria of 4 prism diopters (PD) to exotropia of 30 PD, and one esotropia of 14 PD. Fifty percent of patients (n = 8) had surgery to correct the horizontal deviation by a recession of either one (31%, n = 5) or two (19%, n = 3) muscles. Mean preoperative horizontal deviation (9.3 ± 3.4 PD) decreased significantly following surgery (1.7 ± 1 PD, P = .001) (paired t test). The authors concluded that significant horizontal misalignment is often present in patients with Brown syndrome, and its correction should be considered at the time of surgery.

**Test-retest variability of cyclodeviations measured using the double Maddox rod test.**

The double Maddox rod test is often used to measure cyclodeviations and to monitor change over time. The purpose of this retrospective study was to estimate test-retest reliability and the amount of cyclodeviation that would be considered real change using 95% limits of agreement. A total of 86 clinically stable patients with double Maddox rod measurements 5-175 days apart (median, 69 days), were included. The range of cyclodeviations at the first measurement was 6 degrees incyclodeviation to 15 degrees excyclodeviation. The authors calculated the half width of the 95% limits of agreement to be 4.7 degrees, which means that a change of ≥ 5 degrees in cyclodeviation would be considered a real change. This study is evidently
the first to calculate test–retest variability for subjective cyclodeviation using the double Maddox rod test in patients. The authors concluded that the threshold of 5 degrees should be used when assessing change between two measurements made with double Maddox rods.

Statistics of TNO stereotest for the diagnosis of microesotropia in children.

In this study, the authors examined the sensitivity and specificity of the TNO stereotest for diagnosis of microesotropia. Given that small angles of undetected strabismus have a profound consequence on the development of stereopsis, the authors sought to identify a quick and reliable screening method for discovering the presence of a microtropia in children. 312 children aged 3-18 were evaluated. Results were compared to the Paliaga 8-D base in test as the gold standard. The cutoff for microesotropia was 120 arcseconds of stereo. The authors found that the TNO stereotest had 98% specificity and 94% sensitivity with a positive predictive value of 80% and negative predictive value of 99%. The primary limitation identified in this study of the TNO stereotest included difficulty in administering the test with good comprehension of the more difficult images in younger patients. Further the authors question whether there may be patients with crude stereopsis in the setting of monofixation syndrome who may be able to successfully pass the TNO test in spite of a microtropia. Nevertheless, the TNO test appeared to be a useful and reliable tool.

The Effect of Childhood Eye Disorders on Social Relationships during School Years and Psychological Functioning as Young Adults

To determine the social and psychologic impact of visible eye conditions and their treatments in childhood and young adulthood. The study directly contacted the patients treated as preschoolers, as opposed to previous studies which surveyed the parents, in adulthood to assess the psychosocial effects their eye issues had on them as children and adolescents. Response rate to the on-line survey was only 22.5%. The study found that adults treated for a visible eye condition in pre-school, compared to controls, reported a higher incidence of generalized anxiety and more victimization in school.

Abnormal fixational eye movements in strabismus
Prior studies have reported greater fixation instability in patients with amblyopia as well as strabismus. In particular patients with strabismus can have disconjugate horizontal saccades. This study examined the stability of eye position during fixation with strabismus in order to correlate the severity of the instability with strabismus angle and vision. They recorded movements in 13 patients with strabismus and 16 controls using a high-resolution video eye tracker. The authors found that patients with strabismus had greater fixation instability in the deviating eye, higher intersaccadic drift velocity and greater disconjugacy in fixational saccades. Patients with small-angle strabismus and preserved binocular vision had better fixational stability than those with large-angle strabismus and absent stereopsis. Therefore they conclude that strabismus alone is sufficient to disrupt the fixational stability even in the absence of amblyopia and latent nystagmus, and fixational instability could be a screening tool to diagnose strabismus.

**Long-term Surgical Outcomes in the Sagging Eye Syndrome.**

Sagging eye syndrome is due to degeneration of the connective tissues supporting the extraocular muscles, elongation of the muscles and anomalies in the pulley positions. The lateral rectus is the most affected of all the muscles. In order to compare the various procedures to treat this form of strabismus, the authors performed a retrospective chart review of consecutive patients who underwent strabismus surgery for small angle horizontal or vertical strabismus over a ten year period. Of the 103 cases included, 93 underwent surgery. 84 used prisms prior to surgery. Except for imbrication of the LR muscle to the SR muscle combined with superior LR transposition, all other procedures had a recurrence rates between 14 and 25%. The average age of the 15 patients with recurrences was 72 ± 7.5 years (five males), significantly higher than the 72 patients who maintained orthotropia at 66 ± 12 years (p = 0.02). The authors conclude that the recurrence of post-operative diplopia in patients with SES was due to progression of the age-related dehiscence of orbital connective tissue, not surgical overcorrection or undercorrection. This is supported by the fact that there were no cases of surgical overcorrection, only undercorrection which manifested as symptomatic diplopia over a period of time. They recommend that counseling patients that strabismus surgery can provide relief from diplopia for an interval of time but the diplopia and strabismus may recur.

**10. STRABISMUS SURGERY**

*Strabismus, Strabismus Surgery, and Reoperation Rate in the United States: Analysis from the IRIS Registry*
Recent population-based estimates of the prevalence of strabismus are available for children younger than 6 years of age in the United States, but are lacking for older age groups. Data are even more limited for rates of strabismus surgery in adults. The purpose of this study was to determine the prevalence of strabismus, the rate and types of strabismus surgery and the 1-year reoperation rates among all ages in the US population using the IRIS (Intelligent Research in Sight) Registry. The IRIS Registry is the nation’s first comprehensive clinical registry of eye disease. It collects real-world practice patterns from electronic health records of ophthalmology practices across the United States. This study includes encounters from January 1, 2013, to December 31, 2016. As of December 31, 2016, there were 7200 ophthalmologists in 2307 electronic health record-integrated practices participating in the IRIS Registry. Of these, self-designated pediatric ophthalmologist specialists numbered 258. Based on the diagnosis codes and procedures codes, the study identified types and rates of strabismus and strabismus surgery from 2013 to 2016 with subgroups by age, sex, race/ethnicity, and region of the United States. The 1-year reoperation rate was determined for strabismus surgery performed during 2013–2015 for all age groups. A total of 30,827,185 unique patients were identified; 846,477 (2.75%) had a diagnosis of strabismus: 3.02% of male patients and 2.55% of female patients (difference = 0.47%, 95% confidence interval [CI], 0.46–0.48, P < 0.0001). Strabismus surgery was performed in 40,780 (0.13%) unique patients during the 4 years. The rate of surgery decreased from 1.99% for children from birth to 5 years of age to 0.05% for adults 40 years of age and older. Horizontal surgical codes were reported 38,813 times, vertical surgery codes were reported 9,304 times, and superior oblique codes were reported 711 times. Adjustable sutures were used for 3,027 patients (7.42%). Cases with a code for repeat eye muscle surgery or restrictive myopathy were reported for 6,098 patients (14.9%). Esotropia accounted for 30.06% and exotropia in 21.77% of diagnoses reported for surgery. The rate of reoperation within 1 year of a strabismus surgery was 6.72%, lowest for the group 6 to 9 years of age (3.95%) and increasing with age (P < 0.001) to 11.5% for patients 65 years of age and older. Overall, approximately 1 in 750 patients in the IRIS Registry received strabismus surgery (1 in 20 with a strabismus diagnosis) during a 4-year period. Reoperations during the first year after surgery were performed for 1 in 15 patients, increasing with age at surgery. “Big” data from clinical data registries represent real-world care that can be used to develop benchmarks for clinical outcomes and to identify areas for practice improvement and training program design.

Infection following strabismus surgery

The incidence of infection following strabismus surgery is rare and estimated to be between 1/1100 to 1/1900. Most commonly the causative organisms are MRSA, S. aureus, S. pneumoniae, S. epidermidis, Group A
strep, and H. flue. In children, early symptoms may be systemic such as fever and lethargy. Other signs include increasing lid edema, eye redness and pain. Infection usually occurs in the first week and symptoms often begin to appear on postoperative days 1-5. The infections can manifest in a number of ways. Sub-tenon’s abscess usually had discharge, painful eye movements and fever associated with it and is often the site of muscle reattachment which can weaken the tendon. IV antibiotics and abscess drainage are used to treat. Orbital cellulitis and abscess usually occurs within 5 days and has systemic symptoms such as fever as well as lid swelling, chemosis, restricted EOMs, and proptosis. Aggressive treatment with IV antibiotics and surgical drainage is warranted if abscess is present. Endophthalmitis occurs in 1:3500 to 1:185,000 cases. Usually visual outcome is poor and can occur with or without globe perforation. It also presents with systemic signs initially in children and then with local pain, redness and swelling. Preoperative measures can reduce the risk of post-operative infection. Preoperative topical antibiotics do not reduce the risk or severity of infection. There may be a role for IV antibiotics as they do achieve adequate levels in the conjunctiva. Children who have excessive eye rubbing, poor hygiene and are of preschool age have a higher risk of infection. Currently, the most effective method to reduce bacterial colony count prior to surgery is a drop of povidone-iodine 5% in the eye. A second application of two drops after placement of the speculum helps maintain the concentration. And a single dose of povidone-iodine 5% at the conclusion of surgery is as effective as a post-operative course of topical antibiotic/steroids. Soaking sutures in povidone-iodine 5% reduced the suture contamination rate from 28% to 9%. There is NO evidence that postoperative topical antibiotics reduces the incidence of post-op infection.

The authors undertake a review of the frequency of post-operative infection in strabismus surgery and steps to prevent its occurrence. Most notably the use of povidone-iodine 5% before and after surgery is the most effective method of infection prevention.

**Efficacy of Botulinum Toxin in the Treatment of Convergence Spasm.**

Options for the treatment of convergence spasm include long-term cycloplegic drops with plus lenses, base out prisms or botulinum toxin injections to the medial rectus muscles. Currently there is no consensus on the best option. The authors performed a retrospective review of six patients (mean 44 years, range 16-71 years) with an average esotropia of 32.5 PD at near (range 25-45 PD). Five of the six had previously tried and failed conservative therapy with plus lenses and the other patient had failed prism therapy. Three patients received simultaneous injections to both MR muscles and 3 received sequential injections. Four of 6 patients were overcorrected at 2 weeks with an average deviation of 10 PD XT (range 20 PD XT to 25 PD ET). At 3 months after injection, the average deviation
was 12.5 PD ET (range 15 PD XT to 35 PD ET). At 9 months after injection, all patients returned to their pre-injection levels. The authors conclude that there is limited benefit from botulinum toxin as the efficacy varies. In addition, repeat injections may be required and overcorrection is a common side effect.

Clark RA, Demer JL. Ophthalmology 2018 Aug;125(8):1234-1238

Surgical tables typically recommend greater lateral rectus (LR) than medial rectus (MR) doses for horizontal strabismus of any given magnitude, a difference unexplained by mechanical models that assume globe rotation about its center. We tested this assumption during horizontal ductions of healthy adult subjects with normal binocular vision. Surface coil magnetic resonance imaging at 390 or 430 μm resolution was obtained using 2-mm-thick contiguous axial planes while subjects fixated targets in central, right, and left gaze. Angular displacements of lines connecting the corneal apex through the minor lens axis to the retina were measured to approximate clinical ductions. Globe centers were calculated from their area centroids. Apparent lens and globe-optic nerve (ON) junction rotations around the globe center were then compared with clinical ductions. The authors found that the globe-ON junctions appeared to rotate significantly less around globe centers than did lenses for abduction (20.6°±4.7° vs. 27.4°±7.4°, ± standard deviation (SD), P < 0.001) and adduction (25.3°±6.7° vs. 31.9°±8.3°, P < 0.001). Both rotations differed significantly from clinical adduction (27.9°±8.3°, P < 0.007), but only in abduction was globe-ON junction rotation significantly less than clinical abduction (28.6°±9.4°, P < 0.001). The true geometric globe rotational center was 2.2±0.5 mm medial and 0.8±1.0 mm posterior to the geometric globe center and was displaced farther medially and posteriorly during adduction. This eccentricity imbues each millimeter of MR recession with approximately 30% more trigonometric rotational effect than equivalent LR recession. The authors concluded that the medial and posterior eccentricities of the normal ocular rotational axis profoundly influence horizontal rectus action. The proximity of the globe's rotational axis to the MR shortens its lever arm relative to the LR, explaining why mechanical effects of smaller MR recessions are equivalent to larger LR recessions.

Stereoacuity outcomes following surgical correction of the non-accommodative component in partially accommodative esotropia.

Previous studies of partially accommodative esotropia (PAET) have assessed factors requiring surgery and alignment outcomes. The purpose of this retrospective study was to additionally evaluate stereoacuity in pa-
tients who required surgery for their nonaccommodative component. The medical records of consecutive patients with PAET who underwent bilateral medial rectus recession from April 1990 to July 2010 to treat the non-accommodative component were reviewed. Preoperative data included visual acuity, stereoacuity, cycloplegic refraction, deviation at distance and near, and age at surgery. The primary outcomes were stereoacuity and alignment. A total of 84 patients were included. Stereopsis by the Titmus StereoTest was demonstrated in 51 (61%) by the final visit. The average follow-up time was 4.4 ± 2.8 years (range, 0.8-11.0 years). Fine stereopsis (100 arcsec or better) was appreciated in 29 patients (35%, 57% of those with stereopsis). Of those with residual esotropia, 11 (50%) demonstrated stereopsis, and 7 (32%) appreciated fine stereoacuity. No exotropic patient had stereopsis. There was a statistically significant correlation between age at time of surgery and stereopsis at 1 year ($\rho = 0.233; P = 0.033$), but not at the final visit ($\rho = 0.106, P = 0.34$). Of the 84 patients, 56 (67%) had a favorable alignment (within 10 prisms diopters (DP) of orthotropia at the final visit; 22 (26%) had residual esotropia; and 6 (7%) had consecutive exotropia. The authors concluded that in their subset of esotropic patients who required surgery for their nonaccommodative component, favorable sensory outcomes can be achieved. Furthermore, favorable stereoacuity can be found even when there is a residual esodeviation. Despite inherent limitations with the study design, this well written report gives encouraging results regarding binocular outcome of PAET cases who require surgery. The discussion expands on different features of PAET that can affect surgical success and binocular function.

Informed consent for strabismus surgery: the importance of patient information sheets.

The purpose of this prospective randomized study was to analyze the additive effect of supplementing verbal consent with written patient information sheets in optimizing patients' and families' understanding of strabismus surgery. A total of 28 patients (7 adults and 21 children) were enrolled prior to strabismus surgery and randomized into two groups: group 1 with standardized oral informed consent, and group 2 with standardized oral consent and a written information sheet. A confidential questionnaire with 13 questions was completed by patients and families before surgery. The mean score (number of correct answers) for group 1 was 4.14 ± 1.99; for group 2, 5.79 ± 2.12 ($P = 0.044$), indicating that patients and families in group 2 understood their strabismus surgery better than those in group 1. Areas needing more emphasis during the consent process were identified, including risk of under- or overcorrection or repeat surgery and use of eyedrops postoperatively. The authors concluded that their study indicated that patient information sheets seemed to help patients and families better
understand information about their surgery. Patient recall of information provided is poorly reliable and must be considered in decision making for medicolegal cases. Despite some limitations with the study’s design that are discussed, it raises an important topic and offers a way to improve the surgeon’s communication with their patients prior to strabismus surgery by using information sheets.

Developing and validating a simple and cost-effective strabismus surgery simulator.

The purpose of this non-inferiority study was to demonstrate that a non-biologic strabismus surgery simulator is not inferior to a biologic wet lab for teaching the key steps of strabismus surgery. To optimize the limited training opportunities available to ophthalmology residents and to minimize the potential risk to patients, residents should master the pertinent technical skills prior to participating in the operating room. A total of 41 medical students were randomly assigned to one of two groups: biologic wet lab or non-biologic simulator. The students trained according to the group’s protocol then participated in a recorded final assessment using a realistic strabismus surgery model. Two independent reviewers (experienced pediatric ophthalmologists), masked to training method, graded the video recordings using three scoring systems: the International Council of Ophthalmology Approved-Ophthalmology Surgical Competency Assessment Rubric for Strabismus Surgery (ICO-OSCAR), the Global Rating Scale of Objective Structured Assessment of Technical Skills (OSATS), and the Alphabetic Summary Scale (ASS). The study’s primary endpoint, total ICO-OSCAR score, was 36.7 +/- 2.2 for the wet lab group and 36.0 +/- 2.7 for the non-biologic group (difference in means, -0.7; one-sided 95% CI, -2.0, infinity). The lower bound of the one-sided 95% confidence interval for the difference in mean scores was -2.0, which was greater than the a priori non-inferiority margin of -5.0 points. Full explanation of the statistical analysis used is fully described in the article. The secondary outcome measure, mean total OSATS score and ASS score, revealed no statistical significant differences between training methods (P = 0.73 and P = 0.44, resp.). The authors concluded that the simple, non-biologic strabismus surgery simulator is not inferior to the biologic wet lab with respect to total ICO-OSCAR score. This well-designed study demonstrated that a low-fidelity inexpensive model can be an effective training tool for novice surgeons.

Surgical outcomes according to distance between preplaced suture and muscle insertion in lateral rectus recession.
In this retrospective study, the authors explored motor outcomes in exotropia comparing suture placement in lateral rectus surgery: preplaced either in front or behind the hook. The main outcome measure was ocular alignment within 10 PD of ortho if undercorrected (still exotropic) and within 5 PD if overcorrected (slight esotropia). The authors found that there was no significant difference between the two groups at most recent follow up at 6 months and that the surgical manipulation did not affect the surgical dose.


The authors of this study present 6 cases of orbital trauma, double vision and strabismus after functional endoscopic sinus surgery (FESS). This was a retrospective study of patients treated at one institution over 10 years. Five of the 6 patients had medial rectus transection and exotropia. The 6th patient had transient double vision, no evidence of muscle transection, and resolution of symptoms. In all 5 patients with a transected muscle, surgical correction by retrieval of the medial rectus was performed, but in none of the 3 eyes what had primary stump reattachment had resolution of symptoms. Transposition was the only definitive strabismus surgery that resulted in orthotropia, it was temporary in all patients in this case series who had follow up care. All patients who had follow up had recurrent exotropia, demonstrating the poor prognosis in these cases.

The Impact of Strabismus Surgery on Irish Adults

The author’s objective was to evaluate quality of life (QOL) in Irish adult strabismus patients after strabismus surgery. The psychosocial implications of strabismus on QOL is well documented. Patient undergoing strabismus surgery were given a pre- and post-operative AS-20 QOL questionnaire, addressing both functional and psychosocial factors. The overall average increase in QOL was 14.29, females had lower pre-operative QOL values than males and showed a greater improvement in QOL than males. The analysis demonstrates a significant improvement in QOL after adult strabismus surgery.

Evaluation and surgical outcome of acquired nonaccommodative esotropia among older children
Most previous papers on acquired nonaccommodative esotropia (ANAET) focus on younger children. These studies suggest most cases present at a young age (<5 years of age). This study sought to determine the characteristics and management of ANAET in older children (>8 years of age). The authors performed a retrospective review of children >8 presenting with ANAET to a single pediatric ophthalmologist in Canada. A total of 7 cases of spontaneous ANAET were identified (5 males, 2 females). The average age was 11.9 years, and all patients had sudden onset of diplopia. There were no anterior or posterior segment abnormalities. 6/7 had uncorrected or corrected acuity of 20/20 OU or better, with one patient with slightly lower acuities. All 7 had comitant deviations with similar measurements at distance and near. Average deviation was 26 prism diopters (range 18-45). MRI was performed in all patients, 6 of which were normal. One patient had evidence of previous ischemic infarct. Blood work was unremarkable in all. All patients underwent bilateral medial rectus surgery with resolution of diplopia in all cases. 6/7 regained 40 sec of arc stereopsis. Overall, the authors conclude that spontaneous ANAET is rare but has an excellent surgical and functional prognosis. They do recommend neuroimaging as part of the workup.

**Preliminary Study: Impact of Strabismus and Surgery on Eye Movements When Children are Reading.**

There is variable data on the relationship between strabismus and its effect on eye movements during reading. Even less data is available on reading performance before and after strabismus surgery in children. The authors evaluated 9 strabismic children (mean 12.9 years old, range 11-15 years old) and 10 healthy children (mean 12.9 years old) with eye movement recordings via an infrared camera. They found that strabismic children read faster with the dominant eye compared with both eyes and read slower than age-matched controls. After surgery, strabismic children increased their reading speed and decreased the number of backward saccades. Therefore the authors suggest that strabismus surgery improves cosmesis as well as coordination of the eyes, even if binocularity itself does not objectively improve.

**Risk of Anterior Segment Ischemia Following Simultaneous Three Rectus Muscle Surgery: Results from a Single Tertiary Care Centre.**

Anterior segment ischemia is thought to result from disruption of the anterior ciliary vessel circulation. The number of rectus muscles operated on during strabismus surgery is a factor in developing ASI, as a greater number of muscles increases the risk. The authors performed a retrospective review of the medical records of all patients who underwent simultaneous three rectus muscle surgery
at a single institution from 2003-2014. Eighty-seven patients were included (54 males, mean age 21 ± 13 years, average follow up 5.9 months). The incidence of ASI was 2.29% (2 of 87 patients). Both patients underwent surgery on two vertical and one horizontal rectus muscles, but were otherwise healthy. The patients were treated with topical steroids and the ASI resolved without sequelae. This study differed from others as the patients were both under 35yo (9yo and 30yo), much younger than other reported studies in which no children developed ASI. Alternative methods to limited the chance of ASI include staged procedures, modifications of surgical techniques (such as partial tendon), plication, Botox injections and microvascular dissections. In addition, the authors recommend considering risk factors for ASI such as thyroid orbitopathy, blood dyscrasias, intracranial surgery, carotid artery ligation, radiation therapy and dyslipoproteinemias when planning for surgery.

Tendon Elongation with Bovine Pericardium in Patients with Severe Esotropia after Decompression in Graves' Orbitopathy - efficacy and Long-term Stability.

Fibrosis of the extraocular muscles is the primary cause of motility disorders in patients with Graves. These patients commonly present with large deviations and complex strabismus which involves the horizontal, vertical and torsional planes. Recession of the fibrotic muscles to alleviate restriction is the most common procedure, however the amount of recession is limited by the eye’s anatomy. Bovine pericardium has been used to elongate the medial rectus muscle with good success and tolerability, with lower risk of infection and no risk of extrusion. The authors performed a retrospective review of 60 patients who underwent strabismus surgery with bovine pericardium (27 unilateral, 33 bilateral) at 3 months, 1 year and >4 years after surgery. At one year 11.5% were undercorrected, 82.7% achieved fusion (with or without prisms) and 3.8% were overcorrected. Fusion in primary and reading positions was obtained in 90.9% at >4 years. There were no complications or serious adverse events such as allergy, rejection, infection or granuloma. The authors conclude that tendon elongation with bovine pericardium is a safe surgical method to correct severe esotropia up to 50 PD after decompression and has good long-term stability.

Surgical outcome of a new modification to muscle belly union surgery in heavy eye syndrome.
Several surgical techniques have been described to treat ocular misalignment due to heavy eye syndrome. The authors presented a modified technique in which the muscle bellies of the superior rectus muscle and lateral rectus muscle were united with two 5-0 Mersilene sutures 15 mm posterior to the insertion. The authors used two sutures to join the muscles as they observed inadequate muscle approximation with only one suture in prior cases. They did not include scleral fixation due to the risk of scleral perforation in high myopes. They performed a medial rectus recession if restriction was noted on forced duction testing. Of the 24 eyes of 16 patients, the mean deviation improved from 93.71 ± 23.1 PD (range 45 to 104 PD) to 11.53 ± 15.59 PD (range 0 to 25 PD). There were no overcorrections and no patients required additional surgery. The authors conclude that their modification is comparable and perhaps easier than other surgical options to treat heavy eye syndrome.

**Horizontal muscle surgeries**

**Long-term outcomes After Same Amount of Bilateral Rectus Muscle Recession for Intermittent Exotropia With the Same Angle of Deviation.**


The purpose of this retrospective review is to evaluate the long-term outcomes of homogenous bilateral rectus recession in patients with the same preoperative angle of deviation in intermittent exotropia and investigate factors associated with surgical outcomes. Patients with the same preoperative angle of deviation who underwent bilateral 6-mm lateral rectus recession were observed for 2 or more years. Patients were classified into two groups based on deviation angle: success (orthophoria or exodeviation < 10 prism diopters [PD]) or recurrence (exodeviation ≥ 10 PD). Preoperative and postoperative ophthalmologic factors were compared between groups. The success and recurrence groups contained 50 and 49 patients, respectively. Preoperative maximum angle of deviation was 29.0 ± 1.8 PD at distance in the success group and 28.9 ± 1.8 PD in the recurrence group. Deviation at the 2-year follow-up was 3.7 ± 3.7 and 18.3 ± 5.3 PD in the success and recurrence groups, respectively (P < .001). Preoperative factors were not significantly different between groups except for presence of lateral incomitance; success group patients presented more lateral incomitance (P = .035). The success group also presented more esodeviation just after the operation and showed a more stable course during follow-up. Surgical outcomes of patients with 10 PD or more of esodeviation 1 week postoperatively were significantly more favorable than patients with less than 10 PD of esodeviation (P = .027, log-rank test). The authors conclude that the presence of lateral incomitance and early postoperative overcorrection were significantly associated with
favorable surgical outcome and should be considered when planning intermittent exotropia surgery. There were some limitations in this study. First, this was a retrospective study. Second, the authors assigned groups based on 2-year postoperative deviation values because the final follow-up period was different for all patients. Even if the minimum follow-up was 2 years, a prospective study including a long-term follow-up exceeding 2 years would be necessary to validate the results of the study.

Immediate Postoperative Alignment Following Bimedial Rectus Recession for Esotropia in Children Compared to Adults.


The purpose of this study is to determine whether the immediate postoperative alignment among patients undergoing successful bilateral weakening surgery for esotropia is different in children compared to adults. The medical records of all patients undergoing surgery for esotropia by a single surgeon at a major academic referral center between January 1, 2002, and July 1, 2014 (n = 544), were retrospectively reviewed. Exclusion criteria included those with prior strabismus surgery, unilateral surgery, strengthening procedures, vertical or superior oblique surgery, and those wearing hyperopic spectacles for accommodative esotropia. Additionally, all patients had to have a 1- and 6-week postoperative examination and 8 prism diopters (PD) or less of deviation at their 6-week examination. Ninety-five (17.5%) of the 544 patients met the inclusion criteria. Surgery was performed at a median age of 3.7 years (range: 7 months to 86 years) for a median esodeviation of 35 PD (range: 12 to 70 PD). Among the 73 patients younger than 11 years, the immediate mean postoperative alignment was 9 PD of exotropia (range: 14 PD esotropia to 30 PD exotropia) compared to 2 PD of exotropia (range: 9 PD esotropia to 30 PD exotropia) in the 22 patients 11 years or older (P = .001). Seventy-one percent of successfully aligned patients younger than 11 years were exotropic in the immediate postoperative week compared to 23% of those 11 years or older (P < .001). Twenty-four (32.8%) of the younger cohort had an immediate overcorrection of 15 PD or more compared to 1 (4.5%) in the older cohort (P = .006. The authors conclude that children younger than 11 years who undergo successful surgery for esotropia are significantly more likely to exhibit overcorrection in the immediate postoperative period when compared to those 11 years or older. Successfully aligned esotropic children were more significantly exotropic, including one-third with 15 PD or more of exotropia, in the first postoperative week compared to adults undergoing the same procedure. There are limitations to the findings of this study. The retrospective nature of this investigation is hindered by incomplete data and irregular follow-up. Moreover, the study cases were drawn from the practice of one surgeon. This study is also re-
restricted by a small sample size, especially the number of patients aged 11 years or older, which limits the conclusions drawn from these findings. However, statistical significance in the postoperative alignment was still observed, and significance was maintained even if the cut-off age for the two groups was increased, leaving even fewer patients in the older cohort. Finally, given the inclusion criteria of requiring both 1- and 6-week postoperative examinations, this was not a consecutive series of patients undergoing surgery for esotropia and may have unexpectedly eliminated some patients with less overcorrection.

The value of Fusional Convergence Amplitudes in Esodeviation Surgery Without Adjustable Sutures.


The purpose of this study is to explore the application of preoperative fusional convergence amplitudes in the selection of a target angle for non-adjustable suture strabismus surgery with deteriorated intermittent esotropia and diplopia. Thirty-one consecutive cases of presumed acquired non-accommodative, deteriorated intermittent esotropia managed surgically were reviewed retrospectively. For each individual, a target angle (deviation angle for which surgery was based) was selected preoperatively after analysis of fusional convergence amplitudes. Outcomes in patients selected for overcorrection at 6 meters (target angle > angle in primary position at 6 meters) were compared to those who had planned surgery based on a target angle ≤ angle in primary position) at 6 meters. The study showed that all 31 patients achieved binocular single vision in primary position at both near and 6 meters without prisms, orthoptic therapy, or additional surgery at 4 to 6 months postoperatively. Greater mean correction in the target angle > angle in primary position group compared to the target angle ≤ angle in primary position group was observed, but this difference was not statistically significant (P = .57). The authors demonstrated a role for using clinically measured motor fusion to select a target angle for this group with esotropia with binocular single vision undergoing lateral rectus resection where target angles could be selected that are larger, similar, or less than the primary position deviation measured at 6 meters, and with no statistically significant difference in medium-term outcome without resorting to adjustable sutures. The authors recognize the benefits of adjustable sutures in more complex cases, notably strabismus with restrictive and neurological causes, and in those with less robust binocular single vision potential. However, categorizing esodeviations according to their etiology and binocular single vision potential is a seemingly desirable management strategy, allowing some etiological cases to be recommended for non-adjustable suture surgery and achieving clinically successful outcomes by economical and subjectively less stressful means. This study has limitations: a relatively small sample size and retrospective design, an etiological retrieval bias, heterogeneity of surgical approach, and incomplete data.
set at final follow-up visit. Arguably, combining different etiological groups with varying levels of stereopsis in their analysis could affect the durability of the surgical result.

Comparison of plication and resection in large-angle exotropia.

Rectus muscle plication has recently attracted attention as an alternative to resection in exotropias of varying degree. In contrast to resection, it is a vessel-sparing procedure that permits simultaneous operations on multiple rectus muscles. The purpose of this small cross-sectional case series was to compare the relative efficacy of plication of rectus muscles to resection in cases of exotropia along with quantitative assessment of ultrasound biomicroscopy (UBM). A total of 28 patients with basic comitant exotropia of 30 PD – 50 PD who had undergone first-time horizontal strabismus surgery were recruited and prospectively underwent UBM evaluation 1 year after surgery; Fifteen patients underwent resection of the medial rectus and 13 underwent plication. Deviation and motility were assessed postoperatively, when UBM was performed. The two groups were matched for age and deviation size preoperatively. The patients undergoing plication and resection fared equally in terms of postoperative deviation (P = 0.81) and abduction limitation (P = 0.169). UBM could identify and quantify plication in all cases with excellent agreement with the operative data (intraclass correlation coefficient = 0.886; P = 0.000). The authors concluded that medial rectus plication or resection performed for similar angles of exotropia produced quantitatively similar results. Plication offered the advantage of being characteristically identifiable and measurable on UBM. This study has several limitations, apart from its small sample size, the UBM was prospectively performed by an unmasked observer. Yet, it expands on a topic of controversy with limited information and demonstrates with imaging that plication of the medial rectus is comparable to resection of this muscle.

Long-term motor and sensory outcomes after surgery for the nonaccommodative component of partially refractive accommodative esotropia.

The purpose of this retrospective study was to assess the long-term motor and sensory outcomes after surgery for the nonaccommodative component of partially refractive accommodative esotropia (PRAET). A total of 47 consecutive patients ≤11 years old (median age, 3.0 years) operated for the nonaccommodative component of PRAET and follow-up of at least 10 years, were included in the study. Excluded from the study were patients with high AC/A ratio. The mean cycloplegic refraction was +4.22±1.65 D (range, +1.75 to +9.00 D). Forty patients (85%) underwent unilateral medi-
rectus recession combined with lateral rectus resection, and 7 (15%) underwent unilateral medial rectus recession alone. The mean postoperative follow-up was 12.15 ± 2.05 years (range, 10.00-17.50 years). Overall, 23 patients (49%) had surgical success (an orthophoria or alignment within 10 PD of esotropia at near and distance); 10 (21%), decompensation (an increase of a previously controlled esotropia to >10 PD at near and distance); and 7 (15%), esotropia with a high ratio of accommodative convergence to accommodation (AC/A) or consecutive exotropia. None of the patients had residual esotropia. Kaplan-Meier survival analysis showed probabilities of surgical success of 57% at 5 years, 51% at 10 years, and 47% at 15 years postoperatively. Surgical success was achieved in 22 of 40 patients (55%) who underwent recession-resection surgery, compared to 1 of 7 patients (14%) with unilateral medial rectus recession alone (P = 0.008). The median age at surgery, mean cycloplegic refraction, median near and distance deviation, presence of binocular vision, and amblyopia did not predict long term outcome (decompensation, a high AC/A ratio esotropia or consecutive exotropia). Eight patients (18%) achieved stereopsis. Patients with an older age at onset (2.87 ± 1.31 years) and a shorter duration of strabismus (≤4 years) achieved better stereopsis. The authors concluded that in their cohort of patients with PRAET nearly half achieved a successful ocular alignment after surgery for the nonaccommodative component. Few patients achieved stereopsis. Older age at onset and a shorter duration of strabismus predicted a better stereopsis outcome. Despite its relatively small sample size, this study provides us with some insights into the of the long-term effects of surgery in partially accommodative esotropia.

Short prism adaptation test in patients with acquired non-accommodative esotropia; clinical findings and surgical outcome.


The purpose of this prospective interventional case series was to evaluate the surgical outcomes of patients with acquired nonaccommodative esotropia (ANAET) operated on based on a short prism adaptation test (PAT). The authors were also keen on characterizing the subgroup of patients most responsive to PAT. Patients with ANAET were enrolled between 2014 and 2016. The PAT was performed prior to surgery as follows: patients wore Fresnel trial lenses based on the results of alternate prism-cover testing. With the Fresnel prism in place, alignment was measured after 20 minutes. If the deviation increased, the power of prism was increased to neutralize this angle. The test was repeated every 20 minutes to achieve motor stability. Patients were classified as either prism responders (if the angle of deviation increased by >10 PD compared to the entry angle) or prism non-responders. Of the 28 subjects enrolled, 14 (50%) were prism re-
sponders and 14 (50%) were classified as prism non-responders. Interestingly, the deviation did not increase after 1 hour in patients who showed motor stability after 20 minutes. After 6 months, 100% of prism responders and 92.9% of non-responders were aligned within 8 PD. The authors concluded that a short PAT of 20-minutes with an endpoint of motor stability, which is less rigorous than previously described techniques, in patients with acquired nonaccommodative esotropia was associated with a good surgical outcome and a low rate of over- and undercorrection. All the responders in this cohort had an angle of deviation at entry that was 30 PD or less, hence the authors concluded that PAT may be unnecessary for patients with an angle of deviation of >30 PD.

Surgical results and factors affecting outcome in adult patients with sensory exotropia.
Jung EH, Kim SJ. *Eye (Lond).* 2018 Aug 28. doi: 10.1038/s41433-018-0189-x.

This retrospective evaluated the results of surgical treatment for sensory exotropia and examined the factors associated with the surgical outcome in patients older than 18 years at the time of surgery. Surgical success was defined as a final deviation of <10 prism diopters (PD) at distance in the primary position.
A total of 64 patients were included. Forty patients (62.5%) achieved surgical success. Twenty (31.3%) had a residual exotropia larger than 10 PD. Only the preoperative distant angle of deviation was significantly associated with surgical outcome.

Clinical Research on the efficacy of Modified Surgery for Esotropia Fixus With High Myopia.
Dongmei Qi, Lixia Gao, JingXie, Tao Yu *J of Ped Ophth & Strabismus.* 2018; 55(4): 219-224

The purpose of this study is to investigate the efficacy of a modified surgical procedure for esotropia fixus with high myopia. Thirteen patients (15 eyes) with esotropia fixus and high myopia who underwent the Jensen procedure for superior and lateral rectus muscles at Southwest Hospital between February 2014 and December 2015 were retrospectively analyzed. Intraoperatively, the superior rectus and lateral rectus muscles were separated up to 12 to 14 mm posterior to their respective insertion. A medial rectus large recession or rectus tenotomy was performed based on the degree of fibrosis of the medial rectus muscle. Postoperative examinations were performed at 1 day, 2 weeks, 3 months, and 6 months. The study showed that on the first postoperative day, 12 eyes (10 patients) were in the primary position (80.0%), 2 eyes (2 patients) exhibited 5° to 10° esotropia (13.3%), and 1 eye (1 patient) exhibited 15° esotropia (6.7%). At the 2-week follow up, 1 eye (1 patient) was lost to follow-up, 9 eyes (7 patients)
were in the primary position (64.3%), 3 eyes (3 patients) exhibited 10° esotropia (21.4%), and 2 eyes (2 patients) exhibited 15° to 20° esotropia (14.3%). At the 3-month follow-up, the patient whose ocular alignment was 20° esotropia at 2 weeks was found to have developed 30° esotropia; no change was observed in the other patients. A remarkable improvement in ocular motility was observed in all patients. The authors concluded that the Jensen procedure for the union of the superior rectus and lateral rectus muscles, using two pairs of sutures applied 12 to 14 mm posterior to their respective insertions, yielded favorable outcomes.

The clinical effect of surgical timing in infantile exotropia.

The purpose of this retrospective study was to review the association of postoperative ocular alignment, sensory outcomes, and need for reoperation after surgical management of infantile exotropia. The clinical records of patients who presented with constant infantile exotropia of >25 prism diopters (PD) and subsequently underwent strabismus surgery at a single center from 2004 to 2014 were reviewed retrospectively. Postoperative binocular sensory status was assessed using Worth 4-Dot and Titmus stereoaucy tests. Patients with postoperative exotropia of >10 PD or esotropia of >5 PD were advised to undergo additional surgery. A total of 49 cases were included (28 boys). The patients who underwent reoperation were younger at the time of first surgery (mean age, 13.15 +/-1.68 vs 18.58 +/- 0.92 months [P = 0.005]). Patients who developed consecutive esotropia were also younger at the time of initial operation (P = 0.039). Among 20 patients who underwent sensory outcome assessment, only 4 patients developed stereopsis, whereas 15 patients achieved bifixation by Worth 4-Dot test. All of the 4 patients with measurable postoperative stereoaucity had initial surgery after 1 year of age. The authors concluded that in their patient cohort, earlier surgery at a younger age did not necessarily have the benefit of better sensory outcomes, at the expense of an association with higher reoperation rate. They suggest delaying surgery to age 12 mo or older and reducing the amount of lateral rectus recession if surgery is performed earlier. The study’s cohort reflects the surgical results of a single surgeon at a single center. The authors’ analysis did not take into account possible confounding variables, such as esotropia size, length of follow-up, and developmental problems.

Long-term Surgical Outcomes for Large-angle Infantile Esotropia

This is a two center, retrospective, nonrandomized study of 88 patients with large angle (≥55 prism diopters) infantile esotropia with the goal of reporting the long-term surgical outcomes. The study period was 13 years (2002 to 2015) and pa-
tients were followed for a minimum of 3 years post op. The authors excluded pa-
tients with other ocular comorbidities, those with developmental delays, or eyes
without full motility. Success was defined as postoperative deviation of ≤10 prism
diopeters without need for more surgery. Treatment was bilateral medial rectus
recession in 70 patients, botulinum toxin-augmented surgery in 15 patients, 3-
muscle surgery in 3 patients. The mean follow up was 40 months and of those
23% had a successful outcome. Of the treatment failures, 59/68 patients had re-
current esotropia and 9 had consecutive exotropia. Patients with botulinum toxin
augmented surgery were more likely to have successful outcomes compared to
those with bilateral medial rectus recessions only (47% vs. 17%). Of those who
had retreatment, the mean number of procedures was 2.1 and 27% of those 97
patients had a deviation of 10 or fewer prism diopeters at final follow up. The au-
thors also looked at some secondary outcomes. Of the patients who had BMRc,
21 of the 70 developed inferior oblique overaction and 44% developed dissociat-
ed vertical deviation. In the botulinum group, 20% (3/15) had IOOA, 5 developed
DVD. Of those with 3 muscle surgery (3 patients), none developed IOOA or
DVD. At the end of the final follow up, 24 patients (27%) had evidence of some
stereo acuity, though that was not well defined in the methods section. The au-
thors concluded that success rates for large angle infantile esotropia were poor,
most children had recurrent esotropia, and that botox augmented surgery had
better outcomes at the 3 year follow up. The nonstandardized approach due to
retrospective nature of the study was discussed by the authors. Additionally,
longer term studies in the future will be helpful for the clinician to decide which
surgical approach is best.

The effect of Botulinum Toxin Augmentation on Strabismus
Surgery for Large-Angle Infantile Esotropia

This is a retrospective comparative case series of 30 patients from one center
with large angle infantile esotropia. The authors compared the effect of botuli-
num toxin augmented surgery with traditional bilateral medial rectus recessions
with the goal of creating dosing table. There were 14 patients who had botulinum
augmentation and 16 patients who had surgery only. The authors looked at ocu-
lar alignment at 4 months and calculated the change in prism diopeters per milli-
meter of surgery. Alignment was measured by a certified orthoptist using prism
alternate cover testing or Krimsky if needed. Secondary outcome was eye
alignment at 1 year and the change of alignment between 4 months and a year.
The mean recession for the surgery only group was 5.5mm in the augmented
surgery group and 6.1mm in the surgery-only group. The median dose of botuli-
num used was 3.9 units in each medial rectus. 86% of patients in the botulinum
augmented group had a transient overcorrection and 50% had transient ptosis,
all resolved within 3 months. Patients who had botulinum augmentation had a
larger mean effect at 4 months and at 1 year. At 4 months the botulinum aug-
mented group had a deviation of 5.7mm per mm and the surgery-only group had
a rate of effect of 4.0PD/mm (prism diopeters per millimeter). At one year, the
botulinum group had a rate of effect of 5.4PD/mm and the surgery-only group was 3.7PD/mm. There was a trend toward improved effect with the botulinum augmentation, but it was not statistically significant. The authors used this mathematical formula to create a dosing table for botulinum augmented medial rectus recessions for infantile esotropia. The authors point out some of the limitations, one being the lack of standardization of the botulinum dose. The number of patients in this study and nonstandardized botulinum dosing and concentration makes creating a dosing table a step too far, but certainly a good starting point since there are no other papers looking at this to guide clinicians who want to start using this technique.

**Surgical success and lateral incomitance following three-muscle surgery for large-angle horizontal strabismus**


This paper evaluates motor alignment, motility, and sensorial outcomes of simultaneous three-muscle surgery for large-angle horizontal strabismus, with special attention to lateral incomitance and long-term success. The medical records of consecutive patients with large-angle deviations (≥30Δ) who underwent simultaneous surgery on three horizontal muscles to correct esotropia or exotropia were reviewed retrospectively. Successful motor alignment was defined as residual deviation of ≤10Δ and consecutive deviation in primary position of ≤4Δ, with no induced lateral incomitance >5Δ between lateral gazes. Sensory success was defined as an improvement in stereopsis of ≥2 octaves. Surgical procedures included a combination of recessions and resections/plications depending on surgeon preference. The majority of cases were two-muscle recessions combined with one-muscle resection or plication. A total of 19 patients with exotropia and 9 patients with esotropia were included in this study. In the esotropic group, the mean age at surgery was 48 ± 15 years and the mean preoperative deviation improved from 45.6Δ ± 11.9Δ to 1.5Δ ± 1.6Δ (P < 0.001); there was no undercorrection, recurrence or overcorrection. In the exotropic group, the mean age at surgery was 44 ± 25 years, and the mean preoperative deviation improved from 44.1Δ ± 8.7Δ to 5.8Δ ± 9.6Δ (P < 0.001), recurrence occurred in 2 patients (22%). The overall motor success at distance was 85%, with 1 (3.8%) unsuccessful patient due to induced incomitance. Sensory success was 44% for esotropia and 31% for exotropia. No patient lost stereopsis. In this paper, the authors found a higher dose response than generally expected for esotropic patients. Although this is a small study, the authors conclude that patients undergoing three-muscle surgery for horizontal strabismus can have good motor outcomes with a low incidence of induced lateral incomitance; in addition, the motor and sensorial outcomes for esotropia were very stable.
Surgical outcomes following rectus muscle plication versus resection combined with antagonist muscle recession for basic horizontal strabismus
Huston PA, Hoover DL  J AAPOS. 2018 Feb;22(1):7-11

This paper evaluates the change in ocular alignment and surgical success of rectus muscle plication versus resection when coupled with antagonist muscle recession recession for basic esodeviations and exodeviations. The authors retrospectively evaluated consecutive patients with basic horizontal strabismus who underwent a rectus muscle plication or resection combined with a known amount of antagonist muscle recession from January 2009-June 2016 by one. Changes in ocular alignment and surgical success at 4-16 weeks after surgery and re-operation rates for plication compared to resection were assessed. Success was defined as undercorrection of ≤10Δ and overcorrection of ≤4Δ at distance. A total of 162 patients with basic esotropia (88 lateral rectus muscle plications; 74 lateral rectus resections) and 60 patients with basic exotropia (31 medial rectus muscle plications; 29 medial rectus resections) were included. Success rates at 4-16 weeks after surgery were 95.5% for lateral rectus plication, 89.2% for lateral rectus resection, 77.4% for medial rectus plication, and 96.6% for medial rectus resection. No significant differences were found when analyzing the change in ocular alignment between the plication and resection groups for patients with either basic esotropia or basic exotropia. Reoperation rates were low for all groups (range, 3.2%-5.4%) during a follow-up period of 4 weeks to 72 months. In summary, the authors found that horizontal rectus muscle plication produced similar changes in ocular alignment and surgical success compared to rectus muscle resection at 4-16 weeks after surgery when coupled with comparable amounts of antagonist muscle recession.

Early versus late surgery for infantile exotropia
Na KH, Kim SH J AAPOS. 2018 Feb;22(1):3-6

This purpose of this paper is to determine whether age at surgery influences postoperative outcome in infantile exotropia. This longitudinal, retrospective study included children who underwent bilateral lateral rectus recession between 2004 and 2012 for an exotropia with onset by 12 months of age. Surgical outcomes were considered failures if recurrence occurred with exodeviation of >8Δ or overcorrection with esodeviation of >5Δ developed during postoperative period. A total of 93 children were included in the study and the mean age at surgery was 3.2 years. At a mean follow-up of 3.6 years, 19 of 93 patients (20.4%) experienced recurrence and 3 (3.2%) had overcorrection. In the multivariate analyses, increased age at surgery was associated with higher risk for recurrence (OR = 1.031 per 1-month; 95% CI, 1.003-1.060). In subgroup analyses, the association was significant only in the constant exotropia group (OR = 1.410; 95% CI, 1.037-1.917) and not in the intermittent exotropia group (OR = 0.995; 95% CI, 0.938-1.056). In both groups, overcorrection was not asso-
Associated with any factors, including age at surgery. This paper finds that older age at surgery was associated with risk of recurrence in infantile exotropia with constant deviation, but it was not correlated with surgical outcomes for patients with intermittent exotropia in this study.

**Clinical and Histopathologic Features of Consecutive Exotropia.**

Consecutive exotropia occurs in up to one-quarter of patients who undergo surgery for esotropia. Commonly it is caused by stretched scars and slipped muscles, with stretched scars usually occurring later than slipped muscles. However as they can appear similar, and thus the term “abnormal scleral attachment” has been proposed. The authors prospectively examined 30 eyes of 30 patients with consecutive exotropia over an 8 month period. During surgery the stretched scar was excised and sent for histopathology and compared to 11 medial rectus muscle specimens. Of the 30 cases, 12 (40%) had abnormal scleral attachments. Seven of the 12 showed no muscle in the specimen. The mean amount of medial rectus resection was 4.15 ± 0.44 (4–6) mm. The mean amount of medial rectus advancement was 3.42 ± 1.6 (0–6) mm. The mean amount of medial rectus resection plus advancement was 7.57 ± 1.47 (4–10) mm. Dose–response analysis showed that for near the result was 4.7 ± 2.7 PD/mm and for distance the result was 4.2 ± 1.9 PD/mm. The dose–responses in abnormal scleral attachment subgroup were slightly different but not statistically significant with 5.6 ± 3.8 PD/mm at near and 4.9 ± 2.6 PD/mm at distance. Nineteen patients (63%) had surgical success at 6 months. There was no significant correlation between surgical success and patients’ age, sex, first surgery type, time from first surgery, time from deviation occurrence, preoperative far and near deviations, abnormal scleral attachment, and preoperative adduction limitation (all P > 0.05). This study showed surgical success of 63% with one-muscle surgery in consecutive exotropia. The addition of lateral rectus recession or the use of nonabsorbable sutures might improve the success rate.

**Reduction of Consecutive Esotropia Using Modified Contralateral Recession and Resection for Recurrent Intermittent Exotropia.**
Soon Young Cho, Se youp Lee *J of Ped Ophth & Strabismus.* 2018; 55(1):53-58

The purpose of this study is to compare the surgical outcomes of modified (surgical dose reduction by 5 PD compared to conventional surgical dose ) and conventional contralateral lateral rectus recession and medial rectus resection for exotropia after unilateral lateral rectus recession and medial rectus resection. A total of 36 patients were included in this retrospective study. As a primary surgery for exotropia, all patients underwent unilateral lateral rectus recession and medial rectus resection on the non-dominant eye. Patients were subsequently assigned
to either conventional contralateral lateral rectus recession and medial rectus resection (surgical dosages based on Wright's surgical table) (n = 19; conventional group) or modified contralateral lateral rectus recession and medial rectus resection (surgical dosages reduced by 5 prism diopters on Wright's surgical table) (n = 17; modified group) for recurrent exotropia. Surgical success rates were evaluated. Reoperation or prism glasses prescription rates due to consecutive esotropia were evaluated. The mean follow-up durations after reoperation were 25.8 and 24.0 months in the conventional and modified groups, respectively. The surgical success rates were 73.7% and 82.4% (P = .538) and the recurrence rates were 0% and 17.6% (P = .059) respectively. The reoperation or prism glasses prescription rates due to consecutive esotropia were 26.3% and 0%, respectively (P = .025). The authors state that in their study on patients with recurrent exotropia, conventional contralateral lateral rectus recession and medial rectus resection showed a significantly higher rate of overcorrection in the early and late postoperative periods. Therefore, the surgical dosage for contralateral lateral rectus recession and medial rectus resection in recurrent exotropia should be reduced. A novel modification for contralateral lateral rectus recession and medial rectus resection in recurrent exotropia after unilateral lateral rectus recession and medial rectus resection might be useful to reduce the rate of consecutive esotropia after a secondary operation for patients with recurrent exotropia. To reduce consecutive esotropia after surgery for recurrent exotropia after previous unilateral lateral rectus recession and medial rectus resection, surgical dosages reduced by 5 PD from the conventional surgical table are highly recommended, per the authors of the article.

**Surgical Outcome of Intermittent Exotropia With Improvement in Control Grade Subsequent to Part-time Occlusion Therapy.**

Seung Pil Bang, Dong Cheol Lee, Se Youp Lee  
*J of Ped Ophth & Strabismus.* 2018; 55(1):59-64

In this study the authors evaluated the effect of improved control with part-time occlusion therapy on the final postoperative outcome in patients with intermittent exotropia. Control of intermittent exotropia was graded as good, fair, or poor in 89 consecutive patients with intermittent exotropia during their first visit. The patients were reevaluated after part-time preoperative occlusion therapy and divided into two groups (improvement and no improvement) according to whether they showed improvement in control grade. The surgical success rate was compared retrospectively between the two groups. The mean angle of deviation on the first visit was $27.61 \pm 5.40$ prism diopters (PD) at distance and $29.82 \pm 5.28$ PD at near. There were significant improvements in the angles of deviation for distance ($26.17 \pm 5.09$ PD) and near ($27.26 \pm 5.56$ PD) after part-time occlusion (both $P < .001$). The 49 patients who had a significantly improved control grade had a significantly better surgical success rate (77.6%) than the 40 patients who did not (50%; $P = .007$). The final success rate of surgery was better in the improvement group than in the no improvement group (77.6%
vs 50.0%), without any other contributing factors that might have caused a statistically significant difference between the two groups. This suggests that patients with intermittent exotropia who achieve improved control with part-time occlusion therapy could expect better surgical outcomes than their counterparts who did not. There are some limitations to this study. First, its retrospective nature meant that it was difficult to confirm the exact degree of compliance with occlusion therapy. Second, the sample size was relatively small, and the larger size of the improvement group might have led to an overestimation of the success rate in this group. Third, it was not possible to perform fusion and stereoacuity tests at distance or near, so we could not determine the relationship between control, fusion, and stereoacuity. Fourth, the follow-up period was only 1 year, so a study incorporating a longer follow-up evaluation might be necessary in the future. The authors conclude that improving the control grade of intermittent exotropia through the implementation of part-time preoperative occlusion therapy may lead to a better surgical success rate than that achieved by surgery alone. Part-time occlusion therapy improves the control grade, which affects the surgical outcome in addition to decreasing the angles of deviation for distance and near.

**Vertical muscle surgeries**

**Surgical Outcome of Single Inferior Oblique Myectomy in Small and Large Hypertropia of Unilateral Superior Oblique Palsy.**


The purpose of this study is To determine the efficacy of isolated inferior oblique myectomy on hypertropia in primary position, side gazes, and tilts, and its effect on comitancy and abnormal head posture in unilateral superior oblique palsy. Thirty-nine patients with unilateral superior oblique palsy who had inferior oblique overaction underwent inferior oblique myectomy. The hypertropia was measured in primary position, side gazes, and tilts preoperatively and postoperatively. Abnormal head posture was also assessed. Success was defined as primary position hypertropia of 5 prism diopters (PD) or less. The mean distance hypertropia was 15.7 ± 7.7 PD (range: 3 to 30 PD) preoperatively and 1.5 ± 3.3 PD (range: 0 to 16 PD) postoperatively ($P < .001$). The mean reduction of distance hypertropia postoperatively was 14.2 ± 7.8 PD (range: 3 to 30 PD). The contralateral gaze hypertropia decreased from 21.7 ± 9.0 PD (range: 5 to 45 PD) preoperatively to 3.6 ± 5.1 PD postoperatively (range: 0 to 20 PD) and ipsilateral head tilt hypertropia decreased from 21.9 ± 8.4 PD (range: 8 to 40 PD) preoperatively to 5.0 ± 5.9 PD (range: 0 to 24 PD) postoperatively ($P < .000$ for both). Incomitance (contralateral ipsilateral gaze hypertropia) decreased from 15.0 ± 7.4 PD (range: 3 to
Preoperatively to 2.8 ± 4.1 PD (range: 0 to 16 PD) postoperatively (P < .001). The success rate between the two groups of patients who had hypertropia of 15 PD or less and greater than 15 PD in primary position was not statistically different (94.7% vs 85%). Two patients underwent a second operation for residual hypertropia. There was no overcorrection. Thirty-two patients had abnormal head posture, which resolved postoperatively in 29 cases. The authors conclude that isolated inferior oblique myectomy is a simple and effective procedure in improving hypertropia due to superior oblique palsy. It can resolve large amounts of hypertropia with low risk of undercorrection and overcorrection. It is effective in resolving abnormal head posture and concurrent small amounts of horizontal deviation. In addition, inferior oblique myectomy is a self-adjusting measure that also decreases incomitancy. It is recommended that isolated inferior oblique myectomy be the first procedure for every patient with hypertropia of 30 PD or less due to unilateral superior oblique palsy with negligible superior oblique under action. This study has some limitations. The traumatic superior oblique palsy group is small and there is no quantification for abnormal head posture. In addition, objective torsion was not measured in this study.

Surgical Management in Type 1 Monocular Elevation Deficiency.


The purpose of this retrospective chart review is to evaluate the outcome of surgical treatment in patients with type 1 monocular elevation deficiency who were diagnosed as having type 1 monocular elevation deficiency by forced duction test and exaggerated traction test. Epidemiologic and clinical features of the patients were noted. The efficacy of ipsilateral inferior rectus recession to vertical misalignments and limitation of elevation were evaluated. The clinical features of the patients who did not achieve surgical success after inferior rectus recession were determined. The surgical and functional results of contralateral superior rectus recession were evaluated for patients who had residual hypotropia under inferior rectus recession. Thirty-nine patients were included in the study. Preoperatively, vertical deviations were 20.53 ± 4.50 prism diopters (PD) for near and 22.21 ± 5.12 PD for distance. After inferior rectus recession, the amount of vertical deviation corrected was 15 ± 1.14 PD for near and 17.01 ± 2.00 PD for distance. Ten (25.64%) patients did not achieve surgical success (> 6 PD residual hypotropia). Nine patients (preoperative inferior rectus recession measurements = 28.77 ± 7.25 PD for near and 27 ± 7.44 PD for distance) underwent contralateral superior rectus recession as a second surgery. After contralateral superior rectus recession, 7 of 9 (77.78%) patients achieved surgical success. The limitation of elevation significantly improved after both surgeries (Wilcoxon test, P < .05). No diplopia or other complications after surgeries were reported. The authors concluded that inferior rectus recession is the first surgical option for inferior rectus restriction in patients with type 1 monocular elevation deficiency. It is an effective
procedure to decrease vertical misalignments but can be insufficient for large vertical deviations. After inferior rectus recession, contralateral superior rectus recession was effective for decreasing large vertical deviations. Contra-lateral superior rectus recession is a suitable alternative treatment option because it is relatively easy to perform and avoids the potential risks of tendon transposition surgery, such as anterior segment ischemia. The main limitations of this study were the relatively small sample size and no comparison with other surgical options, such as tendon transposition surgery, due to the retrospective design.

Consecutive superior oblique palsy after adjustable suture spacer surgery for Brown syndrome: incidence and predicting risk.


The aim of this retrospective study was to determine the incidence of significant superior oblique palsy (SOP) after adjustable superior oblique suture spacer surgery for treatment of Brown syndrome and to identify characteristics predicting its development. A total of 19 patients treated for unilateral Brown syndrome with adjustable suture spacers (2005-2016) were reviewed to identify possible association of age at surgery, spacer length, surgeon performing procedure, severity of Brown syndrome, preoperative hypotropia in primary position and affected side gaze, and reduction in Brown restriction on postoperative superior oblique function. "Good" postoperative superior oblique function was defined as absence of hypertropia and diplopia in primary position and no more than intermittent diplopia in downgaze comfortably fused with ≤4 PD base-down or head tilt of <10°. Of 19 patients, 16 (84%) achieved sufficient resolution of Brown syndrome (defined as Brown restriction of ≤-2), but 6 (32%) developed significant SOP. Using logistic regression modelling, preoperative minimal hypotropia on contralateral gaze was shown as the only predictor of significant SOP (likelihood ratio test =7.11; P= 0.008). The authors concluded that suture spacer surgery can result in significant SOP. Risk may be predicted by magnitude of preoperative contralateral side gaze hypotropia. In their discussion the authors suggest that given the potential for spontaneous resolution of Brown syndrome and the high risk of SOP associated with minimal preoperative hypotropia in affected side gaze, conservative management would have been preferable for these patients. On the other hand, patients with >16PD of hypotropia in affected side gaze have ≥80% estimated probability of retaining good postoperative superior oblique function. These patients benefit the most from surgery. This study makes an important observation regarding adjustable suture spacers in Brown. The discussion outlines the possible approach to patients with Brown drawn from this study’s data.
Anterior superior oblique tuck: an alternate treatment for excyclotorsion.


Excyclotorsion is typically treated with surgical procedures such as the Harada-Ito, rectus muscle transposition, and inferior oblique weakening. The authors describe in this short report an alternative technique, the anterior superior oblique tuck. Their report includes 5 consecutive patients with a symptomatic excyclotropia of at least 5°. The patients ranged in age from 47 to 67 years. Preoperative torsion measured with the Maddox rods ranged from 7° to 15° (mean, 10±3°), decreasing significantly to 2.5±2° (P = 0.009). Postoperative follow up ranged from 20 to 113 days (mean, 69±34 days). The effect on torsion was stable in all but 1 patient, who had developed non-symptomatic excyclotorsion of 5° by final follow-up. The authors conclude that this procedure is technically simpler than the Harada-Ito and provides similar results. A demonstrative video is included.

Modified anterior transposition of the inferior oblique muscle.


The purpose of this retrospective case series was to introduce a modified method of anterior transposition of inferior oblique (ATIO) and to compare it with the traditional method in terms of efficacy and complications. A total of 31 patients who had undergone unilateral ATIO and were followed for at least 6 months were included in the study. The patients were divided into two groups according to surgical method: modified ATIO (modified group, n = 16) and traditional ATIO (traditional group, n = 15). In modified ATIO, the anterior nasal fibers of the inferior oblique muscle were anchored to the sclera and the posterior temporal fibers were folded and buried under the fixed anterior nasal fiber of inferior oblique muscle. In the traditional method, both the anterior and posterior fibers were fixed with individual suturing. Postoperative change in vertical deviation and grade of inferior oblique overaction (IOOA) were analyzed. Complications, including anti-elevation syndrome, fat adherence syndrome, and lower lid deformity were assessed. Both modified and traditional methods effectively weakened the action of the inferior oblique muscle. The efficacy of the two methods did not differ in terms of change in vertical deviation (P = 0.225) and grade of IOOA (P = 0.169). Anti-elevation syndrome occurred more frequently in the traditional group than in the modified group (8/15 vs 2/16, resp. [P = 0.019]). Incidences of fat adherence syndrome (0/15 vs 0/16 [P = 1.0]) and lid deformity (3/15 vs 1/15 [P = 0.678]) were not different. The authors concluded that modified ATIO was comparable to traditional ATIO in correcting vertical deviation and IOOA and had a lower risk of anti-elevation syndrome compared with traditional ATIO. Despite its retrospective nature and small
sample size, this study demonstrates nicely the advantages of this technique.

Dose Effect and Stability of Postoperative Cyclodeviation After Adjustable Harada-Ito Surgery

A retrospective cohort study of one surgeon’s patients over a 20-year period was performed with the goal of reporting the dose-response relationship of the adjustable Harada-Ito surgery. The secondary goals of this study were to report the changes in the cyclodeviation over time and to recommend a target angle in the immediate postoperative period (adjustment target). There were 20 patients who underwent a unilateral adjustable advancement of the anterior fibers of the superior oblique tendon. Double Maddox rod was use to measure the cyclodeviation. The pre op measurements were compared to the 1 day and 6-week post op measurements in all patients and to the in 1- and 5- year measurements when available. The authors found that there was a dose effect of 1.3 degrees per mm of advancement (+ resection). There was a regression towards excyclodeviation between adjustment and the 6 week post op of 6.5 ± 2.6 degrees, and to a lesser extent after that. The authors recommend an initial overcorrection target of 7 degrees of incyclotorsion after adjustment. The authors point out the limitations, which include lack of complete follow up data in all patients and continued debate about the need for an adjustable procedure for torsion. This paper’s most important contributions are the reminder of the cyclodeviation regression with time and the dose effect calculations.

Superior oblique tuck: evaluation of surgical outcomes.

A variety of techniques exist to surgically manage superior oblique palsy. The authors performed a retrospective chart review of 162 patients who underwent a superior oblique tuck from 1992-2016 to compare surgical success. Of the cases of superior oblique palsy, 110 patients had a congenital palsy. Pre-operatively the mean angle of deviation was 15.88 PD (range 4-35 PD) and the mean post-operative angle was 5.09 PD (range 0-20 PD). The mean overall reduction was 10.79 PD (range 0-34 PD). A significant difference was observed between those patients who had pre-operative angles of deviation >15 PD and those with <15 PD (14.85 PD vs. 6.83 PD; p < 0.0001). 54 patients (33.33%) required additional extraocular muscle surgery. 24 patients (14.82%) experienced post-operative iatrogenic Brown’s syndrome but only two of these required further corrective surgery. Patients with acquired superior oblique palsy tended to have worse clinical outcomes with a greater incidence of post-operative diplopia and the requirement for further surgery. There was no linear relationship between the amount of the tuck and surgical outcomes. Overall, a superior oblique tuck seems to be an ef-
Effective manner of surgically managing superior oblique palsy, although there appears to be a somewhat unpredictable amount of correction.

Vertical rectus muscle recession versus combined vertical and horizontal rectus muscle recession in patients with thyroid eye disease and hypotropia

This paper compares the postoperative vertical drift in patients with thyroid eye disease (TED) with hypotropia who underwent vertical rectus recession alone versus vertical rectus recession combined with horizontal rectus recession. The study was a retrospective review of the medical records of patients with TED who underwent strabismus surgery for hypotropia between 2006 and 2015 were reviewed retrospectively. Patients were divided into two groups: group 1 underwent vertical rectus recession only; group 2 underwent vertical rectus recession plus horizontal rectus recession. Data collection included pre- and postoperative deviation measurements and amount of surgical recession performed. The amount of postoperative vertical drift between groups was compared. Of 67 patients who underwent surgery during the study period, 9 in each group met inclusion criteria for a total of 18 included in the study. In the study, the mean postoperative hypotropia was 24.2Δ in group 1 and 24.5Δ in group 2 (P = 0.82). The mean vertical deviations were 0.3Δ and −2.2Δ (P = 0.134) on postoperative day 1; −0.9Δ and −8.0Δ (P = 0.043) at final follow-up for groups 1 and 2. The mean postoperative vertical drift toward hypertropia was 1.2Δ in group 1 and 6.8Δ in group 2 (P = 0.048). The authors found that the surgical success rate for group 1 was superior to that for group 2 (89% vs 67% [P = 0.024]). The paper is limited by the short average follow up of 4 months and small number of patients. The authors conclude that there was a significantly larger postoperative vertical drift in TED patients with hypotropia who had combined vertical rectus and horizontal rectus recessions compared with those who underwent vertical rectus recession alone; this is important to consider in approaching these patient surgically.

The efficacy of superior rectus recession with simultaneous inferior oblique disinsertion on superior oblique palsy with superior rectus contracture.

Ipsilateral superior rectus contracture may develop in cases of long-standing superior oblique palsy. The authors sought to evaluate the efficacy of superior rectus recession with simultaneous inferior oblique weakening in these patients. The records of 145 patients were reviewed retrospectively and 15 patients met the inclusion criteria. Of these the superior oblique palsy was congenital in 12 patients and traumatic in 3 patients. SR contracture was confirmed intraoperatively by forced ductions in all patients. The SR was recessed 4.86±1.18 mm. The
mean post-operative vertical deviation was -3.0±4.3 PD. Postoperative overcorrection occurred in 3 of 15 cases. All three overcorrected patients received Botox. Two resolved and one was determined to have a masked bilateral superior oblique palsy. The results of our study suggested that SR recession in combination with IO disinsertion is an effective procedure in long-standing SOP with SR contracture. However, we have found 20% risk of overcorrection despite adjustable suture surgery.

**Long-term follow-up after vertical extraocular muscle surgery to correct abnormal vertical head posture.**

There is a lack of studies looking at the results of extraocular muscle surgery to address chin up or chin down head positions in nystagmus. The existing studies are limited by short followup, heterogenous patient populations and a variety of surgical techniques. The authors report a case series of 7 patients who underwent vertical extraocular muscle surgery to address a chin up or chin down head position. The patients ranged in age from 19-96 months and were all categorized as infantile nystagmus syndrome. Five of 7 underwent combined vertical recti and oblique surgery, and 2 underwent vertical recti muscle recessions only. Six patients improved post-operatively, of which 3 had complete resolution of the anomalous head position. One patient was overcorrected, however the family opted to defer further surgery. Overall the authors conclude that combining the procedures resulted in smaller surgical doses, which avoids other complications such as eyelid malposition and restricted range of ductions. Additionally the combination lowers the risk of inducing torsion, which improves the chances of maintaining binocularity in patients capable of perceiving diplopia.

**Comparative study of unilateral versus bilateral inferior oblique recession/anteriorization in unilateral inferior oblique overaction.**

This randomized, prospective study evaluated the rate of antielevation syndrome which develops after inferior oblique surgery in a cohort of 34 patients. The authors anticipated the possibility of antielevation syndrome because they perform graded recession/anteriorization procedure rather than myectomy for inferior oblique weakening. The outcome measures included motor outcomes, resolution of torticollis, and antielevation. Antielevation was noted more frequently in the unilateral IO weakening group than in bilateral surgery.

**Simultaneous Superior Rectus Recession and Anterior Transposition of Inferior Oblique Muscle as a Surgical Option for Traumatically Lost Inferior Rectus Muscle.**
The inferior rectus muscle is the most common extraocular muscle to be disinserted due to trauma, most likely due to Bell’s phenomenon with forced eye closure. This results in hypertropia in primary position with severe limitation to depression. Current surgical techniques for repair often result in undercorrection and incomitance. In order to address this issue, the authors proposed performing simultaneous ipsilateral superior rectus recession and inferior oblique recession with anterior transposition. They evaluated the post-operative outcomes of six adult patients (5 males between 30-45 years old and 1 female who was 38 years old) with traumatically lost inferior rectus muscles who underwent this procedure. At three weeks after surgery, 3 of 6 patients were orthophoric and the remaining patients had 4-7 PD of vertical misalignment in primary gaze. The authors conclude that simultaneous recession of the superior rectus with ATIO is a reasonable option to treat a lost inferior rectus muscle due to trauma.

**Rectus Muscle Resection for Vertical Strabismus in Thyroid Eye Disease.**

Rectus muscle recession is the preferred procedure in patients with thyroid eye disease (TED) in order to avoid the theoretical increase in muscle restriction and re-activation of inflammation. However recessions alone may be insufficient to address large angle deviations and/or diplopia. The authors performed a retrospective review of patients with TED who had previously undergone maximal vertical rectus muscle recessions who subsequently underwent vertical rectus muscle resection without adjustable sutures by a single surgeon at a single center. The authors included eight adult (mean age 65 ± 8.9 years) patients (all female) who had stable TED for at least six months prior to surgery. The mean pre-operative distance misalignment was 15.8 PD (range 6-28 PD). Nine vertical rectus muscles were resected (5 SR, 4 IR). Post-operatively, the mean vertical misalignment at distance was decreased to 3.9 PD (range 0-12 PD) at one month, with a gradual regression to 7.4 PD (range 0-25PD) at final follow up. The majority of patients (62.5%) achieved single binocular vision in primary and reading positions with no prism or prism < 5PD. This study suggests that that resection may be a useful surgical option in patients with large residual deviations after maximal recession surgery.

**Median 8 year follow-up after vertical extraocular muscle surgery to correct abnormal vertical head posture.**

There is a lack of studies looking at the results of extraocular muscle surgery to address chin up or chin down head positions in nystagmus. The existing studies
are limited by short followup, heterogenous patient populations and a variety of surgical techniques. The authors report a case series of 7 patients who underwent vertical extraocular muscle surgery to address a chin up or chin down head position. The patients ranged in age from 19-96 months and were all categorized as infantile nystagmus syndrome. Five of 7 underwent combined vertical recti and oblique surgery, and 2 underwent vertical recti muscle recessions only. Six patients improved post-operatively, of which 3 had complete resolution of the anomalous head position. One patient was overcorrected, however the family opted to defer further surgery. Overall the authors conclude that combining the procedures resulted in smaller surgical doses, which avoids other complications such as eyelid malposition and restricted range of ductions. Additionally the combination lowers the risk of inducing torsion, which improves the chances of maintaining binocularity in patients capable of perceiving diplopia.

**Inferior Oblique Belly Transposition for Small Angle Hypertopia With Inferior Oblique Overaction: A Pilot Study**


The purpose of this retrospective study is to evaluate the efficacy of transposition of the belly of the inferior oblique muscle in treating inferior oblique overaction with small angle hypertropia. Ten patients participated in the study. Transposition of the inferior oblique muscle belly consisted of suturing the entire body of the muscle to the sclera 5 mm posterior to the temporal insertion of the inferior rectus muscle. All patients had small hypertropias (< 5 prism diopters) in the primary gaze position with associated inferior oblique overaction. Deviations in both primary and lateral gazes, compensatory face turns or head tilts, and the degree of inferior oblique overaction were evaluated preoperatively and postoperatively. The study showed that 9 out of 10 patients had a complete resolution of inferior oblique overaction. In the remaining patient, the inferior oblique overaction improved from +3 to +1. None of the patients had any residual vertical deviation. There was elimination of compensatory head tilting in 5 patients and correction of compensatory face turns in 4 patients. One patient with mild up drifting of the involved eye also improved after the procedure. All patients expressed subjective satisfaction with the surgical outcome. The authors conclude that transposition of the inferior oblique muscle belly effectively weakened mild to moderate inferior oblique overaction and corrected small primary position hypertropias. This procedure may be a useful addition to surgical treatment options in patients with small hypertropias associated with inferior oblique overaction.

**Transposition surgeries**


The purpose of this article is to describe a new surgical technique for the treatment of complete third nerve palsy. The lateral rectus muscle was split, followed by disinsertion of the superior and inferior halves, which were passed between the sclera and superior and inferior rectus muscles, respectively. Then the medial rectus muscle was sutured as posteriorly as possible from its insertion and cut. Next, the distal stump of the medial rectus muscle was split into two halves and united with the superior and inferior halves of the lateral rectus muscle. Finally, the proximal portion of the medial rectus muscle was sutured back to its original insertion. In cases with hypotropia and a functional superior oblique muscle, superior oblique tenectomy was also performed. Success was defined as postoperative horizontal deviation of 10 prism diopters (PD) or less and vertical deviation of 5 PD or less. Ten patients with a mean age of 32.4 ± 18.4 years had surgery using this technique; 2 of them had a history of strabismus surgery. Mean exotropia was 84 ± 14.9 PD, which reduced to 6.5 ± 8.2 PD. Mean vertical deviation was 16.5 ± 10 PD, which reduced to 2.5 ± 3.5 PD. Mean follow-up was 13.2 ± 7.9 months, and the success rate was 70% and 90% for horizontal and vertical deviations, respectively. The patients were followed for 3 months. One should note that, with this method, the sequence of actions during the operation must be precisely followed for the procedure to be successful and this requires a long learning curve. It is also predictable that reoperation may be difficult after this procedure; however, reoperation was performed in two of the authors’ cases successfully. One limitation of all types of surgeries for correction of strabismus associated with complete third nerve palsy is the inability to address aesthetics by ptosis surgery in most cases; in this study, ptosis correction could be performed in only 30% of cases. Another limitation of this study is the small sample size requiring further evaluation to show its efficacy and safety and the short follow-up. The authors conclude that transposition and union of a split lateral rectus muscle with the stump of a resected medial rectus muscle, together with superior oblique tenectomy in hypotropia cases, is a dynamic procedure that improves alignment in primary position and can help balance ocular movements in a paralytic eye. This technique can be used as a reoperation procedure and in children without using any autogenous or exogenous material.

Dual-Augmented Transposition of Vertical Recti in Chronic Abducens Palsy


This retrospective case series of 14 patients with abducens palsy aims to report the results of dual-augmentation of a partial tendon transposition. The author of this paper collected pre and post surgical data including alignment, head posi-
tion, limitation in eye motility, and demographic data. The author uses a combination of posterior scleral fixation (Foster modification) and a suturing the transposed vertical recti to the lateral rectus (Wright modification) to augment the effect of the partial tendon transposition in the treatment of abducens nerve palsy. A partial transposition was performed in all patients and eyes with positive intraoperative forced duction testing an ipsilateral weakening of the medial rectus muscle was also performed. The dual augmented partial tendon transposition procedure provided a mean of 31.3 prism diopters of correction. Head position and limitation in abduction was also improved with this procedure. The author had no cases of anterior segment ischemia, and 3 cases did have a small angle vertical deviation (hypertropia) post operatively, but none requiring surgical intervention. This paper does a good job providing the reader with another option in the treatment of abducens palsy. The small sample size is a main limitation. The discussion section has a good review of other options for treating this difficult condition. The title should reflect that this is a partial tendon transposition.

A modified vertical muscle transposition for the treatment of large-angle esotropia due to sixth nerve palsy.

Non-resolving sixth nerve palsy can be treated by a variety of surgical procedures, of which the augmented Hummelsheim has become the most popular. However alternatives to this procedure, such as the Nishida procedure, are emerging. The authors performed a prospective study in which they enrolled 10 patients with complete sixth nerve palsy who underwent a modified Nishida procedure. In the procedure, the authors used 6-0 Mersilene through the temporal margin of each vertical rectus muscle 1/3 of the width from the edge 10mm behind in the insertion and then transposed the vertical muscles without tenotomy or splitting, inserting them 16mm from the limbus in the superotemporal and inferotemporal quadrants. A medial rectus recession was performed in conjunction with the transposition. The mean correction was 49 PD. The post-operative deviation ranged from ortho to 12PD ET at final followup. Two patients had a slight overcorrection at POM 1 but this resolved. All patients had some abduction to at least midline. There were no cases of anterior ischemia syndrome. This procedure may be an option to consider when surgical treatment for complete CN 6 palsy is planned.

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**Sutures / Adjustables**

**Retrobulbar anaesthesia for adjustable strabismus surgery in adults: a prospective observational study**


Retrobulbar anesthesia allows for patients with significant comorbidities to undergo surgery without the risk of general anesthesia. There is limited data on the utility of retrobulbar anesthesia in adjustable strabismus surgery. Concerns about how long it takes for the anesthesia to wear off prior to same day adjustments as well as injection complications may limit its use. This observation study attempted to characterize ocular responses to retrobulbar anesthesia and its efficacy for adjustable strabismus surgery. 33 patients were included in the study. Two of these were excluded from data analysis due to complications – perioperative retrobulbar hemorrhage and postoperative suprachoroidal hemorrhage (both of which recovered to baseline). Of the 31 patients included in analysis, surgery outcome was satisfactory (within 10PD of orthotropia for horizontal surgery, 5 PD for vertical surgery) in 30/31 at first post-operative visit and in 15/19 at last follow-up visit (mean 6.1 months). Visual impairment due to the anesthesia resolved to pre-operative levels within mean of 3.7 hours. Pain returned at 4.1 hours, ptosis resolved at 4.3 hours, and pupils returned to normal reactivity at 6.1 hours. Extraocular motility returned to normal within 5.7 hours. These data allowed the authors to conclude that retrobulbar anesthesia is relatively safe and effective, and allows for same day suture adjustments to be performed.

**Comparison of adjustable sutures versus nonadjustable sutures in intermittent exotropia**
There are fewer than 5 randomized controlled studies comparing adjustable to non-adjustable suture technique for strabismus and this is one of the papers. In this study, the authors evaluate the efficacy of adjustable sutures in patients undergoing bilateral lateral rectus surgery for intermittent exotropia. The paper evaluated motor outcomes, binocularity, and need for reoperation in this cohort of 40 adults. When needed, adjustment would be performed on same day of surgery in the adjustable cohort and occurred in 20% of patients (4). The primary endpoint was at 3 months. The authors found no difference in the two techniques.

**Adjustable Strabismus Surgery under Topical Anesthesia: Alignment in Supine vs Seated Position.**


Topical anesthesia allows adjustment in the operating room while the patient is still conscious. No prior studies have compared strabismus alignment before adjustment in the seated and decubitus positions while under topical anesthesia. The authors sought to compare the ocular deviations between the seated and decubitus positions as well as the post-operative alignment outcomes at 1 day, 1 month and 3 months. The authors performed a prospective observational study of 30 adult patients undergoing adjustable suture strabismus surgery comparing the alignment outcomes in a supine or decubitus position. Defined parameters for viewing target type and distance and for proceeding with adjustment were standardized. The diagnoses were diverse and consistent of sixth nerve palsy, esotropia in high myopes, and age-related strabismus among others. The most frequent procedure was a unilateral recession and resection. Intraoperative adjustment was performed in 12 (40%) cases. No statistically significant differences were found between ocular deviations in the seated or supine position in the operating room. No statistically significant differences were detected in the final deviation between patients who were adjusted and those who were not. None of the factors evaluated (age, gender, diplopia, number of muscles operated on, surgical adjustment, preoperative deviation, and intraoperative deviation in the seated and decubitus position) influenced surgical outcome. The intraoperative deviation was not a predictor of success and most patients had a favorable outcome at all of the post-operative visits.

**Strabismus surgery - Misc**

Surgery option in the management of delayed diplopia after radiation therapy for nasopharyngeal carcinoma
The authors in this study retrospectively evaluate outcomes of strabismus surgery for patients with 6th nerve palsy after radiation treatment for nasopharyngeal carcinoma. In this study, all patients underwent unilateral lateral rectus resection for a mean reduction in horizontal strabismus from 16 PD to 1.5 PD. Outcomes were favorable at 1 year with no recurrence of diplopia in the cohort.

Spontaneous reattachment of medial rectus after free tenotomy.


The purpose of this study is to assess the outcome of free tenotomy of the medial rectus muscle in post-natal monkeys. The medial rectus muscle was disinserted in both eyes of 6 macaques at age 4 weeks to induce an alternating exotropia. After the impact on the visual cortex and superior colliculus was investigated, the animals were examined post-mortem to assess the anatomy of the medial rectus muscles. The study showed that after tenotomy, the monkeys eventually recovered partial adduction. Necropsy revealed that all 12 medial rectus muscles had reattached to the globe. They were firmly connected via an abnormally long tendon, but at the native insertion site. The authors conclude that the medial rectus muscles are able to reattach spontaneously to the eye following free tenotomy in post-natal macaques. The early timing of surgery and the large size of the globe relative to the orbit may explain why reinsertion occurs more readily in monkeys than in children with a lost muscle after strabismus surgery.

A randomized controlled trial comparing the efficacy of topical antibiotic steroid combination versus no treatment after fornix-incision strabismus surgery.


The purpose of this prospective, randomized single-masked study was to compare comfort and inflammation in patients treated with postoperative topical antibiotic-steroid combination in one eye versus no treatment in the other eye. The study included all patients with planned symmetrical strabismus surgery via fornix incision. One eye was randomly assigned to topical postoperative tobramycin-dexamethasone and the other eye was used as control and was not treated. Patient and parent questionnaires were administered, and two masked observers assessed conjunctival injection over the muscle and wound site. A total of 70 patients completed at least 1 postoperative visit and were included. There was no statistically significant
difference between the treated eye and the untreated eye in any of the studied parameters. The authors concluded that post-operative topical antibiotic steroid was not superior to no treatment in uncomplicated fornix surgery regarding patient comfort and inflammation. The authors suggest that in uncomplicated fornix strabismus surgery, consideration should be given to sparing the patient the inconvenience, cost, and potential complications of the topical medication. The study was not designed to draw any conclusions regarding the possible risk of infections, when antibiotic drops are avoided post-operatively.

Developing and validating a simple and cost-effective strabismus surgery simulator

The goal of this paper is to demonstrate that a nonbiologic strabismus surgery simulator is not inferior to a biologic wet lab for teaching the key steps of strabismus surgery. A total of 41 medical students were randomly assigned to one of two groups: biologic wet lab or nonbiologic simulator. The students trained according to the group’s protocol then participated in a recorded final assessment using a realistic strabismus surgery model. Two independent reviewers, masked to training method, graded the video recordings using three scoring systems: the International Council of Ophthalmology Approved-Ophthalmology Surgical Competency Assessment Rubric for Strabismus Surgery (ICO-OSCAR), the Global Rating Scale of Objective Structured Assessment of Technical Skills (OSATS), and the Alphabetic Summary Scale (ASS). The primary endpoint, total ICO-OSCAR score, was 36.7 ± 2.2 for the wet lab group and 36.0 ± 2.7 for the nonbiologic group (difference in means, −0.7; one-sided 95% CI, −2.0, ∞). The lower bound of the one-sided 95% confidence interval for the difference in mean scores was −2.0, which was greater than the a priori noninferiority margin of −5.0 points. The secondary outcome measure, mean total OSATS score and ASS score, revealed no statistical significant differences between training methods (P = 0.73 and P = 0.44, resp.). The authors conclude that the simple, nonbiologic strabismus surgery simulator is not inferior to the biologic wet lab with respect to total ICO-OSCAR score. In addition, they feel that it is a portable, inexpensive, and effective training tool for novice surgeons; this type of system could be considered for training programs.

Informed consent for strabismus surgery: the importance of patient information sheets
Bhambhwani V, Taie RA, KU J, Mora J. JAAPPOS. April 2018;22(2):89-91.e3

This study was designed to analyze the additive effect of supplementing verbal consent with written patient information sheets in optimizing patients’ and families’ understanding of strabismus surgery. A prospective randomized study was
conducted with 28 patients for strabismus surgery randomized into two groups: group 1 with standardized oral informed consent, and group 2 with standardized oral consent and a written information sheet. A confidential questionnaire with 13 questions was completed by patients and families before surgery. A total of 7 adults and 21 children were included in the study. The mean score (number of correct answers) for group 1 was 4.14 ± 1.99; for group 2, 5.79 ± 2.12 (P = 0.044), indicating that patients and families in group 2 understood their strabismus surgery better than those in group 1. Areas needing more emphasis during the consent process were identified, including risk of under- or overcorrection or repeat surgery and duration of the use of eyedrops postoperatively. The authors conclude that patient information sheets seemed to help patients and families better understand information about their surgery. In addition, they point out that patient recall of information provided is poorly reliable and that this must be considered in decision making for medicolegal cases. Written information sheets should be considered in supplementing verbal consent prior to strabismus surgery.

Strabismus surgery outcomes without removal of scleral buckle in patients with previous retinal detachment repair

The goal of this paper was to report the motor and sensory outcomes of strabismus surgery following scleral buckle procedure for retinal detachment (RD) without removal of the scleral buckle. The medical records of patients who underwent strabismus surgery without removal of the scleral buckle following RD surgical repair at a tertiary referral center between 2002 and 2015 were reviewed retrospectively. Demographic data were recorded, and rates of surgical motor success (defined as horizontal deviation of ≤10Δ and vertical deviation of ≤4Δ) and sensory success (resolution of diplopia) were calculated. A total of 23 patients (mean age, 58.4 ± 24.4 years; 12 males) were included in this study. The average time between the RD surgery and onset of strabismus was 11.05 ± 10.95 months (range, 1-42 months) in this patient group. The strabismus was horizontal in 6 patients, vertical in 2 patients, and combined in 15 patients. Eighteen patients (78%) presented with diplopia prior to surgery. Adjustable sutures were used in 18 patients. Final motor surgical success was achieved in 17 of 23 patients (74%), and diplopia improved in 17 of 18 patients (94%) who had preoperative fusional capability. There was no statistically significant difference in age, number of RD surgeries, macular status, time to strabismus surgery, visual acuity in the worse eye, or magnitude of preoperative horizontal and vertical deviation with regard to motor success rate and with persistence of diplopia postoperatively. In this study cohort, strabismus surgery without removal of the scleral resulted in motor success and alleviated diplopia in the majority of patients with prior RD. Strabismus surgery can be considered without removing the buckle in patients with previous RD repair with anticipation of a good success rate.
Investigation of factors associated with the success of adult strabismus surgery from the patient’s perspective
Sim PY, Cleland C, Dominic J, Jain S. JAPOS. Aug 2018;22(4):266–271.e3

This paper seeks to explore factors that influence the success of adult strabismus surgery based on health-related quality of life (HRQOL) criteria. The HRQOL aspect of strabismus surgery was assessed using the Adult Strabismus 20 (AS-20) questionnaire. Adult patients (≥16 years of age) undergoing strabismus surgery between 2014 and 2016 were identified using a treatment register. In this study, pre- and postoperative AS-20 scores were calculated. The HRQOL surgical success was defined as a pre- to postoperative change in AS-20 score exceeding previously published 95% limits of agreement. In addition, the relationship between surgical success and demographic factors (sex, age, and socioeconomic status), presence or absence of diplopia, type and magnitude of deviation, and change in deviation size with HRQOL success was investigated. In this study, a total of 87 patients were included (mean age, 47 years; 53% female). The authors found that nondiplopic patients showed significantly lower pre- and postoperative scores on the AS-20 psychosocial subscale compared to diplopic patients. Of the total of 87 surgeries, 54 cases (62%) were classified as successful based on HRQOL criteria. The multiple logistic regression analysis showed the only lower socioeconomic status was significantly associated with a higher rate of HRQOL success (P = 0.04). The authors conclude that strabismic patients with a lower socioeconomic status are more likely to achieve HRQOL success following surgery. The authors also show that nondiplopic patients have more psychosocial concerns than those with diplopia and that this disparity persists even after strabismus surgery. These factors should be considered in assessing patients for adult strabismus surgery.

Surgical outcome of a new modification to muscle belly union surgery in heavy eye syndrome.

Several surgical techniques have been described to treat ocular misalignment due to heavy eye syndrome. The authors presented a modified technique in which the muscle bellies of the superior rectus muscle and lateral rectus muscle were united with two 5-0 Mersilene sutures 15 mm posterior to the insertion. The authors used two sutures to join the muscles as they observed inadequate muscle approximation with only one suture in prior cases. They did not include scleral fixation due to the risk of scleral perforation in high myopes. They performed a medial rectus recession if restriction was noted on forced duction testing. Of the 24 eyes of 16 patients, the mean deviation improved from 93.71 ± 23.1 PD (range 45 to 104 PD) to 11.53 ± 15.59 PD (range 0 to 25 PD). There were no overcorrections and no patients required additional surgery. The authors con-
clude that their modification is comparable and perhaps easier than other surgical options to treat heavy eye syndrome.

**Immediate postoperative alignment Measurements as a Predictor of Alignment stability in fixed Suture Strabismus Surgery.**
Charlene S. Boente, Griffin J.Jardine, Tina G.Damarjian, Derek T. Sprunger et al
*J of Ped Ophth & Strabismus.* 2018; 55(4):240-244

The purpose of this study is to evaluate the use of immediate postoperative alignment measurements as a predictor of future alignment stability in fixed suture strabismus surgery. Forty-seven patients were prospectively evaluated after undergoing horizontal or vertical rectus muscle surgery using a fixed suture technique. Alignment measurements were taken approximately 1 hour, 1 to 3 weeks, and 2 to 3 months postoperatively. A Spearman correlation coefficient was used to compare measurements from the immediate postoperative period to the 2- to 3-month postoperative period. Patients with dissociated strabismus, only oblique muscle surgery, or poor vision in one or both eyes precluding precise alternate cover test were excluded.

Mean age of all patients was 46.7 years (range: 12 to 86 years). Twenty-two patients underwent surgery for exotropia: 19 for esotropia and 6 for hypertropia. Mean alignment for all surgeries was 2 prism diopters (PD) undercorrection in the immediate postoperative period, which was similar to the mean of 4.6 PD undercorrection at 2 to 3 months postoperatively. However, the Spearman correlation between the immediate postoperative and 2- to 3-month postoperative measurements was 0.18 for all surgeries, 0.03 for exotropia, 0.56 for esotropia, and 0.40 for hypertropia. The overall success rate, defined as 8 PD or less of horizontal deviation and 4 PD or less of vertical deviation, was 77% at 2 to 3 months postoperatively.

The relationship between immediate postoperative alignment and future alignment stability in fixed suture strabismus surgery has not been previously defined. The current study demonstrated that although the surgical success rate was reasonably good, poor correlation occurred between the alignment immediately postoperatively and 2 to 3 months postoperatively. Limitations of the current study include the relative small amount of patients in each subgroup, the variability of surgical technique by each surgeon, and the follow-up time limited to postoperative month 2 and 3 although it seems reasonable that the alignment at 2 to 3 months postoperatively is an adequate time frame to assess the result of the surgery.

**A novel surgical technique employing donor sclera in strabismus surgery.**
A novel surgical technique is described employing donor sclera as a spacer to solve the problem encountered in complicated cases of restrictive strabismus surgery, when no muscle or tendon is available for surgical extension of the muscle to correct the angle of deviation. This is often the case in patients who have previously undergone extensive surgery and in patients with mechanical restrictions, such as thyroid-associated orbitopathy (TAO). A demonstrative video is attached. Although the authors mention they have performed this procedure on 284 cases, data is unfortunately not presented.

Strabismus surgery for Medicare-aged patients: more than a decade of insights.

The psychosocial and functional impact of strabismus among the elderly is increasingly important as life expectancy increases and factors that enhance the quality of life become more significant. The purpose of this retrospective study was to characterize the demographics, presenting complaints, health status, underlying etiology, and outcomes of strabismus surgery in three age cohorts of Medicare-aged patients. The medical records of patients ≥65 years of age who underwent strabismus surgery between 2004 and 2015 in a university-based strabismus practice were reviewed. A total of 110 patients were identified and divided into three age cohorts for analysis: young-old (age 65-74), middle-old (age 75-84), and old-old (age 85+). At least 75% of patients in all cohorts cited diplopia as their chief complaint (P = 0.87). There was no difference in sex distribution, type of deviation, underlying etiology, or preoperative American Society of Anesthesiologists physical status classification scores between the cohorts (P = 0.68, P = 0.53, P = 0.71, P = 0.93, resp.). By the 6- to 8-week postoperative visit, 63% of all patients reported complete resolution of their presenting chief complaint, 23% reported some improvement, and 11% reported no improvement, with no difference between the cohorts (P = 0.12). Twenty-two patients (20%) required reoperations; 56 patients (51%) did not require any additional medical or surgical treatment for their strabismus. Given the functional and psychosocial impact of strabismus in the elderly, this study lends support to consideration of surgery as a viable option to successfully treating strabismus among the oldest age cohorts.

Long-term follow-up of cryopreserved amniotic membrane transplant during strabismus reoperations: Up 85 months' follow-up.
The authors prospectively examine whether cryopreserved amniotic membrane wrapping of extraocular muscles during reoperation surgery is a successful approach towards prevention of adhesions and overall improvement of postoperative outcomes. Previously these authors reported on short term outcomes up to 1 year with this technique and the current study represents the long term outcomes using this method. Good motor outcomes were noted in 46.7% of patients. There was a statistically significant improvement in vascularity and scarring of the associated conjunctiva. The overall effect was not profound but in the absence of any long term complications, the authors offer this as a potentially useful technique in those reoperation cases in which adhesions and scarring are highly prevalent.

**The effect of strabismus surgery on choroidal thickness.**

In this study, the authors prospectively evaluated choroidal thickness in a pediatric cohort of patients using enhanced depth imaging in patients undergoing strabismus surgery. Authors investigated the impact of horizontal, oblique and combined horizontal and oblique surgery on subfoveal and perifoveal choroidal thickness. Although initially there was a decrease in choroidal thickness in the initial post operative period, this finding did not persist by three months post operatively. Ultimately there was no lasting effect on choroidal thickness in any of the groups investigated. The significance of the initial change in choroidal thickness therefore needs to be investigated further.

**The effect of amniotic membrane grafting on healing and wound strength after strabismus surgery in a rabbit model**

Amniotic membrane grafts (AMGs) are used, with mixed results, as a platform for ocular healing and to reduce pathologic scarring. This study evaluated wound tensile strength and histopathologic changes after strabismus surgery with AMGs in 20 New Zealand white rabbits. All subjects underwent 4 mm inferior rectus hang-back recessions to both eyes. The right eyes served as controls. Ten left eyes (group 1) received processed dehydrated amniotic membrane allografts (Ambiodyr2, IOP Inc, Costa Mesa, CA) and ten left eyes (group 2) received cryopreserved human amniotic membrane allografts (AmnioGraft, Bio-Tissue, Miami, FL) between the sclera and muscle insertion and between the muscle and repositioned conjunctiva. At postoperative month 1, tensile strengths of the muscle-globe and conjunctiva-globe attachments were measured, and histopathologic analysis of each eye was performed. In group 1 the mean tensile strength of the muscle-globe attachments was 441.4 ± 274.4 g; of the conjunctiva-globe attachments, 640.3 ± 266.4 g. In the control eyes, the comparable values were 365.8 ± 199.8 g and 595.2 ± 315.3 g, respectively.
(P = 0.19, P = 0.13). In group 2 the mean tensile strengths were 456 ± 297.5 g and 608.2 ± 306.7 g, compared with control values of 352.7 ± 114.8 g and 583.8 ± 347.1 g (P = 0.43, P = 0.45). The authors concluded that AMG did not have a significant effect on the formation of extraocular muscle attachment or conjunctival adhesions in their rabbit model of strabismus surgery 1 month after surgery, suggesting that AMG may not decrease pathological scarring or adhesion outcomes as measured by tensile strength in clinical strabismus surgery. Their results, although using rabbit eyes, suggest that neither dry nor cryopreserved amniotic membrane would inhibit scarring and formation of adhesions in human subjects following strabismus surgery.

**Efficacy of Botulinum Toxin in the Treatment of Convergence Spasm.**

Options for the treatment of convergence spasm include long-term cycloplegic drops with plus lenses, base out prisms or botulinum toxin injections to the medial rectus muscles. Currently there is no consensus on the best option. The authors performed a retrospective review of six patients (mean 44 years, range 16-71 years) with an average esotropia of 32.5 PD at near (range 25-45 PD). Five of the six had previously tried and failed conservative therapy with plus lenses and the other patient had failed prism therapy. Three patients received simultaneous injections to both MR muscles and 3 received sequential injections. Four of 6 patients were overcorrected at 2 weeks with an average deviation of 10 PD XT (range 20 PD XT to 25 PD ET). At 3 months after injection, the average deviation was 12.5 PD ET (range 15 PD XT to 35 PD ET). At 9 months after injection, all patients returned to their pre-injection levels. The authors conclude that there is limited benefit from botulinum toxin as the efficacy varies. In addition, repeat injections may be required and overcorrection is a common side effect.

**The efficacy of Bilateral lateral Rectus Recession According to Secondary Deviation Measurements in Unilateral Exotropic Duane Retraction Syndrome.**
Daphna Mexad-Koursh, Ari Leshno, Ainat Klein, Chaim Stolovich

The purpose of this retrospective chart review study is to evaluate the surgical results of asymmetric bilateral lateral rectus recession in exotropic Duane retraction syndrome with abnormal face turn toward the opposite side according to secondary deviation measurements. Seven cases of unilateral exotropic Duane retraction syndrome were reviewed. All cases had globe retraction on adduction and exotropia with limited adduction, five of which also had mild limitation of abduction. Four cases had upshoot/downshoot on adduction and all patients had face turn. The exotropia was always measured at the primary position using the alternate cover test while the prism bar was held in front of the healthy eye to de-
tect the maximal secondary deviation. In all patients, an asymmetric bilateral lateral rectus recession was performed using the fixed recession technique. The amount of recession of the lateral rectus muscle of the affected eye was determined according to the maximal deviation measured at distance fixation in the forced primary position. The lateral rectus muscle of the unaffected eye was recessed by 1 mm more than that of the affected eye. Y-splitting of the lateral rectus muscle was performed in all cases with upshoot or downshoot. The average lateral rectus recession was 6.36 mm (range: 5.5 to 7.5 mm) in the affected eye and 7.36 mm (range: 6.5 to 8.5 mm) in the healthy eye. The mean follow-up period was 282 days. Mean exotropia in the forced primary position improved from 27.9 ± 5.7 prism diopters (PD) preoperatively to 7.9 ± 16.8 PD postoperatively (P = .025). Head position resolved completely in all but one case (P = .031). There were no significant changes in ductions. The authors conclude that asymmetric bilateral lateral rectus recession in exotropic Duane retraction syndrome with abnormal head turn posture successfully eliminates abnormal head turn posture and exotropia in most cases. The study is limited by its retrospective nature as well as the fact that there was no control group (symmetric surgical approach), and therefore it is unknown whether a symmetric approach would have given the same results.

11. ANTERIOR SEGMENT

Femtosecond Lasers for Ophthalmic Surgery Enabled by Chirped-Pulse Amplification
Daniel Palanker, Ph.D. NEJM 379:2267-2269. 2018

In this report about the clinical implications of basic research, we learn that Donna Strickland and Gerard Mourour were awarded the 2018 Nobel Prize in Physics for their work leading to the development of femtosecond lasers. Femtosecond lasers precisely deliver small amounts of energy in very short duration, allowing precise cutting of tissues without damage to collateral tissues. Their ophthalmological applications include those in corneal surgery: the creation of corneal flaps for LASIK, cutting the corneal tissue required for SMILE (small incision lenticule extraction) refractive surgery, creating various types of corneal incisions for full and partial thickness corneal transplantation, and creating limbal relaxing incisions. They have additional applications in cataract surgery: cutting precise capsulotomies for cataract surgery, and performing lens fragmentation without ultrasound energy induced collateral endothelial damage. Femtosecond lasers are also being investigated in the treatment of floaters. Knowledge about this technology /Nobel Prize is of relevance to pediatric ophthalmologists because these lasers may become more widely used in pediatric anterior segment surgery in the future.
Prevalence of keratoconus in paediatric patients in Riyadh, Saudi Arabia
Keratoconus (KC) prevalence estimates show significant geographic variation. The study looked at the prevalence of KC using Scheimpflug imaging in pediatric patients in Riyadh, Saudi Arabia. This was a prospective multicenter study of subjects 6 to 21 years old seen at emergency rooms (for non-ophthalmic reasons) at 4 different locations. Corneal measurements were obtained with a Scheimpflug corneal tomography system. Two masked examiners were used to make the diagnosis of KC. 522 patients (1044 eyes) were evaluated. Prevalence for KC was 5.56% for the first examiner and 3.83% for the second. There was discrepancy in the diagnosis in 9 cases. After consensus obtained, final prevalence was 4.79% (1:21 patients). This prevalence is higher than numbers from other studies in other countries. The authors state this might be due to geographical variations or improved screening technology.

Rigid Gas Permeable Contact Lens as a vision-sparing tool In Children After Traumatic Corneal Laceration
The purposed of this comparative study is to evaluate the clinical value of rigid gas permeable contact lenses in children after traumatic corneal scarring. Fifteen children (age range: 5.7 to 14 years; mean ± standard deviation = 9.4 ± 2.9 years) with corneal scars and best-corrected visual acuity (BCVA) of worse than 20/20, history of penetrating ocular trauma, and/or cataract extraction were included in the study. All children were advised to wear spherical rigid gas permeable contact lenses for 6 months with a special regimen. Visual acuity was compared before and after fitting. The total and anterior surface aberrations of all children were measured using a corneal topographer before and after treatment. There was a significant improvement in the BCVA after wearing rigid gas permeable contact lenses compared to spectacle visual acuity \( (P = .001) \). There was also significant improvement of the keratometric astigmatism \( (P = .001) \) and corneal aberrations such as higher order aberrations \( (P = .008) \), lower order aberrations, root mean square, and point spread function \( (P = .001) \). The authors conclude that the optical performance of rigid gas permeable contact lenses has been demonstrated to be effective in the visual rehabilitation of children with traumatic corneal lacerations and prevention of amblyopia. The study regimen of rigid gas permeable contact lenses use was effective in wearing lenses for 6 months of follow-up. Corneal topography was an objective tool for detecting optical disorders compared to visual acuity tests.
Altered corneal biomechanical properties in children with osteogenesis imperfecta.

The purpose of this prospective, observational, case-control study was to evaluate biomechanical corneal properties in children with osteogenesis imperfecta (OI). Children with OI aged 6-19 years and healthy controls underwent complete ophthalmic examinations. Additional tests included Ocular Response Analyzer (ORA) and ultrasonic pachymetry. Primary outcomes were central corneal thickness (CCT), corneal hysteresis (CH), and corneal resistance factor (CRF). Intraocular pressure (IOP) was measured directly by either iCare or Goldmann applanation and indirectly by the ORA (Goldmann-correlated and corneal-compensated IOP). Statistically significant differences between OI and control groups were determined using independent samples t test. A total of 10 of 18 OI cases (mean age, 13 ± 4.37 years; 8 males) and 30 controls (mean age, 12.76 ± 2.62 years; 16 males) were able to complete the corneal biomechanics and pachymetry testing. Children with OI had decreased corneal hysteresis (8.5 ± 1.0 mm Hg vs 11.6 ± 1.2 mm Hg [P < 0.001]), decreased corneal resistance factor (9.0 ± 1.9 mm Hg vs 11.5 ± 1.5 [P < 0.001]) and decreased CCT (449.8 ± 30.8 mum vs 568 ± 47.6 mum [P < 0.001]) compared to controls. The corneal-compensated IOP was significantly higher in OI cases (18.8 ± 3.1 mm Hg) than in controls (15.0 ± 1.6 mm Hg, P < 0.004), but there was no significant difference in Goldmann-correlated IOP (16.3 ± 4.2 mm Hg vs 15.8 ± 2.2 mm Hg). The authors conclude that children with osteogenesis imperfecta have decreased corneal hysteresis, CRF, and CCT, resulting in IOPs that are likely higher than measured by tonometry. The study emphasizes that given the altered corneal structure and biomechanics of patients with osteogenesis imperfecta, affected individuals should be routinely screened for glaucoma and corneal pathologies.

Relation of anthropometric measurements to ocular biometric changes and refractive error in children with thalassemia.

In this cross-sectional, case-controlled study, the authors evaluated the relationship between anthropometric findings in children with thalassemia major and ocular findings in these children. The hypothesis was that in children who suffer from craniofacial and skeletal abnormalities as a consequence of their condition, there may be relevant orbital/ocular findings. The authors found that children with thalassemia major had shorter axial lengths, thicker lenses, steeper corneas and a trend towards myopia. Corneal astigmatism was correlated with shorter height and lower weight in these children. The study highlights the ocular biometric and refractive changes found in children with thalassemia major and heightens awareness of the broad impact of this disease.
Chronic Ocular Sequelae of Steven-Johnson Syndrome in Children: Long-term Impact of Appropriate Therapy on Natural History of Disease
This is a retrospective comparative case series of 568 eyes of 284 children who had Steven-Johnson Syndrome (SJS) with eye involvement between 1990 and 2015. The goal was to look at the visual outcomes of children, the associated ocular morbidities and chronic sequelae of SJS. The primary outcome of the study was best-corrected visual acuity. Two thirds of patients presented over a year after they had acute SJS. Patients who were under 8 at presentation tended to have worse outcomes. At 5 years of follow up, it was clear that definitive therapy (mucous membrane grafts, limbal stem cell grafting, PROSE lenses, etc) significantly altered the natural history of disease. Patients with definitive therapy had better best corrected visual acuities and did not have continued progression of keratopathy when compared to patients who only had conservative treatment. The authors were mainly looking at a large early cohort that was treated conservatively before the advent of AMT for this disease, to compare them with the more modern cohort that was treated more aggressively. This paper highlights the importance of definitive treatment for SJS. However, this paper does not provide insight into which patients to treat since the patients in this study were managed after their acute disease in the outpatient setting thus the results may not be generalizable to all populations.

Herpetic Eye Disease Study: lessons learned
HSV has two manifestations of stromal disease: necrotizing stromal keratitis due to direct viral invasion and immune stromal keratitis (intersitial) due to immune reaction in the stroma. The authors review the HEDS study in this paper. In stromal keratitis, steroid use can reduce the progression and speed recovery with no effect on visual outcome compared to a placebo group. The use of oral acyclovir did not significantly improve the outcome either in time to resolution or visual outcome. The use of oral acyclovir may be beneficial in iritis but the trend was only noted after 3 weeks of treatment. Patients with a history of stromal keratitis and iritis were more likely to experience a recurrence than those without a history. No benefit with a 3-week course of oral acyclovir was noted in preventing HSV stromal keratitis or iritis in the 1 year of follow up. However, the long-term use of oral acyclovir reduces the rate of recurrent HSV epithelial and stromal keratitis by 50%. The reported rates of epithelial keratitis was similar in patients who had previous disease than those who did not. In contrast, previous stromal keratitis increased the risk of recurrence by 10-fold and the risk was strongly related to the number of previous episodes. There have been new treatments since the HEDS study. Two new topical antivirals are available: gan-
cyclovir and acyclovir. A comparative study between the two topical agents found similar efficacy and healing rates. Gancyclovir was better tolerated by patients. At this time acyclovir ointment is not FDA approved. Oral antivirals can be used instead of topical treatment for keratitis in patients with significant ocular surface disease or who cannot use topical medications. Oral acyclovir has been reported to be as effective as topical antivirals for epithelial keratitis. In addition, there are new oral antivirals such as valacyclovir and famciclovir that simplify dosing regimens, although the optimal dose for ocular disease has not been determined. History of ocular HSV is considered a relative contraindication for excimer treatment to the eye. In patients undergoing corneal crosslinking prophylactic antiviral therapy may decrease the possibility of recurrence after CXL therapy. The authors review the HEDS study results and recommendations and discuss new treatment modalities and recommendations as well.

Adenoviral keratitis: a review of the epidemiology, pathophysiology, clinical features, diagnosis, and management


The authors review adenoviral keratitis which is a fairly common issue for ophthalmologists. EKC is most common in adults between 20 and 40 while pharyngoconjunctival fever (PCF) is most common in children. Infections tend to spread in places where patients have close contact and especially in ophthalmic units. Overall a nosocomial infection can cost nearly $30,000. Adenovirus 3 is most commonly implicated in PCF. The virus replicates in epithelial cells once inoculated. Patients have a follicular reaction and in EKC may have significant photophobia, with keratitis occurring 80% of the time. In PCF only 30% develop keratitis. Keratitis usually starts with epithelial microcysts leading to punctate epithelial keratopathy which can lead to subepithelial and stromal infiltrates. Chronic keratoconjunctivitis can lead to symblepharon and pseudomembrane formation. Corneal opacities can lead to astigmatism and refractive errors. Diagnosis can be made with cultures of conjunctival swab with almost 100% specificity. Rapid detection immunoassays are a promising alternative which is sensitive and specific, inexpensive and rapid. Management is achieved with hygiene and prevention of transmission, symptomatic measures such as warm compresses and lubrication as well as anti-inflammatory agents. Topical steroids may be beneficial in patients with photophobia and decreased vision. A newer possible treatment is with povidone-iodine and dexamethasone, which provides antiseptic and symptomatic relief. Topical cyclosporine can be employed for persistent SEI's that are resistant to steroids and is safer with fewer side effects. Cidofovir was in the midst of clinical trials but was terminated due to the risk of lacrimal canalicular obstruction. PTK with mitomycin can be used for persistent corneal infiltrates. The authors summarize the approach to management of adenoviral keratitis as well as some newer treatment modalities.
Mechanical versus transepithelial phototherapeutic keratectomy epithelial removal followed by accelerated corneal crosslinking for pediatric keratoconus: Long-term results

In this retrospective Turkish study of 40 eyes of 35 consecutive keratoconus patients younger than 18 years, transepithelial phototherapeutic keratectomy (PTK) epithelial removal was as effective and safe as mechanical epithelial removal followed by accelerated corneal crosslinking (CXL). While initial visual and topographic outcomes of transepithelial PTK ablation were better than those of mechanical epithelial removal before accelerated CXL when comparing the two patient groups (mechanical=15 patients vs. transepithelial PTK=20 patients), results were similar at 36 months. This article is important to pediatric ophthalmologists in that the Global Consensus on Keratoconus and Ectatic Diseases recommended that pediatric patients with keratoconus receive CXL as soon as the diagnosis is confirmed because of faster progression of corneal ectasia. However, I am not sure how relevant this article would be to the AAPOS audience given that 1) most pediatric ophthalmologists are not performing corneal collagen crosslinking and 2) the accelerated CXL protocol is not yet approved in the United States.

Evaluation of anterior segment parameters in patients with Turner syndrome using Scheimpflug imaging

Ocular abnormalities are common in Turner Syndrome but are underestimated and often neglected. Common ophthalmologic conditions include: strabismus, amblyopia, hypertelorism, epicantus, down-slanting palpebral fissures, ptosis, hypermetropia, reduced color vision, congenital cataract, congenital glaucoma, uveitis, neovascularization, retinal detachment, and papilledema. Anterior segment abnormalities such as keratoconus, anterior chamber dysgenesis and posterior segment abnormalities such as Coats disease, formation of drusen, vascular lesions or retinal detachment have been reported in patients with Turner Syndrome. The purpose of this study was to compare the anterior segment parameters in patients with Turner syndrome (TS) as measured by the Pentacam HR-Scheimpflug imaging system with those of healthy control subjects. This cross-sectional prospective study included 35 patients with TS and 30 age-matched controls. Corneal topographic analysis was performed using the Pentacam HR-Scheimpflug imaging system (Oculus, Wetzlar, Germany). The power of the corneal astigmatism, mean keratometry (Km) values for the both front and back surfaces of the cornea, maximum keratometry (Kmax), central corneal thickness (CCT), corneal volume (CoV), white-to-white diameter (WTW), chamber volume (CaV), angle and anterior chamber depth (ACD) values were recorded. The mean age of TS subjects was 17.2 ± 6.1 years and of controls was
16.4 ± 5.7 years. All participants were female. There was a significant difference in the mean values of WTW (11.3 ± 0.5 mm vs 12.0 ± 0.4 mm [P < 0.001]), CaV (148.4 ± 33.5 mm³ vs 191.9 ± 27.6 mm³ [P < 0.001]), and ACD (2.8 ± 0.3 mm vs 3.1 ± 0.2 mm [P < 0.001]) between TS group and the control group. The mean values of the power of the corneal astigmatism, Km values for the both front and back of the corneal surface, Kmax, CCT, CoV, and angle values were similar between groups (P > 0.05 for each one). Axial length measurements were not taken in this study, therefore it has not been determined whether decreased CaV, ACD, and WTW indicate that the overall eye size is less or that the anterior segment is disproportionately smaller in TS. Overall, there was a reduction in CaV, ACD, and WTW measurements in TS patients compared with controls. Because of the cross sectional nature of the study, it has not been determined whether decreased CaV, ACD, and WTW indicate that the overall eye size is less or that the anterior segment is disproportionately smaller in TS.

**Visual Outcomes and Complications of Type I Boston Keratoprosthesis in Children: A Retrospective Multicenter Study and Literature Review**


Use of Boston type 1 keratoprosthesis (KPro) implantation in children is not well studied. In this retrospective case series, the authors examined the visual outcome, device retention and complications after using KPro in children 16 years or younger. Kpro surgeries were done by 3 surgeons at 3 ophthalmology centers in Canada between January 2010 and November 2014. The KPro was implanted in 11 eyes of 11 patients 0.9 to 15.5 years of age, with 6 being primary corneal procedures. Lensectomy and anterior vitrectomy were performed concurrently in phakic patients. In aphakic patients, anterior vitrectomy was performed as part of the procedure. Best-corrected visual acuity recorded before surgery ranged from 20/600 to light perception (LP), and in vision in 2 eyes was fix and follow. All patients had been diagnosed with glaucoma and 6 eyes had glaucoma drainage devices (GDDs) inserted before KPro implantation. At last follow-up (mean, 41.8 months; range, 6.5-85.0 months), 2 eyes retained BCVA of 20/400 or better, whereas 5 eyes lost LP. The majority of patients did not improve and 55% did worse than at pre-op. Postoperative complications included retroprosthetic membrane (9 eyes), corneal melt (5 eyes), infectious keratitis (3 eyes), endophthalmitis (3 eyes), GDD erosion (2 eyes), and retinal detachment (5 eyes). The initial KPro was retained in 4 eyes (36.4%). Boston type 1 keratoprosthesis implantation in children is associated with a substantially higher rate of complications, higher chance of device failure, and worse visual outcomes than observed in adults. This is also true in comparison to the published pediatric PKP outcomes. The authors also describe their experience that PKP following K pro does not prevent vision loss. In view of these results, the authors do not recommend the use of the KPro in the pediatric population.
Corneal collagen cross-linking in paediatric patients affected by keratoconus

Corneal collagen cross-linking (CXL) is becoming a standard treatment for people with progressive keratoconus (KCN). Its safety and efficacy has been demonstrated in the pediatric population. In this study, the authors conducted a prospective cohort study of children treated with CXL for advanced keratoconus. The study included 43 consecutive patients (52 eyes, with average age 14.63 years) with progressive KCN (defined as 1.5D increase in topography within 1 year or loss of BCVA by one line or more). Traditional corneal CXL was performed with 0.1% riboflavin soaking for 30 minutes and 30 minutes irradiation. After treatment, a significant decrease in maximum keratometry from 59.30 to 57.07 was found two years after treatment. BCVA improved from 0.17 to 0.15 LogMAR (but not statistically significant). The eyes with worse keratometry improved from 64.94D to 62.25D (p<0.001). Endothelial cell density was stable. One patient had progression after treatment, but was stabilized after re-treatment. Another patient underwent later deep anterior lamellar keratoplasty. All cases had mild corneal haze after treatment that resolved 6 to 12 months later. Based on these results the authors conclude the procedure is safe and effective in stabilizing KCN, particularly in advanced KCN with high initial keratometry readings.

Anterior segment disorders - surgical procedures

Anterior segment disorders – nonsurgical management

Anterior segment biometry and refraction

12. Cataract

Long-term treatment effect in cerebrotendinous xanthomatosis depends on age at treatment start.

The authors in this retrospective study examine the outcomes of patients with a rare condition CTX which is associated with the presence of pediatric cataracts.
Outcomes on 56 Dutch patients with CTX were collated with respect to time of diagnosis. Neurologic symptoms were reversed and eliminated in all patients for whom an early diagnosis and treatment were initiated prior to 24 months in contrast to patients whose neurologic function deteriorated with later diagnosis. This study emphasized the importance of early diagnosis. Because childhood cataracts may be the first insight into this diagnosis in the setting of chronic, infantile diarrhea, pediatric ophthalmologists must be aware of the condition and recognize the importance of early diagnosis and its impact on long term neurologic outcomes.

Medical Management of Children With Congenital/Infantile Cataract Associated with Microphthalmia, Microcornea, or Persistent Fetal Vasculature.


The purpose of this study is to report the surgical outcomes of children with cataract associated with microphthalmia, microcornea, or persistent fetal vasculature (MMP) and children with isolated cataract. It included 111 children (cataract associated with MMP: n = 25) who underwent cataract surgery at younger than 16 years. Exclusion criteria were duration of follow-up less than 5 years, intraindividual differences in age at surgery, eye disorders other than MMP, secondary cataract, and syndromal diseases. Main outcome measures were proportion of eyes with glaucoma and best corrected visual acuity (BCVA). Both groups were dichotomized by age at surgery (early intervention group: ≤ 48 days). Descriptive analysis was performed throughout. It showed that the Median age at surgery was 3.9 months for cataract associated with MMP and 23.3 months for isolated cataract. The median (interquartile range [IQR]) duration of follow-up was 95.9 months (range: 76.0 to 154.5 months). In children with bilateral cataract associated with MMP, the proportion of eyes with final BCVA worse than 0.3 logMAR was similar regardless of age at surgery (early intervention: 80%, later intervention: 78%). In bilateral isolated cataract, the proportions were 56% and 33%, respectively. Children with cataract associated with MMP had a high prevalence of glaucoma (28%). Glaucoma prevalence was lower in the later intervention group. The authors concluded that surgery for congenital/infantile cataract is associated with a high risk of secondary aphakic or pseudophakic glaucoma, especially in eyes with cataract associated with MMP. Due to the lower prevalence of glaucoma, these children might profit from surgery at older ages. Randomized controlled trials on this vulnerable group of children are unlikely to be carried out. A sufficiently powered (potentially multicenter), prospective, non-randomized study, taking into account the anatomical situation at the time of diagnosis, the high variability and wide spectrum of potentially coexisting eye conditions, and the burden of children with glaucoma, might help to optimize the care of children with cataract associated with MMP.
Contact Lens Correction of Aphakia in Children: A Report by the American Academy of Ophthalmology

In this review, the authors evaluated the use of 2 most commonly used contact lenses for treating aphakia in children (silicone elastomer and rigid gas permeable) to assess the visual outcome and adverse events associated with these lenses. Literature searches were conducted in January 2018 in the PubMed, Cochrane Library, and ClinicalTrials.gov databases with no date or language restrictions. These combined searches yielded 167 citations, 27 of which were reviewed in full text. Of these, 10 articles were deemed appropriate for inclusion in this assessment and subsequently assigned a level of evidence rating by the panel methodologist. The literature search identified 4 level II studies and 6 level III studies. There were insufficient data to compare visual outcomes for eyes treated using SE lenses versus RGP lenses. Silicone elastomer lenses have the advantage that they can be worn on an extended-wear basis, but they were associated with more adverse events than RGP lenses. These adverse events included microbial keratitis, corneal infiltrates, corneal edema, corneal scars, lenses adhering to the cornea, superficial punctate keratopathy, lid swelling, and conjunctival hyperemia. The lens replacement rate was approximately 50% higher for RGP lenses in the only study that directly compared SE and RGP lenses. The authors concluded that there is limited evidence in the literature on this topic. Both silicone elastomer and RGP contact lenses were found to be effective for treating aphakia in children. Silicone elastomer lenses are easier to fit and may be worn on an extended-wear basis. Rigid gas permeable lenses must be removed every night and require a more customized fit, but they are associated with fewer adverse events. The choice of which lens a practitioner prescribes should be based on the particular needs of each patient.

Association of Pediatric Atopic Dermatitis and Cataract Development and Surgery.


This was a retrospective population-based longitudinal cohort study in Korea from 2002 to 2013 to analyze the association of Atopic Dermatitis (AD) and cataract development and cataract surgery. Incident AD cases were matched to 4 controls each using a propensity score derived from age, gender, residential area, and household income. Of note, the patient analysis was from the nationally representative data from the Korean National Health Insurance Service database. Approximately 85% of all AD cases begin before 5 years old. AD has been associated with ocular complications including anterior subcapsular cataract and
posterior subcapsular cataract. The authors found 34,375 patients with incident AD (47% girls with mean age of 3.47 years) and there were 3,734 patients with severe AD cases (10.9%) with 137,500 matched controls for analysis. The development of cataracts was not significantly different between the AD patients and the matched controls. Results indicated that the incidence probability of cataract was 0.216% in patients with AD and 0.520% in patients with severe AD at 10-year follow up. The authors also report that only a small number of patients with AD underwent cataract surgery (0.075% in patients with and 0.221% in patients with severe AD at 10-year follow up). Therefore, the authors conclude that the threat of cataract and visually significant cataract in children with severe AD is rare, even after 10-year follow up with severe disease. This longitudinal study helps put in perspective the rarity of cataracts associated with severe AD after 10-year follow up and. However rare, the authors suggest that monitoring closely for the development of cataracts in pediatric patients with severe AD is important.

Preoperative biometry data of eyes with unilateral congenital cataract.

In this retrospective, Hungarian study of 42 infants with unilateral congenital cataracts, data collected from each eye at the time of surgery including central corneal thickness (CCT), corneal refractive power (keratometry [K]), horizontal corneal diameter, and axial lengths was recorded and analyzed. In the eyes with unilateral congenital cataract, a greater CCT (p=.1330), higher average K (p=.00243) and smaller corneal diameter (p=.0010) were found. There was no significant difference in AL when compared with the unaffected contralateral eyes. The collected data showed that biometric characteristics of the eyes with unilateral congenital cataract differ from those of the fellow, normal eye before cataract surgery. The authors state that it is essential to use this biometric data in intraocular lens power calculation and to take it into account in long-term care when screening for secondary glaucoma. Overall, I found the quality of this article to be pretty poor. I am not sure that the authors present much new information, but there is some interesting discussion about the abnormal parameters of the cataractous eye resulting from congenital cataract hindering the formation of a normal anterior segment.

Correlation of monocular grating acuity at age 12 months with recognition acuity at age 4.5 years: findings from the Infant Aphakia Treatment Study
This paper's purpose is to determine whether grating acuity at age 12 months can be used to predict recognition acuity at age 4.5 years in children treated for unilateral congenital cataract enrolled in the Infant Aphakia Treatment Study (IATS). Traveling testers assessed monocular grating acuity at 12 months of age (Teller Acuity Card Test [TACT]) and recognition acuity at 4.5 years of age (Amblyopia Treatment Study Electronic Visual Acuity Testing, HOTV) in children treated for visually significant monocular cataract in the IATS. Spearman rank correlation was used to evaluate the relationship between visual acuities at the two ages in the treated eyes. Visual acuity data at both ages were available for 109 of 114 children (96%). Grating acuity at 12 months of age and recognition acuity at 4.5 years of age were significantly correlated for the treated eyes ($r_{spearman} = 0.45; P = 0.001$). At age 4.5 years, 67% of the subjects who had grating acuity at 12 months of age within the 95% predictive limits in their treated eye demonstrated recognition acuity better than 20/200. Similarly, at age 4.5 years 67% of the subjects who had grating acuity at age 12 months below the 95% predictive limits in their treated eye demonstrated recognition acuity of 20/200 or worse. The authors conclude that a single grating acuity assessment at age 12 months predicts recognition acuity in a child treated for unilateral congenital cataract in only two-thirds of cases and therefore provides limited utility in predicting the long-term visual outcomes of these eyes. Clinicians should consider other factors, such as patching compliance and age at surgery, when using an early grating acuity assessment to modify treatment.

**Frequency of pediatric traumatic cataract and simultaneous retinal detachment**


Traumatic cataract in children is a treatable cause of vision loss. In cases of simultaneous retinal detachment, the prognosis for visual recovery is often poor. The purpose of this study was to investigate risk factors for concurrent retinal detachment in patients with traumatic cataract. In this study, a retrospective review of patients diagnosed with traumatic cataract at Children's Hospital Colorado between 2005 and 2014 was conducted. Demographics, mechanism of injury, and incidence of retinal detachment were recorded. Logistic modeling with generalized estimating equations to account for correlation of eyes within patients was used to analyze associations between potential risk factors and retinal detachment. A total of 62 total eyes with traumatic cataract were included: 52 patients presented with unilateral cataract; 5 presented with bilateral cataracts. Mean patient age was 8.4 ± 4.1 years (range, 0-16 years), and 83% of patients were male. A total of 9 eyes (14.5%) had comorbid retinal detachment. Traumatic cataracts caused by self-injurious hitting were more likely to present with simultaneous retinal detachment than those caused by other mechanisms of injury (OR = 24.0; 95% CI, 3.8-153.3; $P = 0.0010$). Patients with traumatic cataract who display self-injurious behavior are at higher risk for concurrent retinal detachment. These patients can often only be examined under sedation and often
have associated developmental delay or intellectual disability. Ophthalmologists should counsel families of high-risk patients and consider involving retinal specialists in surgical planning.

**Association of Pediatric Atopic Dermatitis and Cataract Development and Surgery**

This population-based retrospective longitudinal cohort study from the Korean National Health Insurance Service database from 2002 to 2013. Patients younger that 20 years old with incident atopic dermatitis (AD) were matched to 4 controls each using propensity score derived from age, sex, residential area, and household income. Statistical analysis included incidence probabilities of cataract development and cataract surgery between the AD group and controls were compared using Kaplan-Meier methods and log-rank tests. Cox proportional hazard models were fitted for cataract and cataract surgery to determine the risk factors in the matched cohort.

Of 34375 patients with incident AD (16159 girls [47%]; mean [SD] age, 3.47 [4.96] years), there were 3734 severe AD cases (10.9%) with 137500 matched controls. Development of cataracts was not different between the AD and control groups, (0.216% vs 0.227%; 95% CI, -0.041% to 0.063%; \( P = .32 \)) or between the severe AD cohort and their controls (0.520% vs 0.276%; 95% CI, -0.073% to 0.561%; \( P = .06 \)). Cataract surgery was performed more frequently in the AD cohort than in the control group (0.075% vs 0.041%; 95% CI, 0.017%-0.050%; \( P = .02 \)) and in the severe AD cohort compared with their controls (0.221% vs 0.070%; 95% CI, 0.021%-0.279%; \( P = .03 \)). Severe AD was associated with both development of cataract (adjusted hazard ratio, 1.94; 95% CI, 1.06-3.58, \( P = .03 \)) and requirement for cataract surgery (adjusted hazard ratio, 5.48; 95% CI, 1.90-15.79, \( P = .002 \)). In summary, this study showed that the absolute risk of cataract was rare, with or without AD, even after 10 years of observation. However, AD disease severity may increase the risk for cataract development and cataract surgery.

**Unilateral Congenital Cataract: Clinical Profile and Presentation.**

The purpose of this study is to identify the clinical profile and presentation of children with unilateral cataract. In this hospital-based, observational, cross-sectional study, patients 15 years of age or younger who presented with unilateral cataract were recruited. Cases of cataract secondary to causes such as trauma or uveitis were excluded. Age at detection and presentation, distance from the treatment center, presenting complaints, cataract morphology, and biometry were noted for each case. A total of 76 patients were recruited. Most patients presented with
complaints of leukocoria. Persistent fetal vasculature accounted for 27.6% of cases and was the most common identifiable cause of cataract in this study. Subsequently, patients were divided into two groups: no persistent fetal vasculature (control) and persistent fetal vasculature. A male predominance was noted in both groups. The mean age at detection was 27.58 ± 37.02 and 6.17 ± 8.42 months and the mean age at presentation was 55.613 ± 45.21 and 14.83 ± 17.75 months in the control and persistent fetal vasculature groups, respectively. In the persistent fetal vasculature group, a significant difference was noted in the axial length, keratometry, and corneal diameter between the affected and normal eyes ($P = .027$, .00176, and .0114, respectively). In the control group, this difference was observed only in keratometry readings ($P = .0464$). The mean distance traveled by patients to reach the treatment center was 211 km. The study concluded that it is imperative to increase awareness among parents, pediatricians, and ophthalmologists about disease and its potential to cause an irreversible loss of vision.

**Cataract development associated with long-term glucocorticoid therapy in Duchenne muscular dystrophy patients.**

The purpose of this retrospective study was to evaluate the development of cataracts or elevated intraocular pressure (IOP) in patients with Duchenne muscular dystrophy (DMD) on long-term glucocorticoid (GC) treatment. The medical records of DMD patients evaluated from 2010 to 2015 at a single center were reviewed. The main outcome measures were prevalence of cataracts and elevated IOP, age of first detection of cataract, time from initial steroid use to first detection of cataract, and relative risk of cataract development for deflazacort versus prednisone treatment. Of 596 DMD patients, 514 underwent GC therapy; all but one was male. The prevalence of cataracts was 22.4% in patients on GC therapy. The mean age at which cataract formation was first documented was 12.9 ± 4.1 years (IQR, 9.6-14.6). The mean time from initial steroid use to the first detection of cataract was 6.5 ± 3.6 years (IQR, 4.0-8.6). The odds of cataract development were 2.4-fold higher for patients on deflazacort compared with prednisone treatment (95% CI, 1.3-4.5; $P = 0.004$). Only 7 patients (1.4%) underwent cataract surgery, at a mean age of 16.9 years (range, 10.7-24.6 years); all were on deflazacort. Among patients with available intraocular pressure measurements, elevated IOP occurred in only 1 patient (1.1%), who was on deflazacort. The authors concluded that patients receiving GC therapy for DMD, the rate of cataract formation was slow and well tolerated, with a higher risk among deflazacort patients. The percentage of patients requiring cataract extraction or with elevated IOP was very low. These findings suggest that a schedule of annual eye examinations is appropriate.
Transient lens vacuoles in premature infants.

This case series describes 6 cases of bilateral vacuolar lens opacities in premature infants. These uncommon opacities were noted to be multiple, located peripherally in the lens, and unrelated to the severity of retinopathy. The vacuoles were transient in nature, did not interfere with ROP examination, and were not adversely affected by anti-vascular endothelial growth factor treatment. On long-term follow-up, these opacities had no effect on vision. Despite their seemingly harmless nature, the authors recommend monitoring of vacuolar opacities to confirm that they do not progress to visually significant cataract.

Morphological and biometric features of preexisting posterior capsule defect in congenital cataract
Zhangliang Li, Pingjun Chang, Dandan Wang, Yinying Zhao, et al.
*Journal of Cataract and Refractive Surgery*;2018;44(7):871-877.

This Chinese study reviewed the cases of 81 eyes of 53 patients less than 1 year of age to identify a series of diagnostic signs that were preoperative predictors of a preexisting posterior capsule defect in eyes with congenital cataract. Clinical signs indicative of a preexisting posterior capsule defect in the study group (42 eyes) are described as are biometric characteristics of preexisting posterior capsule defect. The lens was significantly thinner and the vitreous chamber significantly deeper in the study group than in the control group. Also, corneal diameters were significantly smaller in the control group. Multivariate analysis identified lens thickness as an independent risk factor for preexisting posterior capsular defect. While many pediatric cataract surgeons may be familiar with the characteristic morphological clues associated with preexisting posterior capsular defects, awareness that lens thickness and corneal diameter may be decreased in this setting may aid in the preoperative detection of posterior capsule defects and facilitate preoperative planning permitting avoidance of complications during surgery for congenital cataract.

Cataract development in children with Coats disease: risk factors and outcome

The purpose of this paper is to describe the clinical features of cataract during the course of Coats disease and to determine its risk factors and effects on the long-term visual outcome. The medical records of consecutive patients with Coats disease followed for at least 2 years were analyzed retrospectively. Ophthalmological examination, ancillary tests, and treatment modalities were re-
viewed. The time of cataract diagnosis and its management were recorded. Parameters influencing cataract development and final visual outcome were investigated using uni- and multivariate analysis. A total of 57 patients (mean age, 5.0 ± 4.0 years; 51 males) were included; cataract formation was observed in 16 (28%) during a mean follow-up of 7.1 ± 3.7 years. Cataracts were noted to develop earlier in patients with more advanced Coats’ disease. The mean time from diagnosis of Coats disease to cataract detection was 25 ± 22 months. Total white cataract developed in 12 patients (75% of patients) and posterior subcapsular cataract developed in 4 (25%). Cataracts were surgically removed in 10 patients to improve fundus visualization and clinical follow-up. Using univariate survival analyses, we found that the extension of telangiectasia, extension of exudation, presence of exudative retinal detachment or neovascular glaucoma, and disease stage at diagnosis were significantly associated with the development of cataract. Presence of exudative retinal detachment at diagnosis was an independent risk factor for cataract formation (P = 0.031). Cataract development was associated with more advanced disease stages (P < 0.001). History of cataract was a significant predictor for worse final visual outcome (P < 0.001), independent of disease stage (P = 0.003) and presence of macular complication, such as atrophy, fibrosis, or tractional retinal detachment (P < 0.001, adjusted R² = 0.83). In summary, cataract development is frequent in children with Coats disease and aggravates the visual prognosis; visual outcome after cataract surgery is poor. Exudative retinal detachment at diagnosis, present in more advanced disease stages, is an independent risk factor for cataract formation.

13. CATARACT SURGERY

Pediatric cataract surgery outcomes

Visual outcomes of pediatric traumatic cataracts

The authors retrospectively evaluated 147 children with a history of traumatic cataract to identify risk factors and outcomes. Penetrating injury comprised the majority of cases. The authors analyzed whether outcomes were impacted by placement of PCIOL and by primary posterior capsulotomy. Overall both factors contributed positively to good surgical outcomes in these patients and this superceded the type of injury. Therefore the authors advocate for PCIOL placement and primary posterior capsulotomy when performing surgery for traumatic pediatric cataract.
Outcome of pediatric cataract surgery with intraocular injection of triamcinolone acetonide: Randomized controlled trial.


The authors performed a randomized controlled trial evaluating the impact of intraocular injection of triamcinolone acetonide during pediatric cataract surgery in 44 eyes of 22 children. Their hypothesis was that this agent would serve to highlight vitreous as a “vitreous dye” and facilitate better anterior vitrectomy during surgery thereby reducing post operative complication. Outcomes evaluated included IOP, post op inflammation, development of PCO and post op infection. The main difference in outcome was with respect to PCO where it was noted in 1 eye which had triamcinolone and 9 eyes without injection. The authors suggest that this agent is a useful tool and should be considered in pediatric cataract surgery to improve inflammation and reduce PCO formation.

Long-term results of secondary intraocular lens implantation in children under 30 months of age


This study reports the long-term outcome of early secondary intraocular lens (IOL) implantation following congenital cataract extraction in a large number of eyes. Data of aphakic children under 30 months of age who underwent secondary IOL implantation and had at least one year of follow-up after the surgery was reviewed. In all of the patients, a foldable three-piece acrylic IOL was implanted in the ciliary sulcus by the same surgeon using the same technique. Fifty patients (75 eyes) were included. The average age at the time of cataract extraction was 94.20 ± 44.94 days and 20.7 ± 6.0 months in the secondary IOL implantation. After 82.32 ± 48.91 months, the VA was 0.58 ± 0.35 LogMAR and the spherical equivalent was −2.20 ± 4.19 D. There was a negative correlation between a longer follow-up period and myopia at the SE measured (P = 0.001). The most frequent complications included glaucoma and corectopia. Performing the secondary IOL implantation ≤ 20 months of age was not a risk factor for glaucoma development (P = 0.095). Secondary IOL implantation under 30 months of age is an option for children who do not adapt well to contact lenses. A predictable IOL power calculation and satisfactory visual outcomes compared to results of later secondary IOL implantation are possible. This study was limited by its retrospective design, the fact that more than one type of IOL was implanted, and the fact that effective lens position was not calculated.

Five-Year Postoperative Outcomes of Bilateral Aphakia and Pseudophakia in Children up to 2 years of Age: A Randomized Clinical Trial
This is a randomized clinical trial of 60 children (120 eyes) undergoing bilateral congenital cataract surgery. Half of the patients were randomized to receive intraocular lens (IOL) implantation and the other half were randomized to aphakia (n=30 in each group). The authors compared the outcomes of visual acuity, glaucoma, visual axis obscuration requiring surgery, and inflammation. The median age of surgery was 5 months in the aphakic group and 6 months in the pseudophakic group (p=0.56). At 5 years, the incidence of glaucoma was not different between the groups: 16% in the aphakic group and 13.8% in the pseudophakic group (p=0.82). Visually significant obscuration requiring surgery was also not different between the two groups (p= 0.79) with 10.3% of eyes in the pseudophakic group and 8% of eyes in the aphakic group needing surgery. The one significant difference was the incidence of posterior synechiae, which was significantly higher in the pseudophakic group (27.6% vs. 8%; p=0.004). In regards to vision, mean LogMAR acuity was 0.59 +/- 0.33 and 0.5 +/- 0.23 (p=0.79) with a trend toward better vision in the pseudophakic group, and more eyes in that group giving documentable vision earlier in their postoperative course. The authors point out one of the major limitations, which was that the aphakic group had very poor compliance with contact lenses and aphakic spectacle correction vs IOL may not be a fair comparison. There is a letter to the editor from the authors of the Infant Aphakia Treatment Study (IATS) highlighting some of the differences between this study and IATS, which is an important corollary to this paper.

Outcome of paediatric cataract surgery in Northwest Ethiopia: a retrospective case series

Up to one third of childhood blindness in sub-Saharan Africa is due to congenital or developmental cataract. In Ethiopia the prevalence of blindness in children is estimated to be 1 in 1000 children. This retrospective study evaluated the medical records of children less than 16 years old who had cataract surgery between 2010 and 2014. 143 children (176 eyes) were included. Mean age was 7.9 years, with 66% male. 25% were bilateral. 63% were unilateral traumatic cataracts, and 13% were unilateral non-traumatic cataracts. 93% had an intraocular lens implant. At last follow-up, visual acuity was >=6/18 or fix/follow in the better eye in over ½ of bilateral cases. Children with bilateral cataracts had worse outcomes if they had preoperative nystagmus or strabismus. In unilateral non-traumatic cases, only 1/3 achieved a good outcome (>=6/18) with half having poor visual outcome (<6/60). 39% with traumatic cataract had VA 6/18 or better. The authors did note, however, that overall follow-up was poor, which could have skewed visual acuity results.

This study reported the long-term refractive and visual acuity (VA) outcomes and complications of early secondary intraocular lens (IOL) implantation in aphakic patients implanted under the age of 30 months. All patients underwent sulcus implantation of a foldable three-piece acrylic IOL. Fifty patients (75 eyes) were included. Patients underwent lensectomy at the age of 94.2 ± 44.9 days and secondary IOL implantation at the age of 20.7 ± 6 months. Postoperative follow up was 82.3 ± 48.9 months. Authors found a negative correlation between a longer follow-up period and myopia (P = .001). Secondary IOL implantation did not increase the risk for glaucoma development.

Visual and Refractive Outcomes of Children After Secondary Cataract Extraction Following Wound Repair for Penetrating Ocular Trauma.

Kamaldeep Arora, Priyanka Arora, Suma Ganesh, Shriya Gupta et al

*J of Ped Ophth & Strabismus.* 2018; 55(2): 122-127

The purpose of this retrospective, non-comparative case series is to evaluate the visual and refractive outcomes in children 8 years of age or younger with corneal laceration and cataract following penetrating ocular injuries who underwent primary corneal tear repair followed within 1 to 8 weeks by early secondary cataract extraction. The participants were followed for a period of 6 months postoperatively. The main outcomes were best-corrected visual acuity (BCVA) and refractive error as spherical equivalent at the final follow-up visit. A total of 47 children (33 boys, 14 girls) were included. The mean age at the time of injury was 5.9 ± 2.2 years (range: 3 to 8 years). Follow-up periods ranged from 6 months to 3 years (median: 18 months). The mean time gap between the wound repair and cataract extraction was 5 weeks (range: 1 to 8 weeks). Approximately 36 (77%) eyes obtained BCVA better than 6/18. All but one eye achieved BCVA better than 6/60. The deviation from emmetropia was less than 1.00 diopter (D) in 23 (54%) eyes, 1.00 to 3.00 D in 15 (35%) eyes, and more than 3.00 D in 5 (12%) eyes. Early removal of cataract with implantation of an IOL after primary wound repair in young children with penetrating corneal injury and traumatic cataract and no other associated ocular damage can result in excellent visual outcomes. In children of amblyogenic ages, visual outcomes comparable to older children can be achieved with early cataract surgery, a limited period of visual deprivation of less than 8 weeks, visual rehabilitation with an IOL, and elective primary posterior capsulotomy with anterior vitrectomy followed by aggressive amblyopia therapy. The study is limited by its retrospective nature and the small sample size.
Mobile femtosecond laser platform for pediatric cataract surgery.

This study explores the utilization of a mobile femtosecond laser in pediatric cataract surgery in 5 eyes of 3 children. This is the first demonstration of its use in pediatric cataract surgery with the goal of achieving a more controlled and precise approach to performing anterior capsulotomy. There were no perioperative complications and there were specifically no issues with the capsulorrhexis. Use of the laser added a median of 2 minutes 36 seconds to surgical time. The “laser-on-wheels” design appears to be promising compared with a previous report using femtosecond laser assisted anterior capsulotomy in pediatric patients with a permanently installed laser. This is a proof-of-concept study which still needs to be evaluated with respect to younger patients (infants) and whether it may be successfully used for posterior capsulotomy.

Outcomes of cataract surgery in children with persistent hyperplastic primary vitreous.

This retrospective study investigated visual outcomes in 29 eyes of 28 children with PHPV. All children underwent cataract extraction with primary posterior capsulotomy. Cauterization of the persistent fetal vasculature was not performed consistently and authors found that post operative hemorrhage was a complication in 37.9% of eyes including both vitreous hemorrhage and hyphema. The authors note that the complications encountered including retinal detachment and posterior hemorrhage were more frequently associated with “posterior PHPV” and outcomes were more favorable when the bulk of disease was anterior.

Long-term outcomes for pediatric patients having transscleral fixation of the capsular bag with intraocular lens for ectopia lentis

This study from the Moran Eye Center in Utah of 37 patients (67 eyes) with attraumatic ectopia lentis having transscleral fixation of the capsular bag using a capsular tension ring fixated with 9-0 or 10-0 polypropylene, 8-0 polytetrafluoroethylene, or 9-0 nylon found a 78.5% improvement in corrected distance visual acuity at a mean follow up time of 35.3 months (0.25-120 months). The mean age at time of surgery was 7.25 years (2-18 years). The range of resulting refrac-
tive error was similar to that seen with traditional IOL placement. Short-term
complications included hyphema in 1 eye and IOL repositioning at 3 months in 1
eye and long-term complications included posterior capsule opacification in 35
eyes (52%), uveitis-glaucoma-hyphema syndrome in 1 eye (1.5%), and sponta-
neous IOL dislocation in 3 eyes (4.4%) requiring IOL repositioning. As 7 patients
who were initially considered for transscleral CTR suturing were unable to re-
ceive the procedure for various reasons determined intraoperatively, the authors
note that the technique presented may not be appropriate for all cases. Never-
theless, this is an important article for pediatric ophthalmologists given the pauc-
ity of data regarding long-term outcomes in pediatric patients having surgical in-
tervention for visually significant ectopia lentis.

**Surgical outcomes and complications of sutured scleral fixated
intraocular lenses in pediatric eyes**


Sutured scleral fixated intraocular lens (SSFIOL) implants have useful ad-
vantages, but known complications include retinal detachment, vitreous hemor-
rhage, suture erosion, and late dislocation. Studies of complications of SSFIOL
are limited in the pediatric population. Therefore the authors conducted a retro-
spective observational study of patients 18 years or age or less who underwent
SSFIOL with pars plana vitrectomy from 2000 to 2014 at a tertiary eye care cen-
ter in India. All cases had fixation of the IOL with 10-0 prolene suture. 279 eyes
of 230 patients were included in the study. Mean age was 10.8 years. 21.3% of
cases were bilateral, and the most common indication was traumatic subluxation
of the lens. BCVA was maintained or improved from pre-operative visual acuity in
93% of cases. 19 eyes (6.8%) had a decrease in visual acuity. 7 of these 19
were due to retinal detachment. Other complications included serous choroidal
detachment (8 patients), vitreous hemorrhage (8 patients), endophthalmitis (2
patients), and IOL dislocation (13 patients). The interval from surgery to retinal
detachment ranged from 6 days to 7 years post-op. IOL dislocation was seen af-
after a mean duration of 110 months after surgery (range 68-159 months). All but 2
of these cases were spontaneous without known trauma. The authors do note
the possibility of suture degradation and IOL dislocation as a known risk factor,
and advocate for suture materials with a longer life span. However, all cases of
dislocation in this study showed good visual acuity after IOL refixation, and none
had retinal damage. In conclusion, although SSFIOL need long-term observation
due to risks of RD and dislocation, having an IOL present in the visual axis during
critical periods of visual development play an important role in preventing ambly-
opia.

**Surgical Outcome of Congenital Cataract in Eyes With Microcor-
nea.**
In this retrospective, interventional, comparative case series, the authors re-
viewed 47 eyes of 26 children with microcornea and congenital cataract who un-
derwent lens aspiration with primary posterior capsulectomy and anterior vitrec-
tomy between 2008 and 2014 with a minimum follow-up period of 6 months. De-
mographic profiles and systemic and ocular features were documented. In-
trooperative and postoperative complications were studied separately for bilateral and unilateral cases. Patients were also divided into two groups on the basis of their ages at surgery (early surgery group: 3 months or younger; late surgery group: older than 3 months) and postoperative complications were compared. Visual outcome was analyzed in those with a follow-up period of more than 1 year. Early surgery was performed in 24 eyes of 13 patients (11 bilateral and 2 unilateral) and late surgery in 23 eyes of 13 patients (10 bilateral and 3 unilateral). Intraoperatively, all eyes had poor pupillary dilatation and 6 (12.8%) eyes needed iris hooks. Postoperatively, the most common early complication was transient corneal edema observed in 22 (46.8%) eyes (13 and 8 eyes in the early and late surgery groups, respectively). Late complications included visual axis opacification in 6 (12.76%) eyes (3 in each group), and secondary glaucoma in 5 (10.64%) eyes (2 and 3 eyes in the early and late surgery groups, respectively). Vision was normal for age in 18 (60%) of the bilateral cases with a follow-up pe-
riod of more than 1 year. The study shows that we can expect favorable postop-
erative outcomes after early surgery for congenital cataract in microcornea. Me-
ticulous surgery with adequate capsulectomy and complete anterior vitrectomy, as well as regular follow-up with early identification and timely judicious man-
agement of postoperative complications, especially visual axis opacification and glaucoma, is crucial for a successful outcome. Furthermore, good visual rehabili-
tation with the appropriate use of amblyopia therapy and vision stimulation max-
imizes the visual outcome for these children. Although this study has the limita-
tions of being retrospective in design and having a relatively shorter follow-up pe-
riod for some patients, it adds to the limited literature on cataract surgery in mi-
icrocornea in the pediatric age group.

**Modified technique of endocapsular lens aspiration for severely subluxated lenses**


Authors describe an endocapsular technique to remove the lens material in pa-
ients with subluxated lenses. Authors include patients between 5-15 years who underwent a standard surgical technique. An MVR was used to create two paracentesis and to open two small incisions on the lens capsule. A vitrector and an irrigation with a 27 canula. The lens material was removed using the cut I/A vitrector. After the remaining capsules were also removed. An AC IOL was placed. Thirty-two eyes of 16 patients were included. Out of 16 patients, 9 pa-
tients (56.2%, 9/16) were diagnosed as having Marfan’s syndrome, 4 patients (25%, 4/16) had a marfanoid habitus, and 3 patients (18.7%, 3/16) had bilateral microspherophakia with anterior subluxation of lens. The mean age was 9.375 ± 3.16 years (range 5–15 years). All surgeries were uneventful. ACIOL were inserted safely in 22 eyes and 10 eyes were left aphakic. Out of these 10 eyes, 8 eyes had a large W–W diameter (412.5 mm) in which the ACIOL if placed may be small for the eye resulting in undue mobility. The rest of the 2 eyes of the same patient had microspherophakia out of which one eye had an anterior dislocated lens with pupillary block glaucoma (IOP = 30 mm Hg) and corneal edema (CCT = 640 μm), The mean endothelial cell loss at 3 months compared to pre-operative levels was 269.6 ± 151 cells/mm² amounting to 7.1% endothelial cell loss over 3 months which was statistically significant (P = 0.001). The mean CCT at 1 week, 1 month, and 3 months post-surgery were 525.3 ± 39.61 μm, 526.8 ± 39.43 μm, and 526.5 ± 39.17 μm. The modified technique of endocapsular lens aspiration provides for a simple and effective way of removal of the lens-capsular bag complex through small incisions on the cornea.

**Pediatric cataract surgery complications**

**Primary versus secondary intraocular lens implantation in traumatic cataract after open-globe injury in pediatric patients.**
JCRS Dec 2018;44(12):1446-1453.

This retrospective cases series reviewed the charts of 139 patients in India to compare the visual and refractive outcomes and complications of primary and secondary intraocular lens (IOL) implantation after open globe injury in pediatric patients. Cataract extraction was either performed at the time of globe repair or secondarily following repair. The study included 139 patients. Mean follow up was around a year for both groups, and patients with less than 3 months of follow up were excluded from analysis. Thirty (49%) of 61 patients in Group A and 47 (60%) of 78 patients in Group B achieved a corrected distance visual acuity (CDVA) of 20/40 or better. In both groups, a central corneal scar and amblyopia were the main reasons for not achieving a CDVA better than 20/40. The mean spherical equivalent (SE) was 1.81 diopters (D) in Group A and 1.55 D in Group B. Forty patients (66%) in Group A and in 60 patients (77%) in Group B achieved a SE <2.00 D. A large wound was the greatest risk factor for not obtaining a desirable refractive outcome. Fibrinous uveitis was the most common postoperative complication in both groups. Pupillary optic capture and IOL decentration were significantly more common in Group A than in Group B (p=.02), while strabismus was significantly more common in Group B (p=.04). The authors conclude that both approaches had satisfactory and comparable visual and refractive outcomes but state that primary IOL implantation can be considered in cases with small peripheral corneal lacerations with the goal of providing early visual rehabilitation.
and avoiding repeat general anesthesia. This article provides some useful information derived from a large number of pediatric traumatic cataract cases but has the usual limitations of a retrospective study in that the patients were not randomly assigned to either primary or secondary IOL placement—the timing of their cataract surgery was based on the severity of the initial pathology. Also, some even longer term follow up in terms of IOL decentration, glaucoma, etc. would be informative.

Endophthalmitis following Pediatric Cataract Surgery: An International Pediatric Ophthalmology and Strabismus Council Global Perspective.

Almutes M. Gharaibeh, Luis H. Ospina, Eedy Mezer, Tamara Wygnaski-Jaffe


The purpose of this study is to compile international data on the risk factors, diagnosis, and treatment of endophthalmitis following pediatric cataract surgery. An e-mail containing a link to an online survey was sent to all members of the American Association for Pediatric Ophthalmology and Strabismus. The questionnaire examined the incidence, risk factors, treatment, outcomes, and prophylaxis of endophthalmitis following pediatric cataract surgery around the world. Two hundred thirty-seven ophthalmologists answered the questionnaire. Eight ophthalmologists (3.4%) encountered 22 cases of endophthalmitis following pediatric cataract surgery during their practice. Most patients with endophthalmitis following pediatric cataract surgery were 2 to 4 years of age (36.4%). An intraocular lens was implanted in 59.1% of cases, most of which were acrylic intraocular lenses (53.8%). The main presenting symptoms were photophobia (50%) and pain (40.9%). The most common signs were conjunctival injection (36.4%) and hypopyon (31.8%). The final visual acuity was counting fingers or worse in 86% of cases. The most common cultured organism was Staphylococcus aureus (31.8%). The most common management of endophthalmitis following pediatric cataract surgery was a combination of intravitreal, systemic, and topical antibiotics (36.4%). Most ophthalmologists (68.2%) administered prophylactic intracameral antibiotic treatment during surgery and 50% used vancomycin. The authors conclude that endophthalmitis following pediatric cataract surgery is an uncommon, multifactorial complication with poor visual prognosis. Efforts directed at minimizing its risk, such as treating potential predisposing systemic conditions, improving sterilization techniques, optimizing operative conditions to reduce complications and surgery duration, and using subconjunctival and intracameral antibiotics, decrease its incidence. Early postoperative evaluation, subsequent follow-up visits, and keeping a high index of suspicion should facilitate the recognition of endophthalmitis following pediatric cataract surgery to avoid delaying treatment.

**Pediatric cataract surgery – other topics**
Goldmann applanation tonometer versus ocular response analyzer for measuring intraocular pressure after congenital cataract surgery

This study sought to compare intraocular pressure measurement in pediatric patients undergoing lensectomy and vitrectomy with Goldmann applanation versus the ocular response analyzer. 113 eyes were included in the study. There was a statistically significant difference between the two diagnostic modalities with the ocular response analyzer measuring a higher IOP than the Goldmann tonometer: (16.75 ± 4.82 mmHg) versus (14.41 ± 2.27 mmHg, p < 0.001) respectively. This was influenced by central corneal thickness and corneal hysteresis. Subgroup analysis of pseudophakic versus aphakic patients revealed that there was better agreement between the two methods in pseudophakic patients. This study emphasizes that these two methods of IOP measurement cannot be used interchangeably in pediatric patients.

Long-Term Outcome of Nd:YAG Laser Posterior Capsulotomy in Children: Procedural Strategies and Visual Outcome

The purpose of this study was to look at the long-term outcomes of Nd:YAG laser capsulotomy after cataract surgery in children. The authors performed a retrospective review of 31 eyes in 25 patients who were followed for at least 5 years. The mean age at the time of laser was 9 ± 3.5 years and the mean time between cataract surgery and laser was 28 ± 22 months. Twenty-six eyes (83.9%) had successful Nd:YAG capsulotomy on the first attempt and 3 (9.7%) on the second attempt, yielding an overall success rate of 93.5%. Posterior capsular opacity recurred in 7 (24.1%) of eyes. The total delivered energy and number of laser applications were relatively higher than in adult capsulotomy, as expected. The authors reported no serious complications. They discuss that primary capsulotomy and anterior vitrectomy is generally useful in the prevention of posterior capsular opacity in most patients, but it is not 100% effective. There were three eyes of 3 patients in this cohort who had posterior capsulotomy at the time of cataract surgery but were included in this study because they had obscuration of the visual axis. This study’s strengths include the long follow up time. I would add to the conclusion and discussion that this further reinforces the importance of a capsulotomy at the time of cataract surgery in younger patients, when possible.

Influence of the vitreolenticular interface in pediatric cataract surgery.
This case series was performed in order to report the status of Berger space in pediatric cataract cases and the influence of anterior vitreolenticular interface dysgenesis during primary posterior continuous curvilinear capsulorhexis (PCCC). Of 134 pediatric cataract surgeries performed using the bag-in-the-lens technique at Antwerp University Hospital November 2010-April 2016, 64 eyes of 64 children having surgical video recordings available for review were included. A video-based analysis of the surgical interventions included the type of crystalline lens opacification, presence of a posterior capsule plaque (PCP), presence of anterior vitreolenticular interface dysgenesis, complications during primary PCCC, integrity of the anterior hyaloid membrane, need for anterior vitrectomy, and feasibility of BIL IOL implantation. Abnormalities in Berger space were observed in 35 of the 64 pediatric cataract cases. Anterior vitreolenticular interface dysgenesis was most often found in cases with persistent fetal vasculature (PFV) and those with unilateral and posterior cataract. In pediatric cataract cases presenting with PCP and anterior vitreolenticular interface dysgenesis, the primary PCCC procedure was surgically more demanding, often resulting in detectable breaks in the anterior hyaloid membrane (58.6%) and sometimes necessitating an unplanned anterior vitrectomy (13.8%). Bag-in-the-lens IOL implantation was feasible in all except 1 eye with PFV, which was left aphakic. This article alerts us to the fact that anterior vitreolenticular interface dysgenesis is common in pediatric cataract surgery and may complicate primary PCCC.

**Follow-up patterns and associated risk factors after paediatric cataract surgery: observation over a 5-year period**


In developing countries, follow-up of children undergoing cataracts surgery has known to be poor. The authors of this retrospective study aimed to evaluate the pattern of compliance and follow-up of children less than 5 years old undergoing cataract surgery in Hyderabad, India. 169 patients were included in the study, with median age at surgery of 10 months and median follow-up of 22 months. There was a significant correlation between age at surgery and follow-up duration, with higher age at surgery associated with poorer follow-up. Overall 15% of patients were lost to follow-up at 1 month, which increased to 61% at 3 months but slowed thereafter. Patients in higher socioeconomic status had longer follow-up (media 35 months) compared to those of lower socioeconomic status (median 14 months). The drop out was steeper in the lower socioeconomic group. There was no difference between those in rural homes compared to urban, or to distance between residence and hospital. The authors conclude that there needs to be strategies to reduce the economic burden associated with frequent follow-ups in this vulnerable population.

**Delay in presentation to hospital for childhood cataract surgery in India.**
This prospective multicenter study aimed to investigate the age at which children with cataract present for surgery at tertiary hospitals across India. Parents were interviewed. Of a total of 751 consecutive cases, 469 (63%) were boys and 548 (73%) were from rural areas. A total of 258 (34%) were unilateral cataracts of which 179 (69%) were due to trauma. Early cataracts considered congenital were operated at a mean age of 48.2 ± 50.9 months and acquired or developmental cataracts were operated at a mean age of 99.7 ± 46.4 months. Early presentation for surgery was found in patients with 2 or more siblings at home (OR, 4.69; 95% CI: 2.04-10.79; p = < 0.001).

Association of Contact Lens Adherence With Visual Outcome in the Infant Aphakia Treatment Study: A Secondary Analysis of a Randomized Clinical Trial

This is a secondary analysis from the infant aphakia study of the 57 infants born from August 22, 2004 to April 25, 2008 with treatment of unilateral cataract surgery. Data analysis was performed from August 9, 2016, to December 7, 2017 for these 57 children who were randomized to implantation of an intraocular lens versus aphakic contact lens. In particular, contact lens adherence was assessed by a 48-hour recall telephone interview that was administered every 3 months starting 3 months after surgery to age 5 years. In addition, a traveling examiner assessed visual acuity in patients at aged 4.5 years. Adherence to prescribed contact lens use was estimated as the mean percentage of waking hours as reported in 2 or more interviews for each year of life. A total of 872 telephone interviews were completed. In year 1, a median of 95% participants wore their contacts lenses nearly all waking hours (interquartile range [IQR], 84%-100%); year 2, 93% (IQR, 85%-99%); year 3, 93% (IQR, 85%-99%); year 4, 93% (IQR, 75%-99%); and year 5, 89% (IQR, 71%-97%). There was a tendency for poorer reported adherence at older ages (F = 3.86, P < .001). No differences were identified when the results were analyzed by sex, insurance coverage, or age at cataract surgery. Using linear regression, children who wore the contact lens for a greater proportion of waking hours during the entire study period tended to have better visual acuity at age 4.5 years, even after accounting for adherence to patching (partial correlation = -0.026; P = .08). Findings from the 5-year outcome analysis suggest that it is possible to have adherence for aphakic contact lens.

Effects of cycloplegia on Optical Biometry in Pediatric Eyes.
The purpose of this observational study is to determine the effect of cycloplegia on optical biometry parameters in pediatric eyes using the Lenstar LS 900 (Haag-Streit, Koeniz, Switzerland). 56 normal eyes and 20 cataractous eyes in children between 5 and 15 years of age were included. Measurements were taken before and after cycloplegia using 2% homatropine drops. Parameters studied were axial length, central corneal thickness, keratometry, anterior chamber depth, and lens thickness. The Wilcoxon test was used to compare the effects of cycloplegia on all parameters. The study showed that Cycloplegia resulted in a statistically significant decrease in axial length \((P < .05)\), central corneal thickness \((P < .05)\), and lens thickness \((P < .001)\) and an increase in the anterior chamber depth \((P < .001)\) in normal eyes. In the cataract group, cycloplegia resulted in an increase in anterior chamber depth \((P < .001)\) and decrease in lens thickness \((P < .001)\). The authors conclude that there were significant alterations in the various parameters in both groups. Although the study couldn’t demonstrate any impact on the IOL power calculation, the results give scope for further research with other IOL power formulas that uses anterior chamber depth as one of their parameters.

**Femtosecond laser-assisted cataract surgery in pediatric patients.**

Pediatric cataract surgery poses a significant challenge for the cataract surgeon, in part because an elastic anterior capsule can make capsulorhexis difficult. However, the authors claim that with the use of femtosecond laser-assisted cataract surgery (FLACS), the continuous curvilinear capsulorhexis can be made with predictable size, circular shape, centration, and accuracy. In this small case series (3 cases) the authors describe a technique for performing FLACS in cooperative children above 6 years of age using topical anesthesia for the FLACS docking procedure using transparent adhesive polyurethane film segments. Cataract removal was then completed using a conventional lens aspiration technique in a second operating room under general anesthesia.

14. GLAUCOMA

**Pediatric glaucoma - surgical management**

Correlation Between Trabeculodysgenesis Assessed by Ultrasound Biomicroscopy and Surgical Outcomes in Primary Congenital Glaucoma
The purpose of this study is to evaluate the ultrasound biomicroscopy (UBM) characteristics in eyes with primary congenital glaucoma (PCG) and compare these UBM findings to surgical outcomes after trabeculotomy. To do this, the authors performed a prospective, interventional case series of 49 eyes of 33 patients with PCG. Microcatheter-Assisted -Trabeculotomy (MAT) was the planned first glaucoma surgery in these patients, though as expected some cases were completed with the Harms trabeculatome. All patients had a UBM prior to surgery and the authors classified the eye’s trabeculodysgenesis into three types based on the severity of the anterior iris insertion and ciliary processes with type 1 being the most severe and type 3 being the least severe dysgenesis. The authors defined surgical success as a post op pressure less than or equal to 21mmHg and at least a 30% reduction compared to preoperative intraocular pressure without any additional treatment or optic nerve compromise for at least 6 months post op. At the 2-year follow up point, the type 1 trabeculodysgenesis (most severe type) had a success rate of 57.1%, those with type 2 had a 70.5% success rate, and those with type 3 achieved success in 95.5% of eyes (p=0.22). The authors concluded that the severity of the trabeculodysgenesis was a good predictor of prognosis after MAT surgery. Some limitations of this study include the observer error when evaluating the type of trabeculodysgenesis and the small sample size. A discussion about the rate of conversion to the Harms trabeculatome and how this could have affected the results would have added to the breadth of the last section of the paper. This paper adds to the literature in that it helps with counseling patients about the risks of recurrent / uncontrolled glaucoma especially in cases of poorly formed angles.

Mitomycin C in Filtering Surgery for Primary Congenital Glaucoma: A Comparison of Exposure Durations

The purpose of this prospective study is to compare the effect of two exposure durations of mitomycin C in combined angle and filtering surgery for primary congenital glaucoma. Seventy-five eyes with primary congenital glaucoma that underwent combined trabeculotomy–trabeculectomy with intraoperative mitomycin C application for 1 minute (MMC 1) or 2 minutes (MMC 2) and were followed up for 24 months. Success rates were studied and complications noted. Success was defined by a composite primary end point of an intraocular pressure (IOP) of less than 16 mm Hg under general anesthesia, without any IOP-lowering medications and with no hypotony-related complications and/or lack of IOP-related progression of the disease as evidenced by worsening of the ocular biometric characteristics. The mean age of the study participants was 6.7 ± 4.1 months (range: 2 to 16 months; median: 6 months) in the MMC 1 group (35 eyes) and 7.7 ± 5.7 months (range: 1 to 32 months; median: 6.5 months) in the MMC 2 group (40 eyes). The initial surgery was successful in 32 (91.5%) and 31 (77.5%) eyes in the MMC 1 and MMC 2 groups, respectively. The mean IOP was 18.4 ± 5.1 and 18.1 ± 6.1 mm Hg preoperatively and 5.5 ± 3.5 and 4.8 ± 2.8 mm Hg at the end of follow-up in the MMC 1 and MMC 2 groups, respectively. There was no statisti-
cally significant difference in the clinical parameters between the two groups.
Complications included cataracts in each group and hypotony optic disc edema in 3 eyes (7.5%) in the MMC 2 group. The authors concluded that because both exposure durations of mitomycin C yielded comparable postoperative IOP values and the longer exposure durations were associated with a more unhealthy bleb appearance, higher reoperation rate, and higher chance of hypotony-related complications, there seems to be no advantage in using Mitomycin C with an exposure duration of 2 minutes. A mitomycin C exposure duration of 1 minute would be recommended for use in combined angle and filtering surgery for primary congenital glaucoma. This study has several limitations such as the addition of an angle procedure to the filtering procedure rather than testing the filtering procedure effect in isolation, the comparison of only two exposure durations of one concentration of mitomycin C rather than extending the study to include arms with different mitomycin C concentrations and/or different exposure durations, the lack of formal assessment of visual function for the study eyes, the inclusion of both eyes of some patients in the data analysis rather than one eye only, the relatively small sample size, and the relatively short follow-up duration of only 2 years.


The purpose of this retrospective study was to report the long-term efficacy of endoscopic cyclophotocoagulation (ECP) in pediatric glaucoma following cataract surgery (GFCS). ECP was performed on 35 eyes of 25 patients <16 years of age with GFCS. Patients were followed for a minimum of 2 years. Treatment failure was defined as consecutive postoperative intraocular pressure (IOP) of >24 mm Hg, alternative glaucoma procedure following ECP, or occurrence of visually significant complications. Analysis was performed to estimate risk factors for failure. A total of 27 aphakic and 8 pseudophakic eyes were included. Pretreatment IOP averaged 33.9 ± 7.9 mm Hg. Final IOP after a mean follow-up period of 7.2 years was 18.9 ± 8.8 mm Hg (P < 0.001). The success rate was 54% (19/35 eyes). The failure rate was not increased in pseudophakic patients relative to aphakic patients. Eyes requiring multiple ECP had a higher failure rate. Patients with single ECP demonstrated preserved visual acuity from baseline to final follow-up. The authors concluded that in their patient cohort, with average follow-up period of 7.2 years, ECP was useful in the treatment of pediatric GFCS. The authors also state that failed eyes demonstrated an elevated IOP at 6 months after ECP; thus an elevated IOP at this time may be a good predictor of whether a patient is likely to fail ECP.
Long-term intraocular pressure after combined trabeculotomy-trabeculectomy in glaucoma associated with Sturge-Weber syndrome.


This study retrospectively reviews surgical outcomes for 20 children undergoing combined trabeculotomy-trabeculectomy for treatment of glaucoma associated with Sturge Weber syndrome. Children with early onset glaucoma defined as occurring within the first 10 years of life were included. Additional glaucoma filtering surgery was required in eleven eyes with one eye requiring a total of 4 procedures and 4 eyes requiring a total of 3 procedures. Complete success was defined as IOP < 22 mm Hg without the need for additional pressure reducing drops and was not achieved in any patient. However, ~41% of patients had “modified or modified qualified” success defined as an improvement of IOP post operatively but the need for additional IOP lowering medications to sustain the surgical result. The authors did not encounter any perioperative complications with their surgical approach. The study highlights the difficulty in managing glaucoma secondary to SWS.

Pediatric glaucoma – corneal biometry, OCT and visual field

Effect of age on the morphologies of the human Schlemm's canal and trabecular meshwork measured with swept-source optical coherence tomography.


Authors studied normal individuals Schlemm's canal (SC) and trabecular meshwork (TM) to evaluate variations with age from childhood to old age by using swept-source optical coherence tomography (OCT). Study evaluated 114 healthy individuals ranging from 7 to 83 years. The SC diameter and area in the four quadrants decreased significantly with aging (P < 0.001). SC were wider in the nasal and temporal quadrants. There was a significant positive correlation with axial length (AL) and anterior chamber depth (P < 0.001). Authors also found a significant positive association between age and TM thickness in the nasal and temporal quadrants (P < 0.05). The inferior quadrant TM width was the widest among the quadrants. The superior quadrant TM thickness was the thinnest among the quadrants. Changes in TM thickness in the nasal and temporal quadrants showed a significant negative correlation with AL (P < 0.05). There was no statistically significant correlation in SC and TM parameters with central corneal thickness, intraocular pressure, sex, or right or left eye (P > 0.05).
Age has a negative correlation with the size of the SC and positive correlation with the thickness of the TM.

Diagnostic capacity of SD-OCT segmented ganglion cell complex versus retinal nerve fiber layer analysis for congenital glaucoma.

This study compared the circumpapillary retinal nerve fiber layer (cpRNFL) analysis versus segmented ganglion cell complex analysis both by spectral-domain optical coherence tomography (SD-OCT) in children with primary congenital glaucoma (PCG). Forty children diagnosed with PCG and 60 healthy children were evaluated. SD-OCT with automated segmentation was used to measure the thicknesses and volumes of the macular retinal nerve fiber layer (mRNFL), ganglion cell layer (GCL), and inner plexiform layer (IPL). The capacity of each method to discriminate between normal and glaucomatous eyes was compared.

**RESULTS:** Mean age was 11.20 ± 3.94 years for the glaucoma patients and 10.90± 2.46 years for controls (p = 0.64). All measurements were reduced (thinner) in the glaucoma group, significantly so for: cpRNFL, GCL, IPL and outer-superior and outer-inferior quadrant mRNFL. Temporal superior cpRNFL (0.869) and outer superior GCL (0.840), IPL (0.799), and mRNFL (0.767) showed the better diagnostic capacity. No differences were observed the most discriminatory cpRNFL and macular measurements. Authors concluded that segmented macular layer analysis is a good method to discriminate between normal and glaucomatous eyes and it is comparable to cpRNFL analysis in children with PCG.

Diagnostic Performance and Repeatability of a Novel Game-Based Visual Field Test for Children

Perimetry can be of vital importance for the early detection and monitoring of neurological disease and glaucoma in children. The purpose of this study was to demonstrate utility of a game-based test (“Caspar’s Castle”) for the detection of visual field defects in children. This is a validity and reliability carried out at Manchester Royal Eye Hospital Pediatric Ophthalmology Outpatients Department. The authors recruited 108 children with no eye pathology (aged 4–12 years) and examined a single eye with the Caspar’s Castle system using either normal thresholds or thresholds artificially adapted to recreate defects to assess diagnostic utility. Number of peripheral stimuli missed was used to determine sensitivity and specificity of artificial defect detection and to plot receiver-operator char-
acteristic curves. A further 21 children (aged 4–16 years) with pathology (13 with congenital glaucoma, 7 with secondary glaucoma, 1 with neurological damage to the temporal lobe) were recruited and Caspar's fields compared qualitatively with established field testing. A total of 106 of the Caspar's Castle examinations were able to be performed twice and repeatability was determined through coefficient of repeatability and Bland–Altman chart. In diagnostic testing using children with no eye pathology, 45 children completed a test using normal thresholds and 43 with tests using artificial defects. Area under receiver operator characteristic curves for artificial defect detection was 0.895. Of the 21 children with pathology, seven had completed standard Humphrey field testing and Caspar's Castle fields corresponded with each of these by expert opinion. Coefficient of repeatability for number of points missed across all cohorts of children (106 patients) was 6.9 (95% confidence interval: 6.16–8.07). The Caspar's Castle system of assessing visual fields is novel, affordable, noninvasive, and entertaining and demonstrates encouraging levels of sensitivity, specificity, and reliability in young children. It could help address current difficulties in perimetry in young children. Contrary to expectations, many of the instances where the game did not appear to perform well involved older children, aged 9 years or older, some of whom became able to play the central game so adeptly they were perhaps more tempted to scan the periphery as well as responding to central demands, so more complex versions may be better for older children.

Comparison of Quality and Output of Different Optimal Perimetric Testing Approaches in Children with Glaucoma

This study compared static and combined static/kinetic perimetry in visual field testing in children with glaucoma between 5/2013 through 6/2015 at two hospitals in London. The study included 65 children, ages 5 to 15 years with glaucoma (108 affected eyes). Results indicated a median age of 12 years, with 50.8% girls were tested. Of note, testing reliability improved with increasing age for both Humphrey and Octopus perimetry, with equivalence in children older than 10 years but better quality of testing with Humphrey perimetry achieved in younger children. Of the 7 severe cases of visual field loss, 5 had lower kinetic than static classification scores. In summary, a static perimetry test yields high-quality results in children younger than 10 years but better quality of testing with Humphrey perimetry achieved in younger children. The authors note that for children older than 10 years, the addition of kinetic perimetry allowed for the measurement of far peripheral sensitivity, which is important in children with severe visual field restriction associated with glaucoma.

Pediatric glaucoma – other topics

Systemic Associations of Childhood Glaucoma: A review
The purpose of this article is to review the systemic associations of childhood glaucoma. The 371 patients diagnosed with glaucoma were divided into four groups: primary congenital glaucoma, glaucoma with other congenital ocular anomalies, congenital glaucoma with known systemic diseases, and secondary glaucoma. Prevalence and type of systemic associations in each group were studied. In the primary congenital glaucoma group, 13 of 218 (5.9%) patients had an associated systemic illness: congenital heart disease and global developmental delay were the most common systemic manifestations. In the congenital ocular anomalies group, 10 of 63 (15.8%) patients had an associated systemic illness. Axenfeld-Reiger syndrome, aniridia, and Peters' anomaly frequently had systemic comorbidities with congenital heart disease. In the known systemic diseases group, all 18 (100%) patients had systemic manifestations of an associated syndrome: Sturge-Weber and Down syndrome were the most frequent. In the secondary glaucoma group, 9 of 72 (12.5%) patients had systemic involvement, which was often seen as the most common cause after congenital cataract surgery. These children had congenital heart disease and global developmental delay as a consequence of congenital rubella and congenital cytomegalovirus infection. The study found that 12.9% of patients with childhood glaucoma had an associated systemic abnormality. Patients with congenital glaucoma and other ocular anomalies have a three times higher risk of an underlying systemic anomaly than patients with isolated primary congenital glaucoma. A team comprising an ophthalmologist, pediatrician, and anesthesiologist is recommended to treat these cases.

Icare-Pro Rebound Tonometer Versus Hand-held Applanation Tonometer for Pediatric Screening


The purpose of this prospective study to compare intraocular pressure (IOP) measurements obtained using the new rebound tonometer Icare-Pro (Icare, Tiolat Oy, Helsinki, Finland) and the hand-held version of the Goldmann applanation tonometer (Perkins; Clement Clarke, Haag-Streit, Harlow, United Kingdom) in healthy children during clinical practice. Three IOP measurements were made using each tonometer in a single session, starting with the Icare-Pro. Participants were 173 non-anesthetized patients aged 1 to 16 years. Measurements were made in both eyes but only data for the right eye were entered in the analysis. Central corneal thickness, anterior chamber depth, and axial length were also measured in each patient. Data were compared by determining interclass correlation coefficients (ICCs) for each tonometer and representing the differences detected as Bland–Altman plots. The authors showed that there is good linear correlation between IOP readings obtained using the Perkins and Icare-Pro tonome-


Effect of Chloral Hydrate Sedation on Intraocular Pressure in a Pediatric Population

The purpose of this study was to prospectively study the effect of oral chloral hydrate (CH) on intraocular pressure in children. This prospective, non-comparative case series was performed on 112 children (50.9% female) from 1-month to 5-
years-old undergoing sedation with oral chloral hydrate. The intraocular pressure (IOP) was measured with an Icare tonometer prior to sedation, 25 minutes after sedation and then every 10 minutes after that until the patient was no longer sedated. The authors used linear regression to look at the change in IOP over time. The mean age of the patients was 2.1 years. Sixty-four (57%) of the patients had IOP measured prior to sedation, and of those about half were calm at the time of IOP measurement. Of those with pre sedation IOP, the mean was 19.5mmHg and after sedation their mean IOP was 18.7mmHg (p=0.12). There was no trend toward decline in IOP over time. The authors concluded that CH sedation in the outpatient setting did not impact IOP. The authors discuss that this CH is generally out of favor in the United States, and explain that it is the sedating agent with the least effect on IOP compared to other commonly used agents.

New classification system for pediatric glaucoma: implications for clinical care and a research registry

A worldwide collaboration was established to create a standardization for the definition of glaucoma in the pediatric population. The Childhood Glaucoma Research Network (CGRN) has developed criteria for pediatric glaucoma. Childhood glaucoma is defined as two or more of the following: IOP >21mmHg, visual field defect, progressive increase in axial length, corneal findings such as Haab striae, corneal enlargement, increasing C:D ratio or asymmetry of > 0.2, and focal rim thinning. They also characterized childhood glaucoma suspect as having one of the following: IOP >21 on two separate occasions, suspicious visual fields, increasing axial length with normal IOP, increased corneal diameter with normal IOP, or suspicious optic nerves. A flowchart is provided to allow the user to arrive at the proper classification. Glaucoma after cataract surgery then has further classification based on open or closed angle appearance. All cataract etiologies are included in this subclassification if the glaucoma was acquired only after cataract surgery. If the patient has not had cataract surgery even if a cataract is present then the glaucoma is classified based on the presence of systemic or ocular congenital conditions. If the glaucoma is predominantly systemic or without significant ocular anomalies this is classified as glaucoma associated with nonacquired systemic disease of syndrome. This is regardless of the mechanism i.e. open or closed angle. The next category is glaucoma associated with nonacquired ocular anomalies i.e. congenital conditions with significant ocular findings. Glaucoma associated with acquired conditions includes steroids, surgery, and the like and is subclassified into open and closed types. Primary congenital glaucoma (PCG) develops in the absence of all the conditions mentioned above and has buphthalmos. It is further subclassified into neonatal onset (0-1 month), infantile (>1-24 months), and late onset (>24 months). Lastly,
juvenile onset glaucoma occurs between 4-40 years of age). The authors then describe the Robison D. Harley MD CGRN International Pediatric Glaucoma Registry as a repository for international reporting of glaucoma cases that uses the classification system for the purposes of studying rare disorders with any significant sample sizes. This registry is hosted by a private company and is available to any individual involved with pediatric eye care once their IRB approval is obtained. The registry is HIPAA compliant and allows for entry of both retrospective and prospective data. There is also the ability to submit DNA samples from patients with glaucoma as well.

***This article elucidates a novel approach to the classification of glaucoma that standardizes it worldwide and has set up a database to allow for further research to impact the diagnosis and management of pediatric glaucoma patients.***

**Pretarsal skin height changes in children receiving topical prostaglandin analogue therapy for primary congenital glaucoma**


This goal of this paper is to compare pretarsal skin height (PTSH), as proxy indicator of deepening of the upper eyelid sulcus, in children with primary congenital glaucoma (PCG) treated with topical prostaglandin analogues (PGAs) to PTSH in healthy children (control group 1) and children with PCG but not using PGAs (control group 2). The authors recruited children with PCG who had been using PGAs for at least 6 months (PCG/PGA group). PTSH in all participants was measured using ImageJ software from photographs taken in a standardized manner. The PTSH was compared for the PCG group and both control groups. A total of 34 children with PCG and 41 controls (31 in group 1; 10 in group 2) were included in this study. The difference in PTSH between children in the PCG/PGA group and both control groups was statistically significant with the mean difference $\geq 1.7$ mm [P < 0.01]. The PTSH was significantly greater in children with PCG using PGAs for at least 6 months compared to children with PCG not using PGAs and healthy children. The authors recommend that children and their parents should be counseled about lid abnormalities prior to commencing treatment with PGAs. Furthermore, it is unclear if reversal of the changes would occur once the PGA has been discontinued and how these changes vary in children of different ages.

**Correlation of Corneal and Scleral Pneumatonometry in Pediatric Patients**

Measuring IOP in pediatric patients can be a challenge, especially if there is a significant corneal disease. Scleral tonometry has been proposed as an alternative method. This study examined how the corneal and scleral IOP correlate using pneumatonometry in pediatric patients. The goal of this study was to create a model from which corneal IOP can be derived from scleral IOP measurement. Consecutive patients age 0 to 15 years who were undergoing an exam under anesthesia or eye surgery at UCSF, Benioff Children’s Hospital, from July 2015 to April 2016 were recruited for the study. Using pneumatonometry, IOP was obtained from the central corneal, and the inferonasal and inferotemporal sclera in a random order. All measurements were obtained under general anesthesia within 5 minutes of induction, without lid speculum. All patients underwent general anesthesia using 1 agent or a combination of 3 agents: sevoflurane, fentanyl, and propofol. IOP measurement was taken prior to intravenous agents being administered. Seventy-five eyes from 40 patients were included in the study. Spearman correlations between corneal versus inferonasal scleral IOP and corneal versus inferotemporal scleral IOP were calculated. A linear mixed-effect model was used to derive a predictive equation for corneal IOP from scleral IOP and to perform covariate analysis for age, axial length, central corneal thickness, and lens status. The standard deviation of the predicted corneal IOP was determined by bootstrap mixed-effect regression analysis. Spearman correlation coefficient for corneal versus inferotemporal scleral IOP was 0.79 (P < 0.01) and 0.48 for corneal versus inferonasal scleral IOP (P < 0.01). Corneal IOP may be predicted from scleral IOP via the following equations: corneal IOP = 0.73 × inferotemporal scleral IOP + 7.45 and corneal IOP = 0.21 × inferonasal scleral IOP + 17.83. Central corneal thickness (P = 0.07), lens status (P = 0.4), age (P = 0.33), and axial length (P = 0.15) did not affect significantly the relationship between corneal and scleral IOP in the multivariate regression analysis. The standard deviation of predicted corneal IOP was < 1.2 mmHg within an inferotemporal scleral IOP range of 10 to 35 mmHg. The authors concluded that there is a significant correlation in corneal and inferotemporal scleral IOP. Pneumatonometry on the inferotemporal sclera may be an alternative method to estimate IOP for pediatric patients from whom corneal IOP measurement is difficult to obtain. The range of IOP tested in this study is in normal range and this could not be generalized to very low or high IOPs. This model should be tested in awake pediatric patients to see the impact of anesthesia on IOP.

Glaucma after Lens-Sparing Vitrectomy for Advanced Retinopathy of Prematurity

This study examined the incidence of glaucoma after lens-sparing vitrectomy (LSV) in advanced ROP and possible risk factors related to this disease. This is a retrospective case series of 401 eyes from 270 patients who underwent LSV for stage 4A, 4B, and 5 ROP. Data were collected from patient charts including gender, gestational age at birth, birthweight, stage of ROP at presentation, prior
treatment (laser or cryotherapy), subsequent retinal surgeries, presence of glaucoma, time to glaucoma (interval between LSV and the onset of glaucoma), date of lensectomy (if performed), and retinal attachment status at last visit. Lensectomy was considered as a time-dependent covariate in the analysis. This study excluded patients with prior history of retinal surgery performed at an outside institution. Among 401 eyes with advanced ROP, 40 eyes (10.0%) had glaucoma during a mean of 3.06±4.11 years of follow-up. The incidence of glaucoma was 6.9% (17/247) in stage 4A, 12.0% (16/133) in stage 4B, and 33.3% (7/21) in stage 5 ROP. Twenty-one percent of eyes (87/401) required lensectomy at a mean of 1.23±2.19 years after LSV. In univariate analysis, having stage 5 ROP (vs. stage 4 ROP) and presence of lensectomy were found to be significantly associated with time to glaucoma (hazard ratio = 6.76, 95% CI = 2.19-20.88, P = 0.001; HR = 3.06, 95% CI = 1.56-6.0, P = 0.001, respectively). In multivariate analysis, lensectomy was the only significant independent factor associated with time to glaucoma (HR = 2.76, 95% CI = 1.371-5.581, P = 0.004). The authors concluded that the incidence of glaucoma after LSV was 10% in the overall study population during a mean follow-up of 3 years. Patients with more severe ROP had a higher incidence of glaucoma after lens-sparing vitrectomy. If a patient required lensectomy owing to progression of ROP and/or presence of lens opacity, then the hazard of having glaucoma significantly increased compared with those without lensectomy.

Steroid-induced ocular hypertension in the pediatric age group.
Al Hanaineh AT, Hassanein DH, Abdelbaky SH, El Zawahry OM

This prospective study evaluated the impact of a new topical corticosteroid rimexolone in pediatric patients undergoing bilateral strabismus surgery. Two cohorts of 20 patients each (40 eyes) were created. In one group, IOP post-operatively in children receiving dexamethasone in one eye and rimexolone in the other was compared; in the second group, IOP post operatively in children receiving FML in one eye and rimexolone in the other was compared. Overall, the authors found that there was a statistically significant rise in IOP in the dexamethasone group. There was no significant difference in the cohort receiving FML versus rimexolone. Although ultimately the IOP rise was transient in all but 1 patient, this study highlights the need to carefully consider choice of steroid, frequency and duration in order to avoid ocular hypertension in pediatric patients.

15. REFRACTIVE SURGERY

Accommodative Esotropia Treatment Plan Utilizing Simultaneous Strabismus Surgery and Photorefractive Keratectomy
This was a retrospective interventional case series of 15 patients who the authors treated with simultaneous strabismus surgery and photorefractive keratectomy (PRK) for accommodative esotropia. The goal of this surgery was to determine if this approach was safe and effective, mainly looking to see if eyes were straight and spectacle free after 6 month follow up. The patients were 11 to 17 years old in this series and the PRK was done with a goal refractive error appropriate for their age, aiming to account for the fact that the eye is likely to still grow. The strabismus surgery was based on the alignment in the patient's physiologic refractive error (based on age), and patients with more than 8 prism diopters were treated with strabismus surgery (11 of 15 patients). The strabismus surgery was performed first, then the PRK. All 15 of the patients were spectacle free at the 6 month visit, though 3 eyes had a one line reduction in vision and 3 eyes had 2 or more lines of reduction in their visual acuity. Thirteen patients had post op alignment of 10 diopters or less, two patients had 10-15 prism diopters of esodeviation, and no patients complained of diplopia. This paper is important in that it is a novel treatment of accommodative esotropia, but there are some glaring limitations, only some of which are discussed in the limitations section. The sample size is small, there were some patients with large overcorrection of their hyperopic PRK (1.5D), the tables are redundant and confusing, the doses for the strabismus surgery don’t seem standard, there is a lack of explanation of the of strabismus evaluation in the methods section, it is unclear what kind of binocularity these patients had pre op since that may change diplopia outcomes.

16. **GENETICS**

**Mutation screening of the USH2A gene in retinitis pigmentosa and USHER patients in a Han Chinese population.**


This study aims to detect USH2A mutations in a Chinese cohort of 75 small RP families and 10 Usher syndrome families using a direct Sanger sequencing analysis of the USH2A gene. Reported are a total of eight mutations in four of the 75 small RP families (5.3%) and two mutations in one of the 10 Usher families (10%); all families were detected to have compound heterozygous mutations. In families with nonsyndromic RP, the authors identified the compound heterozygous mutations p.Pro4818Leu and p.Leu2395Hisfs*19 in family No. 19114, p.Arg4493His and p.His1677Glnfs*15 in family No.19162, c.8559-2A > G and p.Arg1549* in family No.19123 and p.Ser5060Pro and p.Arg34Leufs*41 in family No.19178. In addition, reported is the heterozygous mutations p.Arg3719His and p.Cys934Trp in family No.19124, which was the Usher syndrome family. These mutations were predicted to be harmful by SIFT, PROVEAN, Mutation Taster or PolyPhen-2. The paper revealed six novel mutations in the USH2A gene in a Chinese population, which is beneficial for the clinical use of genetic testing of
USH2A in patients with autosomal-recessive or sporadic RP and Usher syndrome.

**Mutations in known disease genes account for the majority of autosomal recessive retinal dystrophies.**

Retinal dystrophies (RDs) are hereditary blinding eye conditions that are highly variable in their clinical presentation. The remarkable genetic heterogeneity that characterizes RD was a major challenge in establishing the molecular diagnosis in these patients until the recent advent of next-generation sequencing. It remains unclear, however, what percentage of autosomal recessive RD remain undiagnosed when all established RD genes are sequenced. This study enrolled 75 families in which RD segregates in an apparently autosomal recessive manner. The authors show that the yield of a multigene panel that contains known RD genes is 67.5%. The higher yield (82.3%) when whole exome sequencing was implemented instead was often due to hits in genes that were not included in the original design of the panel. They also show the value of homozygosity mapping even during the era of exome sequencing in uncovering cryptic mutations. In total, they describe 45 unique likely deleterious variants (of which 18 are novel including one deep intronic and one genomic deletion mutation). This study suggests that the genetic heterogeneity of autosomal recessive RD is approaching saturation and that any new RD genes will probably account for only a minor role in the mutation burden.

**Genome-Wide Association Study Identifies a Susceptibility Locus for Comitant Esotropia and Suggests a Parent-of-Origin Effect.**

This study aims to identify genetic variants conferring susceptibility to esotropia, the most common form of comitant strabismus (with highest incidence in White European ancestry populations). Esotropia is believed to be inherited as a complex trait.

White European American discovery cohorts with nonaccommodative (826 cases and 2991 controls) or accommodative (224 cases and 749 controls) esotropia were investigated. White European Australian and United Kingdom cohorts with nonaccommodative (689 cases and 1448 controls) or accommodative (66 cases and 264 controls) esotropia were tested for replication. A genome-wide case-control association study was performed using a mixed linear additive model. Meta-analyses of discovery and replication cohorts were then conducted. A significant association with nonaccommodative esotropia was discovered (odds ratio [OR] = 1.41, \(P = 2.84 \times 10^{-9}\)) and replicated (OR = 1.23, \(P = 0.01\))
at rs2244352 [T] located within intron 1 of the WRB (tryptophan rich basic protein) gene on chromosome 21 (meta-analysis OR = 1.33, P = 9.58 × 10-11). This single nucleotide polymorphism (SNP) is differentially methylated, and there is a statistically significant skew toward paternal inheritance in the discovery cohort. Meta-analysis of the accommodative discovery and replication cohorts identified an association with rs912759 [T] (OR = 0.59, P = 1.89 × 10-08), an intergenic SNP on chromosome 1p31.1.

This is the first genome-wide association study (GWAS) to identify significant associations in esotropia and suggests a parent-of-origin effect. Additional cohorts will permit replication and extension of these findings. Future studies of rs2244352 and WRB should provide insight into pathophysiological mechanisms underlying comitant strabismus.

**RDH12 Mutations Cause a Severe Retinal Degeneration With Relatively Spared Rod Function.**


This article describes the retinal phenotype of pediatric patients with mutations in the retinol dehydrogenase 12 (RDH12) gene. Twenty-one patients from 14 families (ages 2-17 years) with RDH12-associated inherited retinal degeneration (RDH12-IRD) underwent a complete ophthalmic exam and imaging with spectral domain optical coherence tomography (SD-OCT) and near infrared and short-wavelength fundus autofluorescence. Visual field extent was measured with Goldmann kinetic perimetry, visual thresholds with dark-adapted static perimetry or with dark-adapted chromatic full-field stimulus testing (FST) and transient pupillometry. Visual acuity ranged from 20/40 to light perception. There was parafoveal depigmentation or atrophic maculopathies accompanied by midperipheral intraretinal pigment migration. SD-OCT revealed foveal thinning in all patients and detectable but thinned outer nuclear layer (ONL) at greater eccentricities from the fovea. Photoreceptor outer segment (POS) signals were only detectable in small pockets within the central retina. Measurable kinetic visual fields were limited to small (<5-10°) central islands of vision. Electroretinograms were reported as undetectable or severely reduced in amplitude. FST sensitivities to a 467 nm stimulus were rod-mediated and reduced on average by ∼2.5 log units. A thinned central ONL colocalized with severely reduced to nondetectable cone-mediated sensitivities. Pupillometry confirmed the psychophysically measured abnormalities. The authors conclude that RDH12-IRD causes an early-onset, retina-wide disease with particularly severe central retinal abnormalities associated with relatively less severe rod photoreceptor dysfunction, a pattern consistent with an early-onset cone-rod dystrophy. Severely abnormal POS but detectable ONL in the pericentral and peripapillary retina suggest these regions may become targets for gene therapy.

**Prevalence of FOXC1 Variants in Individuals With a Suspected Diagnosis of Primary Congenital Glaucoma.**
This article investigates the prevalence of FOXC1 variants in participants with a suspected diagnosis of primary congenital glaucoma. Australian and Italian cohorts were recruited from January 1, 2007, through March 1, 2016. Australian individuals were recruited through the Australian and New Zealand Registry of Advanced glaucoma and Italian individuals through the Genetic and Ophthalmology Unit of l’Azienda Socio-Sanitaria Territoriale Grande Ospedale Metropolitano Niguarda in Milan, Italy. The authors performed exome sequencing, in combination with Sanger sequencing and multiplex ligation-dependent probe amplification, to detect variants of FOXC1 in individuals with a suspected diagnosis of primary congenital glaucoma established by their treating specialist. Data analysis was completed from June 2015 to November 2017. The main outcome is identification of single-nucleotide and copy number variants in FOXC1, along with phenotypic characterization of the individuals who carried them.

A total of 131 individuals with a suspected diagnosis of primary congenital glaucoma were included. The mean (SD) age at recruitment in the Australian cohort was 24.3 (18.1) years; 37 of 84 Australian participants (44.0%) were female, and 71 of 84 (84.5%) were of European ancestry. The mean (SD) age at recruitment was 22.5 (18.4) years in the Italian cohort; 21 of 47 Italian participants (44.7%) were female, and 45 of 47 (95.7%) were of European ancestry. Rare, predicted deleterious FOXC1 variants were observed in 8 of 131 participants (6.1%), or 8 of 166 participants (4.8%) when including those explained by variants in CYP1B1. On reexamination or reinvestigation, all of these individuals had at least 1 detectable ocular and/or systemic feature associated with Axenfeld-Rieger syndrome. The authors conclude that the data highlight the genetic and phenotypic heterogeneity of childhood glaucoma and support the use of gene panels incorporating FOXC1 as a diagnostic aid, especially because clinical features of Axenfeld-Rieger syndrome can be subtle. Further replication of these results will be needed to support the future use of such panels.

**GNAQ Mutations in Diffuse and Solitary Choroidal Hemangiomas.**

GNAQ mutations have been identified in port wine stains (both syndromic and nonsyndromic) and melanocytic ocular neoplasms. This study investigates the presence of GNAQ mutations in diffuse (those associated with Sturge-Weber syndrome [SWS]) and solitary choroidal hemangiomas. Tissue samples from 11 patients with the following diagnoses were studied: port wine stain (n = 3), diffuse choroidal hemangioma (n = 1), solitary choroidal hemangioma (n = 6), and choroidal nevus (n = 1). Ten specimens were interrogated with Memorial Sloan Kettering-Integrated Mutation Profiling of Actionable Cancer
Targets, a hybridization capture-based next-generation sequencing assay for targeted deep sequencing of all exons and selected introns of 468 key cancer genes in formalin-fixed, paraffin-embedded tumors. Digital polymerase chain reaction was used to detect GNAQ Q209 mutation in 1 specimen.

Activating somatic GNAQ mutations (c.547C > T; p.Arg183Cys) were found in 100% (3 of 3) of the port wine stain and in the diffuse choroidal hemangioma. Somatic GNAQ mutations (c.626A > T; p.Gln209Leu) were found in 100% (6 of 6) of the solitary choroidal hemangiomas and (c.626A > C; p.Gln209Pro) in the choroidal nevus. The authors conclude that GNAQ mutations occur in both diffuse and solitary hemangiomas, although at distinct codons. An R183 codon is mutant in diffuse choroidal hemangiomas, consistent with other Sturge-Weber vascular malformations. By contrast, solitary choroidal hemangiomas have mutations in the Q209 codon, similar to other intraocular melanocytic neoplasms.

Choroideremia Gene Therapy Phase 2 Clinical Trial: 24-Month Results.

Choroideremia is a rare X-linked recessive disorder in which gradual vision loss results from a mutation or deletion of the CHM gene and absence of the CHM gene product, Rab escort protein 1 (REP1), essential for intracellular trafficking. Vision loss progresses from nyctalopia in children to visual field constriction in early adulthood and ultimately to near complete blindness by age 40-50 years. There are no current treatments for choroideremia. The authors report the final results of a phase 2 high dose gene therapy clinical trial in choroideremia. Six men (aged 32-72 years) with genetically-confirmed advanced choroideremia were included in the study. Patients received subfoveal injection of AAV2-REP1 (10^{11} genome particles in 0.1 mL) in the worse-sighted eye. Primary measure was best-corrected visual acuity (BCVA) change from baseline in the treated eye compared to the untreated eye. Secondary endpoints included change from baseline in microperimetry, fundus autofluorescence, and spectral-domain optical coherence tomography (OCT). Safety evaluations included adverse events, viral shedding in body fluids, and vector antibody responses. Baseline mean ETDRS BCVA was 65.3 ± 8.8 (SD, range 56-77, 20/32-20/80) letters in the treated eyes and 77.0 ± 4.2 (69-81, 20/25-20/40) letters in the untreated eyes. At 2 years, 1 treated eye improved by 10 letters and another by 5 letters, while 1 untreated eye improved by 4 letters. All other eyes were within 2 letters of baseline. Baseline microperimetry sensitivities in the treated eyes were poor (1.2± 2.1 (0, 5.1) dB) and showed no significant change. No serious adverse event occurred. Two patients developed an atrophic retinal hole in a nonfunctioning macular area where baseline OCT showed preexisting thinning. Intraoperative microscope-integrated OCT allowed proper subretinal injection with avoidance of excessive foveal stretching and macular hole formation. In conclusion, the study provides evidence that treatment of choroideremia with high-dose subfoveal gene
therapy has the potential to maintain BCVA, as well as improve BCVA in some cases, indicating that improvement in BCVA could be used as a viable primary outcome for future choroideremia gene therapy trials for patients with advanced choroideremia. Choroideremia gene therapy safety is enhanced with automated injection guided by real-time MIOCT. Larger-scale studies are required to ascertain the significance of these initially encouraging results.

Quantitative Analysis of Hyperautofluorescent Rings to Characterize the Natural History and Progression in RPGR-Associated Retinopathy.


Retinitis pigmentosa (RP) as a collection of genetically diverse disorders is a common form of retinal degeneration with a prevalence of 1:3,000; with 30% to 40% of cases inherited through an autosomal dominant (AD) route, 45% to 60% through an autosomal recessive (AR) route, and 5% to 15% as an X-linked trait. Three quarters of X-linked RP (XLRP) can be attributed to mutations arising within the retinitis pigmentosa GTPase regulator (RPGR) gene. RPGR-associated retinopathy is especially severe, as characterized by early disease onset in childhood and fast progression. The authors did quantitative analysis of hyperautofluorescent rings and progression in subjects with retinitis pigmentosa associated with RPGR gene mutations. It was a prospective observational study of 46 subjects. Ring area, horizontal and vertical diameter measurements taken from outer and inner ring borders were documented. Intraobserver repeatability, baseline measurements, progression rates, interocular symmetry, and association with age and genotype were investigated. Baseline ring area was 11.8 ± 13.4 mm and 11.4 ± 13.2 mm for right and left eyes, respectively, with very strong interocular correlation (r = 0.9398; P < 0.0001). Ring area constriction was 1.5 ± 2.0 mm/year and 1.3 ± 1.9 mm/year for right and left eyes, respectively, with very strong interocular correlation (r = 0.878, P < 0.0001). Baseline ring area and constriction rate correlated negatively with age (r = -0.767; P < 0.0001 and r = -0.644, P < 0.0001, respectively). Constriction rate correlated strongly with baseline area (r = 0.850, P < 0.0001). Age, but not genotype, exerted a significant effect on constriction rates (P < 0.0001), with greatest rates of progression seen in younger subjects. An exponential decline overall was found. This study provides disease-specific baseline values and progression rates together with a repeatability assessment of fundus autofluorescence metrics. Our findings can guide future treatment trials and contribute to the clinical care of patients with RPGR-associated retinitis pigmentosa.

Clinical and imaging characteristics of posterior column ataxia with retinitis pigmentosa with a specific FLVCR1 mutation.

Posterior column ataxia with retinitis pigmentosa (PCARP) is an autosomal recessive, slowly progressive, neurodegenerative syndrome due to malfunction of heme-iron transport, that typically presents in early childhood. PCARP primarily leads to sensory ataxia due to degeneration of proprioceptive neurons in the posterior column and retinitis pigmentosa (RP), a progressive retinal degenerative disease. This disorder is caused by a known pathogenic mutation in the feline leukemia virus subgroup C cellular receptor 1 (FLVCR1) gene, which encodes for a plasma membrane receptor protein responsible for heme transport. PCARP has been predominately reported from a neurological viewpoint in the current literature. Ophthalmic descriptions are limited to fundus exam, visual acuity, and visual fields. The authors conducted a retrospective case series study of patients diagnosed with PCARP and genetic testing positive for FLVCR1 mutation between 1 January 2015 and 1 October 2017 at the Children's Hospital of Pittsburgh. Clinical charts, visual fields, fundus autofluorescence, and spectral-domain optical coherence tomography (SD-OCT) were reviewed. Seven patients from three families were identified to have PCARP and FLVCR1 mutation. The median age at presentation was 13 years (range, 7-28 years). Common clinical exam findings were astigmatism, cataracts, and vitreous syneresis. Funduscopy on all patients revealed bull's eye maculopathy, retinal vessel attenuation, and bone spicule changes in the peripheral retina. Fundus autofluorescence showed bilateral hyperautofluorescent rings. SD-OCT demonstrated morphological changes, which differed based on age. The youngest sibling family exhibited peripheral loss, but subfoveal preservation of the outer retinal layers. These layers were lost in the oldest sibling family. Visual fields loss paralleled SD-OCT findings. There is limited published ophthalmic data on FLVCR1-related PCARP. The authors describe clinical and retinal imaging features in the one of the largest cohorts of affected patients in the literature. Given the availability of genetic testing for this phenotype, testing for FLVCR1 mutations should be considered in pediatric and adult patients with sensory ataxia and retinitis pigmentosa.

Analysis of multiple genetic loci reveals MPDZ-NF1B rs1324183 as a putative genetic marker for keratoconus.


Keratoconus is a complex disease involving both genetic and environmental factors. Eye rubbing, asthma, allergies and eczema are some of the major risk factors. In addition, the role of inheritance had been demonstrated in twin studies, familial aggregation studies, and linkage analyses. So far, however, no specific gene variant had been found to directly cause keratoconus. The authors investigate the associations between 16 single-nucleotide polymorphisms (SNPs) in 14 genetic loci and keratoconus in an independent Chinese cohort. This cross-sectional, case-control association study included a Chinese cohort of 133 pa-
tients with keratoconus and 371 control subjects. In a recent meta-analysis study, the authors identified association of 16 SNPs in 14 gene loci with keratoconus. In this study, these 16 SNPs were genotyped in all the patients and controls and their association with keratoconus was analyzed (clinical severities and progression profiles). The authors also analyzed the genotype-phenotype correlation between individual SNPs and steep keratometry, flat keratometry (Kf), average keratometry (Avg K) and best-fit sphere diameter (BFS) of the anterior and posterior corneal surface. Among the 16 selected SNPs, rs1324183 in the MPDZ-NF1B locus showed a significant association with keratoconus (OR=2.22; 95% CI 1.42 to 3.45, p=4.30×10^{-4}), especially severe keratoconus (OR=5.10, 95% CI 1.63 to 15.93, p=0.005). The rs1324183 A allele was positively associated with anterior Kf (p=0.008), anterior Avg K (p=0.017), posterior Kf (p=0.01) and negatively associated with apex pachymetry (p=0.007) and anterior BFS (p=0.023) in keratoconus. The other 15 SNPs had no significant association with keratoconus or genotype-phenotype correlations. In summary, the authors have confirmed the association of SNP rs1324183 in MPDZ-NF1B with keratoconus in the Chinese population, providing new evidence to support MPDZ-NF1B as a susceptibility gene of keratoconus. In particular, this SNP conferred a higher, more than 5-fold of risk to severe keratoconus. Moreover, more copies of the risk allele A of rs1324183 were correlated with higher anterior Kf and Avg K and lower posterior Kf and apex pachymetry, suggesting its association with corneal thickness and curvature and keratoconus severity. Therefore, the SNP rs1324183 in MPDZ-NF1B may potentially play a role in differentiating different severities of keratoconus, thus facilitating earlier intervention.

CFH Y402H polymorphism in Italian patients with age-related macular degeneration, retinitis pigmentosa, and Stargardt disease.


The complement system has been implicated in the pathogenesis of age-related macular degeneration (AMD) and the CFHY402H polymorphism has been suggested as a major risk factor for AMD. Recent evidences supported the role of inflammation in the pathogenesis of some retinal dystrophies. The aim of this study was to evaluate the prevalence of CFHY402H polymorphism in a group of Italian patients affected by atrophic AMD, Stargardt disease (STGD), or retinitis pigmentosa (RP). It included 116 patients with atrophic AMD, 77 with RP, 86 with STGD, and 100 healthy controls. All the patients were evaluated by a standard ophthalmologic examination and OCT. ERG was performed on STGD and RP patients. All the subjects underwent a blood drawing for genetic testing and the CFHY402H polymorphism was genotyped with the TaqMan real-time poly-
merase chain reaction single nucleotide polymorphism assay. The prevalence of the risk genotype C/C was higher in the AMD group than in controls \((p < 0.001)\). The risk allele C was more frequent in the AMD group than in controls \((p < 0.001)\). The prevalence of the risk genotype was higher in the RP patients than in controls \((p < 0.001)\) and similarly the risk allele C was more frequent in the RP group \((p = 0.008)\). The CFHY402H genotype distribution was not different between patients with STGD and the controls, for the biallelic \((p = 0.531)\) and for the monoallelic \((p = 0.318)\) evaluation. In this series of Italian patients, the CFHY402H genotype is associated with atrophic AMD and RP, but not with STGD. This result may support the hypothesis of a complement system dysregulation in the pathogenesis of AMD and RP. This may have potential impact on future treatments for these diseases.

**Efficacy Outcome Measures for Clinical Trials of USH2A Caused by the Common c.2299delG Mutation.**

Usher syndrome (USH), an autosomal recessive disorder with 3 clinical types and multiple molecular subtypes, leads to retinal degeneration with accompanying hearing and vestibular impairment. There are no therapies at this time for the progressive retinal degeneration of any form of USH. One of the common forms of USH is owing to mutations in the *USH2A* gene, and the most common *USH2A* mutation is the c.2299delG variant in exon 13, which causes a frameshift at codon 767 resulting in a premature termination or a splicing defect. The goal of this paper was to determine the change in vision and retinal structure in patients with the common c.2299delG mutation in *USH2A* in anticipation of clinical trials of therapy. Eighteen patients, homozygotes or compound heterozygotes with the c.2299delG mutation in *USH2A*, were studied with regard to visual acuity, kinetic perimetry, dark- and light-adapted static perimetry, optical coherence tomography (OCT), and autofluorescence (AF) imaging. Serial data were available for at least half of the patients, depending on the parameter analyzed. The kinetics of disease progression in this specific molecular form of USH2A differed between the measured parameters. Visual acuity could remain normal for decades. Kinetic and light-adapted static perimetry across the entire visual field had similar rates of decline that were slower than those of rod-based perimetry. Horizontal OCT scans through the macula showed that inner segment/outer segment line width had a similar rate of constriction as colocalized AF imaging and cone-based light-adapted sensitivity extent. The rate of constriction of rod-based sensitivity extent across this same region was twice as rapid as that of cones. In conclusion, in patients with the c.299delG mutation in *USH2A*, rod photoreceptors are the cells that express disease early and more aggressively than cones. Rod-based vision measurements in central or extracentral-peripheral retinal regions warrant monitoring in order to complete a clinical trial in a timely manner.
The most common type of juvenile macular degeneration is Stargardt disease (STGD1; OMIM: 248200). Affected individuals start to develop progressive decline in best-corrected visual acuity (BCVA), often within the first or second decades of life. Currently, no treatment to preserve or restore vision is available for STGD1 patients. New therapeutic approaches, such as pharmacotherapy, gene therapy, stem cell therapy, retinal prostheses, and optogenetics are being developed; some of them are already being investigated in clinical trials. Outcome parameters for STGD1 require special considerations with respect to the centrifugal progression of atrophy in STGD1 (initially affecting the macula before the periphery). The authors sought to investigate the natural history of Stargardt disease (STGD1) using fixation location and fixation stability in a multicenter, international, prospective cohort study. This is the first prospective longitudinal analysis of continuous fixation parameters in a large cohort of genetically confirmed cases of ABCA4-related STGD1. Fixation testing was performed using the Nidek MP-1 microperimeter as part of the prospective, multicenter, natural history study on the Progression of Stargardt disease (ProgStar). A total of 238 patients with ABCA4-related STGD1 were enrolled at baseline (bilateral enrollment in 86.6%) and underwent repeat testing at months 6 and 12. Outcome measures included the distance of the preferred retinal locus from the fovea (PRL) and the bivariate contour ellipse area (BCEA). After 12 months of follow-up, the change in the eccentricity of the PRL from the anatomic fovea was -0.0014 degrees (95% confidence interval [CI], -0.27 degrees, 0.27 degrees; P = .99). The deterioration in the stability of fixation as expressed by a larger BCEA encompassing 1 standard deviation of all fixation points was 1.21 degrees squared (deg^2) (95% CI, -1.23 deg^2, 3.65 deg^2; P = .33). Eyes with increases and decreases in PRL eccentricity and/or BCEA values were observed. Based on the presented results, a follow-up period of 12 months does not provide statistically significant changes for a large cohort of patients that could be used to compare effects of treatments in clinical trials. Underlying reasons may be the complex heterogeneity of the changes of fixation parameters that include both deteriorations and improvements. Neuronal adaptation processes may be involved in cases where fixation becomes more central or more stable over time. It is also possible that a follow-up period of 12 months is too short a period to demonstrate significant centrifugal displacement and destabilization of fixation despite the large number of study participants. However, fixation parameters may serve as useful secondary outcome parameters in selected cases and for counseling patients to explain changes to their visual functionality. In addition, the observed changes may explain cases of improvement in BCVA.
Ocular findings in Loeys-Dietz syndrome.


Loeys-Dietz syndrome (LDS), an autosomal-dominant connective tissue disorder, is characterized by systemic manifestations including arterial aneurysm and craniofacial dysmorphologies. Although ocular involvement in LDS has been reported, detailed information on those manifestations is lacking. Based on case reports or small case series, ophthalmological findings include myopia, blue or dusk sclera, cataract, retinal detachment, retinal tortuosity, strabismus and amblyopia, but their frequencies, severities and diagnostic value have not been reported. The authors performed a retrospective chart review of patients with diagnosed LDS and comparison with age-matched control patients. Mean age was 37.8±14.6 years (patients with LDS) and 38.4±13.5 years (controls). Patients with LDS less frequently had iris transillumination, cataract and glaucoma compared with controls. Scleral and retinal vascular abnormalities were not found in any of the LDS eyes. Ectopia lentis was found in one patient with LDS. The eyes of patients with LDS tended to be more myopic (spherical equivalent, -2.47±2.70 dioptres (dpt) vs -1.30±2.96dpt (controls); P=0.08) and longer (24.6±1.7mm vs 24.1±1.5mm (controls); P=0.10). Central corneal thickness was significantly reduced in LDS eyes (521±48µm vs 542±37µm (controls); P=0.02). Corneal curvature (43.06±1.90dpt (LDS) versus 43.00±1.37dpt (controls); P=0.72) and interpupillary distance (65.0±6.0mm (LDS) vs 64.3±4.8mm (controls); P=0.66) did not differ significantly between both groups. Visual acuity was similar between both groups for LDS eyes and for control eyes. Ocular features of LDS include decreased central corneal thickness and mild myopia. Ectopia lentis may be slightly more common than in controls but appears less common than in Marfan syndrome. Hypertelorism, scleral and retinal vascular abnormalities were not features of LDS.

Mutation screening of the USH2A gene in retinitis pigmentosa and Usher patients in a Han Chinese population.


The aim of this study was to detect USH2A mutations in a Chinese cohort of 75 small RP families and 10 Usher syndrome families. Authors performed a direct Sanger sequencing analysis of the USH2A gene to identify mutations for this cohort. A total of eight mutations were found in four of the 75 small RP families (5.3%) and two mutations in one of the 10 Usher families (10%); all families were detected to have compound heterozygous mutations. Authors found six novel mutations in the USH2A gene in a Chinese population. In families with no syndromic RP, authors identified the

Whole-genome sequencing reveals a recurrent missense mutation in the Connexin 46 (GJA3) gene causing autosomal-dominant lamellar cataract.

This study reports potential mutations found in English patients with isolated autosomal-dominant lamellar cataract. Two affected and one unaffected subject underwent whole-genome sequencing (WGS). Segregation analysis was performed. A known cataract-causing mutation was identified. A heterozygous mutation c.7 G > T; p.D3Y was identified in an NH2 terminal region of the gap junction protein GJA3 and found to co-segregate with disease. The paper concludes that WGS is helpful finding otherwise unidentified mutations including a mutation in GJA3 causing the novel phenotype of autosomal-dominant congenital lamellar cataract and a previously reported p.D3Y in a Hispanic family causing pulverulent cataract.

Toward the Mutational Landscape of Autosomal Dominant Retinitis Pigmentosa: A Comprehensive Analysis of 258 Spanish Families.

This study provides a comprehensive overview of the molecular basis of autosomal dominant retinitis pigmentosa (adRP) in Spanish families. It also establishes the molecular characterization rate, gene prevalence, and mutational spectrum in the largest European cohort reported to date. A total of 258 unrelated Spanish families with a clinical diagnosis of RP and suspected autosomal dominant inheritance were included. Clinical diagnosis was based on complete ophthalmologic examination and family history. Retrospective and prospective analysis of Spanish adRP families was carried out using a combined strategy consisting of classic genetic techniques and next-generation sequencing (NGS) for single-nucleotide variants and copy number variation (CNV) screening. Overall, 60% of our families were genetically solved. Interestingly, 3.1% of the cohort carried pathogenic CNVs. Disease-causing variants were found in an autosomal dominant gene in 55% of the families; however, X-linked and autosomal recessive forms were also identified in 3% and 2%, respectively. Four genes (RHO, PRPF31, RP1, and PRPH2) explained up to 62% of the solved families. Missense changes were
most frequently found in adRP-associated genes; however, CNVs represented a relevant disease cause in PRPF31- and CRX-associated forms. The authors conclude that implementation of NGS technologies in the adRP study clearly increased the diagnostic yield compared with classic approaches. The study expands the spectrum of disease-causing variants, provides accurate data on mutation gene prevalence, and highlights the implication of CNVs as important contributors to adRP etiology.

**Prevention of Leber congenital amaurosis through preimplantation genetic diagnosis.**

Preimplantation genetic diagnosis can allow a family with a hereditary genetic mutation to conceive a disease-free child. The authors report the first published case of a child born without Leber congenital amaurosis through preimplantation genetic testing to a couple who had a son with a homozygous mutation in the GUCY2D gene.

**Clinical features of LONP1-related infantile cataract.**

Biallelic mutations in the nuclear gene LONP1 (LON peptidase 1, mitochondrial) cause CODAS syndrome (cerebral, ocular, dental, auricular, and skeletal anomalies), a systemic disease that can include infantile cataract. The authors report that biallelic mutations in the gene can also underlie infantile cataract in the setting of minimal or no apparent extraocular findings. This report highlights the clinical experience with children referred for the management of infantile cataract who were found to harbor biallelic LONP1 gene mutations. Ptosis, external ear abnormalities, and joint abnormalities were accompanying findings and thus should raise suspicion for mutations in the gene when one or more are present in children with infantile cataract.

**Whole-genome sequencing reveals a recurrent missense mutation in the Connexin 46(GJA3) gene causing autosomal-dominant lamellar cataract.**

Congenital cataract is clinically and genetically a heterogeneous childhood disease. This study identifies the underlying genetic cause of isolated autosomal-dominant lamellar cataract in a multi-generation English family. Whole-genome sequencing (WGS) was undertaken in two affected subjects and one unaffected individual. Segregation analysis was performed and a known cataract-causing mutation was identified. Segregation was further validated by
sanger sequencing in the entire pedigree. A heterozygous mutation c.7 G > T; p.D3Y was identified in an NH2-terminal region of the gap junction protein GJA3 and found to co-segregate with disease. The authors identified a recurrent mutation in GJA3 in a large British pedigree causing the novel phenotype of autosomal-dominant congenital lamellar cataract. Previously, p.D3Y was found in a Hispanic family causing pulverulent cataract. WGS proved an efficient method to find the underlying molecular cause in this large family, which could not be mapped due to uninformative markers.

**Genome-Wide Association Study Identifies a Susceptibility Locus for Comitant Esotropia and Suggests a Parent-of-Origin Effect.**

This study aims to identify genetic variants conferring susceptibility to esotropia, the most common form of comitant strabismus (with highest incidence in European ancestry populations). Esotropia is believed to be inherited as a complex trait. White European American discovery cohorts with nonaccommodative (826 cases and 2991 controls) or accommodative (224 cases and 749 controls) esotropia were investigated. White European Australian and United Kingdom cohorts with nonaccommodative (689 cases and 1448 controls) or accommodative (66 cases and 264 controls) esotropia were tested for replication. A genome-wide case-control association study was performed using a mixed linear additive model. Meta-analyses of discovery and replication cohorts were then conducted. A significant association with nonaccommodative esotropia was discovered (odds ratio [OR] = 1.41, P = 2.84 × 10-09) and replicated (OR = 1.23, P = 0.01) at rs2244352 [T] located within intron 1 of the WRB (tryptophan rich basic protein) gene on chromosome 21 (meta-analysis OR = 1.33, P = 9.58 × 10-11). This single nucleotide polymorphism (SNP) is differentially methylated, and there is a statistically significant skew toward paternal inheritance in the discovery cohort. Meta-analysis of the accommodative discovery and replication cohorts identified an association with rs912759 [T] (OR = 0.59, P = 1.89 × 10-08), an intergenic SNP on chromosome 1p31.1. This is the first genome-wide association study (GWAS) to identify significant associations in esotropia and suggests a parent-of-origin effect. Additional cohorts will permit replication and extension of these findings. Future studies of rs2244352 and WRB should provide insight into pathophysiological mechanisms underlying comitant strabismus.

**Presentation of TRPM1-Associated Congenital Stationary Night Blindness in Children.**

This study describes the presentation and longitudinal clinical characteristics
of pediatric patients with molecularly confirmed TRPM1-associated complete CSNB (cCSNB). It was conducted at the University of Iowa from January 1, 1990, to July 1, 2015, and was a retrospective, longitudinal case series of 7 children (5 [71.4%] female) with TRPM1-associated cCSNB followed up for a mean (SD) of 11.1 (2.8) years. Main outcomes and measures include history, ophthalmologic examination findings, full-field electroretinogram (ffERG) results, full-field stimulus threshold testing results, Goldmann visual field results, optical coherence tomography results, and molecular genetic results were evaluated. Presenting symptoms and signs, the correlation of refractive error with electroretinography, and clinical evolution were analyzed.

Seven patients (5 [71.4%] female) presented early in childhood with strabismus (n = 6 [86%]), myopia (n = 5 [71%]), and/or nystagmus (n = 3 [43%]). The mean (SD) age at presentation was 8 (4) months and for receiving a diagnosis by ffERG was 7.3 years, with molecular diagnosis at 9.7 years. The mean (SD) length of follow-up was 11 (2.8) years. The best-corrected visual acuity at the most recent visit averaged 20/30 in the better-seeing eye (range, 20/20-20/60). The mean (SD) initial refraction was -2.80 (4.42) diopters (D) and the mean refraction at the most recent visit was -8.75 (3.53) D (range, -4.00 to -13.75 D), with the greatest rate of myopic shift before age 5 years. Full-field electroretinogram results were electronegative, consistent with cCSNB, without a significant change in amplitude over time. No patient or parent noted night blindness at presentation; however, subjective nyctalopia was eventually reported in 5 of 7 patients (71%). The full-field stimulus threshold testing results were moderately subnormal (-29.7 [3.8] dB; normal -59.8 [4.0] dB). Goldmann visual field results were significant for full I-4e, but constricted I-2e isopter. Eight different mutations or rare variants in TRPM1 predicted to be pathogenic were detected, with 3 novel variants. The authors conclude that children with TRPM1-associated cCSNB presented before school age with progressive myopia as well as strabismus and nystagmus (but not nyctalopia), with stable, electronegative ffERG results, mildly subnormal full-field stimulus threshold testing results, and a constricted I2e isopter on perimetry. These findings suggest that ffERG and cCSNB genetic testing should be considered for children who present with early-onset myopia, especially in the presence of strabismus and/or nystagmus, and that TRPM1-associated cCSNB is a channelopathy that may present without complaints of night blindness in childhood.

Leber Congenital Amaurosis Associated with Mutations in CEP290, Clinical Phenotype, and Natural History in Preparation for Trials of Novel Therapies.


This retrospective case series describes in detail the demographics, functional and anatomic characteristics, and clinical course of Leber congenital amaurosis (LCA) associated with mutations in the CEP290 gene (LCA-
CEP290) in a large cohort of adults and children identified at a single UK referral center.

The authors review case notes and results of retinal imaging (color fundus photography, fundus autofluorescence [FAF] imaging, OCT), electrophysiologic assessment, and molecular genetic testing. Main outcome measures are molecular genetic testing, clinical findings including visual acuity and retinal imaging, and electrophysiologic assessment. Forty patients with LCA-CEP290 were identified. The deep intronic mutation c.2991+1655 A>G was the most common disease-causing variant (23/40 patients) identified in the compound heterozygous state in 20 patients (50%) and homozygous in 2 patients (5%). Visual acuity (VA) varied from 6/9 to no perception of light, and only 2 of 12 patients with longitudinal VA data showed deterioration in VA in their better-seeing eye over time. A normal fundus was found at diagnosis in younger patients (mean age, 1.9 years), with older patients showing white flecks (mean age, 5.9 years) or pigmentary retinopathy (mean age, 21.7 years). Eleven of 12 patients (92%) with OCT imaging had preservation of foveal architecture. Ten of 12 patients (83%) with FAF imaging had a perifoveal hyperautofluorescent ring. Having 2 nonsense CEP290 mutations was associated with worse final VA and the presence of nonocular features.

The authors conclude that there is a window of opportunity in childhood for therapeutic intervention based on relative structural preservation in the central cone-rich retina in a significant proportion of patients, with the majority harboring the deep intronic variant potentially tractable to several planned gene editing approaches.

**Joubert Syndrome: Ophthalmological Findings in Correlation with Genotype and Hepatorenal Disease in 99 Patients Prospectively Evaluated at a Single Center.**

This article describes the ophthalmic manifestations of Joubert syndrome (JS) and draws correlations with the underlying genotype and systemic findings. JS is caused by mutations in >34 genes that encode proteins involved with primary (nonmotile) cilia and the cilium basal body. Ninety-nine patients with JS were systematically and prospectively examined at the National Institutes of Health (NIH) Clinical Center in the setting of a dedicated natural history clinical trial. All patients underwent genotyping for JS, followed by complete age-appropriate ophthalmic examinations at the NIH Clinical Center, including visual acuity (VA), fixation behavior, lid position, motility assessment, slit-lamp biomicroscopy, dilated fundus examination with an indirect ophthalmoscope, and retinoscopy. Color and fundus autofluorescence imaging, Optos wide-field photography (Dunfermline, Scotland, UK), and electroretinography (ERG) were performed when possible. Main outcome measures included VA (with longitudinal follow-up where possible), ptosis, extraocular muscle function, retinal and optic nerve status, and retinal function as measured by ERG. Among patients with JS with quantifiable VA
values ranged from 0 logarithm of the minimum angle of resolution (logMAR) (Snellen 20/20) to 1.5 logMAR (Snellen 20/632). Strabismus (71/98), nystagmus (66/99), oculomotor apraxia (60/77), ptosis (30/98), coloboma (28/99), retinal degeneration (20/83), and optic nerve atrophy (8/86) were identified. The authors recommend regular monitoring for ophthalmological manifestations of JS beginning soon after birth or diagnosis. Result analysis demonstrates delayed visual development and the article notes that the amblyogenic time frame may last significantly longer in JS than is typical. In general, patients with coloboma were less likely to display retinal degeneration, and those with retinal degeneration did not have coloboma. Severe retinal degeneration that is early and aggressive is seen in disease caused by specific genes, such as CEP290- and AHI1-associated JS. Retinal degeneration in INPP5E-, MKS1-, and NPHP1-associated JS was generally milder. Finally, ptosis surgery can be helpful in a subset of patients with JS; decisions as to timing and benefit/risk ratio need to be made on an individual basis according to expert consultation.

Leber Congenital Amaurosis Associated with Mutations in CEP290, Clinical Phenotype, and Natural History in Preparation for Trials of Novel Therapies

Leber congenital amaurosis (LCA) is described as early-onset vision loss, nystagmus and an extinguished ERG. Leber later described a separate group of milder disease phenotypes with some preservation of the ERG called "early-onset sever retinal dystrophy" (EOSRD). There is a considerable genetic overlap between LCA and EOSRD. Among the 25 causative genes, CEP290 is the most common cause, accounting for 15-20% of all known cases. The purpose of this study was to provide detailed characterization of the clinical phenotype and natural history in a large number of patients with CEP290 LCA/EOSRD. The authors described in detail the demographics, functional and anatomic characteristics and clinical course to provide a guide for the advent of novel gene therapy for RPE65-associated LCA. The authors reported on 40 patients with mutations in CEP290 identified at a single UK referral center. The deep intronic mutation c.2991+1655 A>G was the most common disease-causing variant (23/40 patients) identified in the compound heterozygous state in 20 patients (50%) and homozygous in 2 patients (5%). Visual acuity (VA) varied from 6/9 to no perception of light, and only 2 of 12 patients with longitudinal VA data showed deterioration in VA in their better-seeing eye over time. A normal fundus was found at diagnosis in younger patients (mean age, 1.9 years), with older patients showing white flecks (mean age, 5.9 years) or pigmentary retinopathy (mean age, 21.7 years). Eleven of 12 patients (92%) with OCT imaging had preservation of foveal architecture. Ten of 12 patients (83%) with FAF imaging had a perifoveal hyper-autofluorescent ring. Having 2 nonsense CEP290 mutations was associated with worse final VA and the presence of nonocular features. Based on these findings,
the authors concluded that there is a window of opportunity in childhood for therapeutic intervention based on relative structural preservation in the central cone-rich retina in a significant proportion of patients, with the majority harboring the deep intronic variant potentially tractable to several planned gene editing approaches.

**Genome-Wide Association Study Identifies a Susceptibility Locus for Comitant Esotropia and Suggests a Parent-of-Origin Effect**

The purpose of this study was to identify genetic variants conferring susceptibility to esotropia. Esotropia is the most common form of comitant strabismus, has its highest incidence in European ancestry populations, and is believed to be inherited as a complex trait. White European American discovery cohorts with nonaccommodative (826 cases and 2991 controls) or accommodative (224 cases and 749 controls) esotropia were investigated. White European Australian and United Kingdom cohorts with nonaccommodative (689 cases and 1448 controls) or accommodative (66 cases and 264 controls) esotropia were tested for replication. The authors performed a genome-wide case–control association study using a mixed linear additive model. Meta-analyses of discovery and replication cohorts were then conducted. A significant association with nonaccommodative esotropia was discovered (odds ratio [OR] = 1.41, P = 2.84 x 10^{-09}) and replicated (OR = 1.23, P = 0.01) at rs2244352 [T] located within intron 1 of the WRB (tryptophan rich basic protein) gene on chromosome 21 (meta-analysis OR = 1.33, P = 9.58 x 10^{-11}). This single nucleotide polymorphism (SNP) is differentially methylated, and there is a statistically significant skew toward paternal inheritance in the discovery cohort. Methylation status is known to be influenced by the environment; and a meta-analysis has specifically identified reduced methylation of WRB in offspring of mothers who smoked during pregnancy, raising the possibility that genetic and epigenetic influences are working through a common pathway to increase the risk of developmental strabismus. Meta-analysis of the accommodative discovery and replication cohorts identified an association with rs912759 [T] (OR =0.59, P = 1.89 x 10^{-08}), an intergenic SNP on chromosome 1p31.1. This is the first genome-wide association study (GWAS) to identify significant associations in esotropia and suggests a parent-of-origin effect. Additional cohorts will permit replication and extension of these findings. Future studies of rs2244352 and WRB should provide insight into pathophysiological mechanisms underlying comitant strabismus.

**Prevention of Leber congenital amaurosis through preimplantation genetic diagnosis.**
Preimplantation genetic diagnosis (PGD) can allow a family with a hereditary genetic mutation to conceive a disease-free child. The authors describe the first published case of a child born without Leber congenital amaurosis (LCA) through PGD to a couple who had a son with a homozygous mutation in the GUCY2D gene. A PGD reference lab developed probes to test for the known familial mutation in the GUCY2D gene and linked short tandem repeats found upstream and downstream of the mutation. The parents went through in vitro fertilization (IVF) treatment cycles and consented to test their embryos for the LCA gene mutation, in addition to screening the embryos for chromosomal aneuploidy through array complete genomic hybridization. The full process is described in the article. Preimplantation genetic diagnosis has been previously described as a tool to prevent ocular diseases in the offspring. We thought that this article would be of interest for physicians counseling families, who carry mutations for LCA. Abnormal mutations can be identified in embryos through PGD, thus allowing preconception diagnosis and increasing the odds of the birth of a disease-free child.

Pediatric Primary Calcific Band Keratopathy With or Without Glaucoma from Biallelic SLC4A4 Mutations.

Biallelic mutations in the gene SLC4A4 (Solute Carrier Family 4 Member 4) cause protean manifestations in children that include proximal retinal tubular acidosis, developmental delay, band keratopathy, and glaucoma. A unique SLC4A4 mutation causes an ocular-only phenotype. In this retrospective case series, the authors highlight six children (four families) referred to a pediatric ophthalmologist who were found to harbor underlying biallelic SLC4A4 mutations. All were from consanguineous or endogamous families.

A Novel Deletion Downstream of the PAX6 Gene Identified in a Chinese Family with Congenital Aniridia.

Congenital aniridia, a severe bilateral panocular visual disorder, is an autosomal dominantly inherited eye anomaly. Mutations in the paired box 6 gene (PAX6) have been shown to be responsible for congenital aniridia in most patients. The congenital aniridia is characterized by partial-to-complete absence of the iris and is normally accompanied by developmental defects of the cornea, lens, retina, optic nerve, and/or the anterior chamber angle. The purpose of the present study was to report clinical features of a Chinese family with congenital aniridia and to screen novel genetic mutations for congenital aniridia. All members of a three-generation family underwent comprehensive ophthalmic examination, and 8 of its 25 members were diagnosed with congenital aniridia. The proband was analyzed by exome sequencing and whole genome sequencing, and linkage analysis was performed for the family. The mutation was confirmed by direct DNA sequencing.
Using Illumina’s Human Linkage-12 beadchip microarray (including 6090 SNPs) whole genome scan, the LOD score value showed that the interval on chromosome 11 between rs1389423 to rs910090 exhibited a strong linkage. A novel heterozygous 469 kb deletion mutation within the downstream region of PAX6 (chr11:31189937–31659379) was identified in all affected family members, but not in unaffected family members or 2000 ethnically matched controls. This study identified a novel deletion mutation in the PAX6 gene located downstream of its 3’ UTR in a Han Chinese family with congenital aniridia by using exome sequencing, whole genome sequencing, and linkage analysis.

Preimplantation Genetic Diagnosis as a Strategy to Prevent having a Child Born with an Heritable Eye Disease.

Hereditary forms of eye disease account for 14% of all childhood blindness cases in African countries and up to 53% of cases in developed countries such as Europe and the United States. Childhood-onset visual impairment can have major socioeconomic, educational, and psychological consequences. According to a report published by the Vision Cost-Effectiveness Study Group, in 2012 the economic burden associated with vision loss among children age 0–17 years was $5.9 billion in the United States alone. Preimplantation genetic diagnosis (PGD) is a screening technique first introduced in 1990. PGD involves the genetic analysis of one cell, or a few cells, extracted from an in vitro fertilization (IVF)-derived embryo; following analysis, only the embryos that are free of the specific genetic mutation are implanted. Isolated case reports of the successful use of PGD have been reported for several inherited eye diseases, including retinoblastoma, X-linked retinoschisis, and Stargardt disease. The authors report their experience using PGD in order to avoid transmitting a genetic form of eye disease associated with childhood visual impairment and ocular cancer. This is a retrospective case series of women who underwent in vitro fertilization (IVF) and PGD due to a familial history of inherited eye disease and/or ocular cancer, in order to avoid having a child affected with the known familial disease. Each family underwent genetic testing in order to identify the underlying disease-causing mutation. IVF and PGD treatment were performed; unaffected embryos were implanted in their respective mothers. Thirty-five unrelated mothers underwent PGD, and the following hereditary conditions were identified in their families: albinism (10 families); retinitis pigmentosa (7 families); retinoblastoma (4 families); blue cone monochromatism, achromatopsia, and aniridia (2 families each); and Herman-sky-Pudlak syndrome, Leber congenital amaurosis, Norrie disease, papillorenal syndrome, primary congenital cataract, congenital glaucoma, Usher syndrome type 1F, and microphthalmia with coloboma (1 family each). Following a total of 88 PGD cycles, 18 healthy (i.e., unaffected) children were born. These findings underscore the importance an ophthalmologist plays in informing patients regarding the options now available for using prenatal and preimplantation genetic diagnosis to avoid having a child with a potentially devastating genetic form of eye
disease or ocular cancer. This strategy is highly relevant, particularly given the limited options currently available for treating these conditions.

**Keratoendotheliitis Fugax Hereditaria: A Novel Cryopyrin-Associated Periodic Syndrome Caused by a Mutation in the Nucleotide-Binding Domain, Leucine-Rich Repeat Family, Pyrin Domain-Containing 3 (NLRP3) Gene.**

The authors describe the phenotype and the genetic defect in keratoendotheliitis fugax hereditaria, an autosomal dominant keratitis that periodically affects the corneal endothelium and stroma, leading in some patients to opacities and decreased visual acuity. Thirty affected and 7 unaffected subjects from 7 families, and 4 sporadic patients from Finland were studied. Unilateral attacks of keratoendotheliitis typically occurred 1-6 times a year (median, 2.5), starting at a median age of 11 years (range, 5-28 years), and lasted for 1-2 days. The attacks were characterized by cornea pseudoguttata and haze in the posterior corneal stroma, sometimes with a mild anterior chamber reaction, and got milder and less frequent in middle age. Seventeen (50%) patients had bilateral stromal opacities. The disease was inherited as an autosomal dominant trait. A likely pathogenic variant c.61G>C in the *NLRP3* gene, encoding cryopyrin, was detected in all 34 tested patients and segregated with the disease. This variant is present in both Finnish and non-Finnish European populations at a frequency of about 0.02% and 0.01% respectively. In summary, keratoendotheliitis fugax hereditaria is an autoinflammatory cryopyrin-associated periodic syndrome caused by a missense mutation c.61G>C in exon 1 of *NLRP3* in Finnish patients. It is additionally expected to occur in other populations of European descent.

**Jalili Syndrome: Cross-sectional and Longitudinal Features of Seven Patients With Cone-Rod Dystrophy and Amelogenesis Imperfecta.**

The authors characterize a series of 7 patients with cone-rod dystrophy (CORD) and amelogenesis imperfecta (AI) owing to confirmed mutations in *CNNM4*, first described as “Jalili Syndrome.” Retrospective observational case series of patients from 6 families with Jalili Syndrome were identified at 3 tertiary referral centers. They systematically reviewed their available medical records, spectral-domain optical coherence tomography (SD-OCT), fundus autofluorescence imaging (FAF), color fundus photography, and electrophysiological assessments. The mean age at presentation was 6.7 years (range 3-16 years), with 6 male and 1 female patient. The mean Snellen best-corrected visual acuity (BCVA) at presentation was 20/246 (range 20/98 to 20/399) in the right eye and 20/252 (range 20/98 to 20/480) in the left. Nystagmus was observed in all 7 patients, and photophobia was present in 6. Funduscopic findings at presentation were variable,
ranging from only mild disc pallor to retinal vascular attenuation and macular atrophy. Multimodal imaging demonstrated disease progression in all 7 patients over time. Electroretinography uniformly revealed progressive cone-rod dysfunction. In conclusion, Jalili Syndrome is a rare CORD associated with AI. The authors have further characterized its ocular phenotype, including describing SD-OCT, FAF, and electrophysiological features; and report several novel disease-causing sequence variants. Moreover, this study presents novel longitudinal data demonstrating structural and functional progression over time, allowing better informed advice on prognosis.

**Expanded Retinal Disease Spectrum Associated With Autosomal Recessive Mutations in **\textit{GUCY2D}.

Autosomal recessive \textit{GUCY2D} gene mutations were the first reported cause of Leber congenital amaurosis (LCA), a severe form of congenital retinitis pigmentosa (RP) in which profound night blindness, poor visual acuity, high hyperopia, and nystagmus are present in infancy. \textit{GUCY2D} mutations have also been reported to cause AD cone-rod dystrophy, in which patients present with poor vision in bright light and an abnormal cone ERG with preserved rod responses, although rods may eventually be affected. This report expands the phenotype of autosomal recessive mutations to congenital night blindness (CNB), which may slowly progress to mild retinitis pigmentosa. It is a retrospective case series of 5 patients (3 male, 2 female). All patients presented with night blindness since childhood. Best-corrected visual acuity at presentation ranged from 20/15 to 20/30 and at most recent visit averaged 20/25. No patient had nystagmus or high refractive error. ISCEV standard electroretinography revealed nondetectable dark-adapted dim flash responses and reduced amplitude but not electronegative dark-adapted bright flash responses with similar waveforms to the reduced-amplitude light-adapted single flash responses. The 30Hz flicker responses were relatively preserved. Macular optical coherence tomography revealed normal lamination in 3 patients, with abnormalities in 2. Goldmann visual fields were normal at presentation in children but constricted in 1 adult. One child showed loss of midperipheral fields over time. Fundus appearance was normal in childhood; the adult had sparse bone spicule–like pigmentation. Full-field stimulus testing (FST) revealed markedly decreased retinal sensitivity to light. Dark adaptation demonstrated lack of rod-cone break. Two patients had tritanopia. All 5 had compound heterozygous mutations in \textit{GUCY2D}. Three of the 5 patients harbor the Arg768Trp mutation reported in \textit{GUCY2D} associated Leber congenital amaurosis. In summary, \textit{GUCY2D} should be considered when genetically testing young patients with profound night blindness, normal acuity, full visual fields, lack of nystagmus and high myopia, and abnormal FST and dark adaptation testing. Long-term prognosis for this type of congenital night blindness is not well described, but slow progression to mild RP may develop in some patients.
A Distinct Phenotype of Eyes Shut Homolog (EYS)-Retinitis Pigmentosa Is Associated With Variants Near the C-Terminus.

Retinitis pigmentosa (RP) is most commonly inherited in an autosomal recessive manner (arRP), of which biallelic mutations in the eyes shut homolog (EYS) gene (OMIM 612424) is a known cause. Previous studies of arRP found EYS mutations in 5%-33% of cases and among various ethnicities, suggesting a global presence. The highest prevalence exists in the Japanese population, in which EYS mutations are estimated to be the most common cause of inherited retinal degenerations. To date, studies discerning clinical characteristics and retinal phenotype of EYS-associated RP (EYS-RP) patients are few in number. This study used multimodal retinal imaging to elucidate genotype-phenotype correlations in EYS-related RP (EYS-RP). Multimodal retinal imaging and electrophysiologic testing were assessed for 16 patients with genetic confirmation of EYS-RP. A total of 27 unique EYS variants were identified in 16 patients. Seven patients presented with an unusual crescent-shaped hyperautofluorescent (hyperAF) ring on fundus autofluorescence (FAF) imaging encompassing a large nasal-superior area of the posterior pole. Three patients had a typical circular or oval perifoveal hyperAF ring and 6 patients had no hyperAF ring. Spectral-domain (SD) and en face optical coherence tomography (OCT) showed preserved ellipsoid zone and retinal thickness spatially corresponding to areas within the hyperAF rings. Eleven patients presented with a rod-cone dystrophy on full-field electroretinogram (ffERG), 1 patient presented with cone-rod dystrophy, and 4 patients did not undergo ffERG testing. A significant spatial association was found between EYS variant position and FAF phenotype, with variants occurring at a nucleotide position greater than GRCh37 6:65300137 (c.5617C) being more associated with patients exhibiting hyperAF rings at presentation. In summary, EYS-RP is a heterogeneous manifestation. Variants occurring in positions closer to the C-terminus of EYS are more common in patients presenting with hyperAF rings on FAF imaging.

The Fundus Phenotype Associated with the p.Ala243Val BEST1 Mutation.

The authors described a highly recognizable and reproducible retinal phenotype associated with a specific BEST1 mutation-p.Ala243Val. A retrospective review of consecutive cases where genetic testing identified patients with p.Ala243Val BEST1 as the cause of disease. These patients were compared with those with the most common BEST1 genotype, p.Arg218Cys. Eight individuals (six families) were identified with the p.Ala243Val BEST1 mutation and seven patients with the pathologic variant p.Arg218Cys. No patients with mutation of codon 243 knowingly had a family history of retinal disease, whereas all patients with the p.Arg218Cys variant did. The maculopathy was bilateral in all cases.
The p.Ala243Val mutation was associated with a pattern dystrophy-type appearance, most visible with near-infrared reflectance and fundus autofluorescence imaging. This phenotype was never observed with any other genotype. This mutation was associated with an older median age of symptom onset compared with those harboring the p.Arg218Cys mutation. Despite their older age, the final recorded acuity seemed to be better in the p.Ala243Val group, although this did not reach statistical significance. In conclusion, the mutation p.Ala243Val is associated with highly recognizable and reproducible pattern dystrophy-like phenotype. Patients develop symptoms at a later age and tend to have better preservation of electrooculogram amplitudes. These clinical characteristics may provide mechanistic insight, suggesting that the p.Ala243Val mutation acts primarily to impair ion transport and the associated movement of fluid, with minimal disruption to RPE phagocytosis, resulting in a later-onset maculopathy. Family surveys may be necessary to identify similarly affected individuals.

Prenatal Correction of X-Linked Hypohidrotic Ectodermal Dysplasia.


Genetic deficiency of ectodysplasin A (EDA) causes X-linked hypohidrotic ectodermal dysplasia (XLHED), in which the development of sweat glands is irreversibly impaired, a condition that can lead to life-threatening hyperthermia. Ophthalmological manifestations of this disorder include absent Meibomian glands, which can cause dry eye disease, corneal pannus and corneal opacification. This report describes treating and perhaps curing this disease in three infants by injecting a fusion protein (to correct for the missing EDA protein) into the amniotic fluid of fetuses between 26 to 31 weeks gestation. The infants, born in week 33 (twins) and week 39 (singleton), were able to sweat normally, and XLHED-related illness had not developed by 14 to 22 months of age. The authors report on the treated patients’ near-normal Meibomian gland numbers, whereas most patients with hypohidrotic ectodermal dysplasia have no more than three Meibomian glands per eyelid. This is an example of a novel treatment of a rare genetic disease and an example of bench to bedside translational medicine, as the authors first studied replacement of this protein in mouse fetuses with Eda mutations before performing a similar treatment in human fetuses.

In Utero Protein Therapy for an Inherited Developmental Disorder.

Mikkola ML. *NEJM* Apr 2018;378(17):1637-8.
In this editorial, Dr. Mikkola summarizes the clinical manifestations of hypohydrotic ectodermal dysplasia and explains the sequence of research studies that ultimately led to the novel and successful intra-amniotic treatment approach. Hypohydrotic ectodermal dysplasia is characterized by missing and malformed teeth, sparse and thin hair, and an inability to sweat caused by the sweat glands being absent or hypoplastic. Additional manifestations of X-linked hypohydrotic ectodermal dysplasia include dryness of the eyes, skin, mouth, airways, and mucous membranes as a result of the aberrant development of several exocrine glands, including the salivary and Meibomian glands. Some symptoms can be alleviated by avoiding hot temperatures and by using creams and moisturizers, but there are no cures.

Prior studies have included replacing the missing protein in pregnant EDA deficient mice intravenously. Permanent rescue could also be obtained in mice through perinatal administration of the protein. Ten infants who were treated with humanized protein postnatally (between 2 and 14 days) did not, however, show a convincing therapeutic effect. The author explains that the timing of protein administration - at the appropriate developmental stage when the glands are being formed - is key. This trial involving intraamniotic administration of the protein was successful because it delivered the missing protein at the appropriate gestational age. The specific timing of gene therapy and of protein replacement for genetic diseases is a common theme in medicine brought to light by this editorial and manuscript.

Genetic Testing for Wolfram Syndrome Mutations in a Sample of 71 Patients with Hereditary Optic Neuropathy and Negative Genetic Test Results for OPA1/OPA3/LHON

Alberto Galvez-Ruiza, Alicia Galindo-Ferreiroa, and Patrik Schatz

*Neuroophth.* April 2018, 42(2), 73–82

In this study, the authors present a sample of 71 patients with hereditary optic neuropathy and negative genetic test results for OPA1/OPA3/LHON. All of these patients later underwent genetic testing to rule out WFS. As a result, 53 patients (74.7%) were negative and 18 patients (25.3%) were positive for some type of mutation or variation in the WFS gene. The authors believe that this study is interesting because it shows that a sizeable percentage (25.3%) of patients with hereditary optic 25 neuropathy and negative genetic test results for OPA1/OPA3/LHON had WFS mutations or variants.

Mutation spectrum of NDP, FZD4 and TSPAN12 genes in Indian patients with retinopathy of prematurity

ROP shares some resemblance of clinical findings with familial exudative vitreoretinopathy (FEVR). There are genes involved in FEVR, mainly the Norrin β-catenin signaling genes NDP, FZD4, and TSPAN12, that could be involved in ROP pathogenesis. The authors conducted a case-control study of ROP infants in India and performed molecular genetic analysis of their DNA. 246 ROP infants and 300 control infants without ROP were included. There were 3 cases of ROP where gene screening revealed a 14 base-pair deletion in the NDP gene. Screening of FZD4 revealed four heterozygous variants and one compound heterozygous variant. Two of the variants were found to be significantly associated with ROP. One heterozygous variant was found in the TSPAN12 gene of one patient, but phenotype correlation could not be established. The authors concluded that variants of these three genes were involved in the pathogenesis of ROP in this cohort, although due to study designs additional cases may have been missed and other genes in the Norrin pathway may be involved.

17. TRAUMA

Trends in US Emergency Department Visits for Pediatric Acute Ocular Injury.


This was a retrospective cohort study from 2006 to 2014 to characterize pediatric acute ocular injury in the United States from children and teenagers up to age 17 years old who presented to the Emergency Departments (EDs) with acute traumatic ocular injuries. This data was obtained from the Nationwide Emergency Department Sample (NEDS) from a cross-section of U.S. hospitals. Of note, approximately 387,000 patients per year present to the U.S. EDs with ocular injuries and one-third of those injured are children. The authors highlight the importance of pediatric ocular trauma because ocular injuries are among the leading causes of deprivational amblyopia and long-term acquired visual disability. In the data analysis, the authors noted that male children were more often injured (63% with 95% CI) and especially males in the youngest age category of birth to 4 years old (35.3% with 95% CI). Of the ocular injuries noted from trauma, the majority of injuries had a low risk for vision loss (84.2% with 95% CI) with only 1.3% of the injuries being high risk for vision loss. Of data from 376,040 children and teenagers, the authors found a decline in overall ocular injury between 2006 and 2014 with a decline by 26.1% with 95% CI. This decline over the eight-year-period existed across all patient demographics and with the greatest decline in high-risk injuries noted in two areas: motor vehicle crashes (-79.8% with 95% CI) and guns (-68.5% with 95% CI). However, although the authors report a trend of ocular injury decline in children and teenagers over an eight-year-period, ocular injuries remain a source of preventable monocular blindness. Limitations of this
study include the data collections from NEDS, which is from EDs billing data, which may not accurately capture diagnosis codes. In particular, certain sports and home activity related ocular injuries E-codes were introduced in 2009 and there could be a bias regarding missing data from 2006 to 2009 regarding sports-related ocular injuries and household related ocular injuries. Further studies should include analysis about which prevention efforts have contributed to the decrease in pediatric ocular injuries. The authors suggest that identification of the further interventions to protect children from vision loss is important.

Comparison of the characteristics of retinal hemorrhages in abusive head trauma versus normal vaginal delivery.
Kim SO, Morgan LA, Baldwin AJ, Suh DW. JAPOS. April 2018;22(2):139-144.

Retinal hemorrhage (RH) is one of the hallmarks of abusive head trauma (AHT); however, RH is also encountered with normal vaginal deliveries (NVD) and thus presents the clinician with a diagnostic dilemma. The purpose of this study was to compare RHs in AHT with those of NVD. Records of with AHT and NVD infants with RH evaluated from 2013 to 2015 were reviewed retrospectively. Pattern, size, extent, and severity were compared using RetCam images. Severities were calculated using the RH grading scale. A total of 20 patients with AHT and 200 NVD infants were included. RH size was significantly larger in AHT patients compared to the NVD group (3.1 ± 0.512 vs 0.96 ± 0.046 disk diameters, resp.). The AHT group also demonstrated a higher RH incidence involving all three retinal layers compared to the NVD group (60% vs 0.6%, resp. [P < 0.001]). Vitreous hemorrhages were more common in the AHT group compared to the NVD group (54.3% vs 1.5% [P < 0.001]). Also, the grading scale demonstrated higher scores in the AHT group than the NVD group (7.15 ± 0.948 vs 3.59 ± 0.274, resp.).

Subdural hematoma was found in >95% of the AHT group as well. The authors conclude that AHT and NVD share similar retinal findings, but they also have unique differentiators. Clinicians can conclude from this study that AHT presented with more severe retinal findings than NVD, including larger RH size, a higher percentage involving all three retinal layers, a higher percentage of vitreous hemorrhages, and higher RH grading scale scores. Also, NVD retinal hemorrhages resolved quickly, within 4 weeks of birth in 95% of the patients.

Prospective analysis of pediatric ocular chemical burns: laundry detergent pods

The purpose of this paper is to present data on chemical ocular burns in children seen at a single tertiary care facility resulting from accidental eye exposure to the contents of laundry detergent pods. All emergent pediatric ophthalmology consultations specific for chemical ocular burns at a level I trauma center were included as part of a prospective quality improvement investigation over a 13-month period. Age, causative agent, and examination findings at presentation
and final follow-up were recorded and analyzed. A total of 12 children with chemical ocular burns were seen during the study period. All patients were ≤5 years of age. Most chemical ocular burn consultations (n = 8) were specific to ocular exposure of laundry detergent pod contents; the remainder were associated with conventional cleaning agents or pesticides (n = 4). There was a significant association between laundry detergent pod as causative agent and a patient age of 2-5 years, compared to <2 years and any other agent (P = 0.018 [Fisher exact test]). The average extent of corneal epithelial defect in the patients was 43.45% and all of the defects resolved at last follow up in this group, with no patients suffering visual deficits. In this study, laundry detergent pods were the most frequent cause of chemical ocular burns in children. Additionally, preschoolers may be at a higher risk of sustaining these injuries. Increased public awareness, product safety improvements, and/or regulation may be advisable to decrease the ocular hazards associated with laundry detergent pods.

**Airsoft gun-related ocular injuries: long-term follow-up.**

This paper seeks to describe the long-term ocular effects of airsoft gun pellet injuries. This study extends by 7-10 years the results of a 2010 study on the acute ocular findings related to airsoft gun pellet injuries in 59 patients, wherein the authors found a variety of anterior and posterior segment injuries, including hyphema (66%), corneal edema (61%), corneal erosions (59%), and traumatic mydriasis (25%), as well as retinal edema in (22%), retinal hemorrhages and mild vitreous hemorrhage in (2.1%), and, in 1 patient, elevated intraocular pressure and traumatic cataract. Of the 59 patients in the original study, up-to-date medical records were available for 26 (44%; 20 males). The mean follow-up time was 8 years (range, 7.2-10.3 years); the mean age, 17.1 years. Persistent abnormal findings included traumatic cataract in 3 cases (11.5%) and iris dialysis in 1 case (3.8%). In all traumatic cataract cases, cataract was not present at the time of initial examination after injury. Final mean best-corrected visual acuity was 0.92 (range 0.67-1.0), logMAR 0.03 (range 0.18-0). The authors conclude that while most acute airsoft gun-related ocular injuries are transient and do not require surgical intervention, some patients may develop significant and potentially sight-threatening ocular damage, even in the absence of significant pathologic findings at the time of the injury. They note that long-term follow-up on these patients is advisable and that use of safety goggles should be emphasized. Patients with airsoft gun-related injuries should be evaluated and followed closely due to the potential of sight-threatening damage and parents should be educated of the importance of goggles.

**Visual acuity recovery following traumatic hyphema in a pediatric population.**
Boese EA, Karr DJ, Chiang MF, Kopplin LJ. JAAPOS. April 2018;22(2):115-118.
The purpose of this paper is to determine the rate of visual recovery following hyphema caused by traumatic blunt force injury in children. The medical records of patients evaluated between July 2008 and July 2014 were reviewed retrospectively. Primary outcome measures included presenting and follow-up visual acuities. The most common injuries were sports related injuries with small projectiles being the second most common reason for injury. At total of 56 eyes of 55 children (<18 years of age) were diagnosed with hyphema following blunt force non-penetrating injury. The average patient age was 10.3 ± 3.2 years. The majority of subjects were male (78%). Presenting visual acuities ranged from logMAR 0.0 (Snellen equivalent, 20/20) to light perception. Rebleeding occurred in 4 subjects (7.1%). Visual acuity demonstrated improvement over the first 28 days following injury, with 59% achieving visual acuity of logMAR 0.0 (Snellen equivalent, 20/20) and 82% recovering vision to logMAR 0.2 (Snellen equivalent 20/30) by day 28. All but 1 patient (43 of 44 eyes, 98%) had a best-corrected visual acuity of better than or equal to logMAR 0.2 at their last recorded follow-up. The authors conclude that there is good potential for visual recovery following uncomplicated traumatic hyphema in children although the rate of recovery varies between individuals. In this patient cohort, the majority of patients had significant improvement in visual acuity within the first 28 days with them most visual recovery occurring in the first 14 days; in some children visual acuity continued to improve beyond the first month.

Pediatric traumatic brain injury and ocular injury

Traumatic brain injury (TBI) is a leading cause of pediatric disability and mortality. Together with sight-threatening ocular injuries, TBI s may lead to devastating consequences in developing children and complicate rehabilitation. The authors sought to investigate the relationship between ocular injuries and TBI in pediatric patients admitted with major trauma. The records of pediatric patients admitted with ocular injury and concomitant TBI were reviewed retrospectively using the National Trauma Data Bank (2008-2014). Of 58,765 pediatric patients admitted for trauma and also had ocular injuries, 32,173 were diagnosed with TBI. Mean patient age was 12.3 ± 7 years. Most were male (69.8%) and white (61.2%). The most frequent injuries were contusion of the eye/adnexa (39.1%) and orbital fractures (35.8%); globe ruptures occurred less frequently (5.1%). The youngest age groups had greatest odds of falls in home locations, whereas older groups were more likely to suffer motor vehicle trauma as occupants (MVTO), struck by or against injuries, and firearms injuries in street locations (P < 0.001). Blacks and Hispanics were most likely to suffer assault (P < 0.001) and Whites were more likely to suffer unintentional (P < 0.001) and self-inflicted (P < 0.012) injury. Blacks were at a higher risk of firearms injury, Whites of MVTO, and Hispanics of motor vehicles as pedestrians (P < 0.001). In this study, the abducens nerve was the most commonly injured nerve, followed by oculomotor and trochlear nerves; this differs from other studies in which the trochlear nerve is the most
commonly injured. TBI frequently is experienced by trauma patients with concomitant ocular injury and should be considered in children admitted with major trauma. Resultant demographic patterns may help identify patients that have a higher risk of TBI leading to earlier diagnosis and treatment.

Airsoft gun-related ocular injuries: long-term follow-up.

The purpose of this retrospective study was to describe the long-term ocular effects of airsoft gun pellet injuries. It is an extension of a previous 2010 study on the acute ocular findings related to airsoft gun pellet injuries in 59 patients, wherein a variety of anterior and posterior segment injuries were described, including hyphema (66%), corneal edema (61%), corneal erosions (59%), and traumatic mydriasis (25%), as well as retinal edema in (22%), retinal hemorrhages and mild vitreous hemorrhage in (2.1%), and, in 1 patient, elevated intraocular pressure and traumatic cataract. Of the 59 patients in the original study, up-to-date medical records were available for 26 (44%; 20 males). The mean follow-up time was 8 years (range, 7.2-10.3 years); the mean age, 17.1 years. Persistent abnormal findings included traumatic cataract in 3 cases (11.5%) and iris dialysis in 1 case (3.8%). In all traumatic cataract cases, cataract was not present at the time of initial examination after injury. Final mean best-corrected visual acuity was 0.92 (range 0.67-1.0), logMAR 0.03 (range 0.18-0). The authors concluded that while most acute airsoft gun-related ocular injuries are transient, some patients may develop significant and potentially sight-threatening ocular damage, even in the absence of significant pathologic findings at the time of the injury. Despite some inherent limitations with its design and loss of follow-up of many patients from the original study, it raises an important issue, emphasizing the need for long term follow-up of these patients.

Visual acuity recovery following traumatic hyphema in a pediatric population.

The purpose of this retrospective study was to determine the rate of visual recovery following hyphema caused by traumatic blunt force injury in children. The medical records of patients evaluated between July 2008 and July 2014 were reviewed. Primary outcome measures included the difference in visual acuity between presentation and follow-up. At total of 56 eyes of 55 children (<18 years of age, mean age 10.3 ± 3.2 years) were included. The majority of subjects were male (78%). Presenting visual acuities ranged from logMAR 0.0 (Snellen equivalent, 20/20) to light perception. Re-bleeding occurred in 4 subjects (7.1%). Visual acuity demonstrated im-
Improvement over the first 28 days following injury, with 59% achieving visual acuity of logMAR 0.0 (Snellen equivalent, 20/20) and 82% recovering vision to logMAR 0.2 (Snellen equivalent 20/30) by day 28. Only 44 eyes had completed a follow-up visit of a week or more post injury. All but 1 patient (43 of 44 eyes, 98%) had a best-corrected visual acuity of better than or equal to logMAR 0.2 at their last recorded follow-up. The authors concluded that there is good potential for visual recovery following uncomplicated traumatic hyphema in children. In their patient cohort, the majority of patients had significant improvement in visual acuity within the first 28 days. The study is limited by its small sample size and short follow-up. The study aim was to explore the visual recovery course in children suffering hyphema after blunt trauma injury. However, information about the extent of follow-up is missing.

Comparative study of visual outcome between open- and closed-globe injuries following surgical treatment of traumatic cataract in children.

This is a large, retrospective observational study of 1076 eyes comparing visual outcomes in children who experienced traumatic cataract from blunt closed globe injury versus in the setting of an open globe injury. As would be anticipated, those children with closed globe injury had better visual outcomes at final follow up. Over 55.7% of children in the group as a whole achieved >20/60. The authors emphasized the need for early identification, referral, and treatment in order to prevent dense deprivation amblyopia in younger children with traumatic cataract.

NON-ACCIDENTAL HEAD TRAUMA

Predictors of long-term neurological outcomes in non-accidental head injury.

This study aimed to investigate the predictive values of acute findings, especially ocular, for long-term neurological outcomes. A total of 38 patients (24 males, 14 females) were included. Twelve children died acutely from the head injury. A younger age of injury (P=0.004) was the only statistically significant predictor of good neurological outcome as compared with absence of macular retinoschisis, unilateral retinal hemorrhage, and unilateral subdural hemorrhage. Retinoschisis was seen in 17/38 children. Nine children with macular retinoschisis died acutely,
4 suffered a degree of developmental delay. Only 4 children with retinoschisis were developmentally normal. Long-term visual acuity data was available for 18/26. Visual acuity ranged from NPL to Snellen 6/5. Retinoschisis was significantly associated with worsened visual acuity (P<0.05).

Conclusions. Bilateral macular retinoschisis on acute presentation of NAI is associated with a seven-fold and unilateral with a four-fold increase in the development of a poor neurological outcome and eventual death.

**Comparison of the characteristics of retinal hemorrhages in abusive head trauma versus normal vaginal delivery.**


Retinal hemorrhages (RH) are one of the hallmarks of abusive head trauma (AHT); however, RH is also encountered with normal vaginal deliveries (NVD) and thus presents the clinician with a diagnostic dilemma. The purpose of this retrospective study was to compare RHs in AHT with those of NVD. Records of with AHT and NVD infants with RH evaluated from 2013 to 2015 were reviewed. Pattern, size, extent, and severity were compared using RetCam images. Severities were calculated using the RH grading scale. A total of 20 patients with AHT and 200 NVD infants were included. RH size was significantly larger in AHT patients compared to the NVD group (3.1 ± 0.512 vs 0.96 ± 0.046 disk diameters, resp.). The AHT group also demonstrated a higher RH incidence involving all three retinal layers compared to the NVD group (60% vs 0.6%, resp. [P < 0.001]). Vitreous hemorrhages were more common in the AHT group compared to the NVD group (54.3% vs 1.5% [P < 0.001]). Also, the grading scale demonstrated higher scores in the AHT group than the NVD group (7.15 ± 0.948 vs 3.59 ± 0.274, resp.). NVD retinal hemorrhages resolved quickly, within 4 weeks of birth in 95% of the patients. AHT and NVD share similar retinal findings, but they also have unique differentiators. The authors conclude that in their cohort, AHT presented with more severe retinal findings than NVD, including larger RH size, a higher percentage involving all three retinal layers, a higher percentage of vitreous hemorrhages, and higher RH grading scale scores. This study offers some indications to the differences in retinal hemorrhages pattern between normal vaginal deliveries and abusive head trauma. Given the functional and psychosocial impact of strabismus in the elderly, this study lends support to consideration of surgery as a viable option to successfully treating strabismus among the oldest age cohorts.

**MISCELLANEOUS**

18. **RETINA**
Laser Pointer-Induced Maculopathy: more than Meets the Eye


The purpose of this study is to describe the clinical findings in patients with laser-induced retinal injury. Eight eyes of seven young patients (median age 16 years; range 12 to 36 years) had sustained inadvertent ocular exposure to a 5mW green laser. Evaluation included a full ophthalmic exam and spectral-domain optical coherence tomography (SD-OCT). At presentation, all patients complained of a central/paracentral scotoma. Snellen best corrected visual acuity (BCVA) at presentation ranged from counting fingers to 6/6. In 5 eyes, a round, well-defined deep yellowish-orange discoloration at the level of the retinal pigment epithelium in the foveola, ranging from 150 to 350 μm in diameter, was noted on ophthalmoscopic examination. Additional findings were macular subhyaloid hemorrhage in 2 eyes and a full-thickness macular hole with cystoid macular edema in 1 eye. In all cases, baseline SD-OCT revealed disruption involving the photoreceptor inner segment/outer segment junction/ellipsoid zone band, and extended toward the inner aspect of the retinal pigment epithelium band, ranging from focal interruption to extensive full-thickness macular hole. All patients received oral corticosteroid treatment with prednisone (0.5 to 1 mg/kg). Follow-up ranged between 2 and 12 months. Over time, improvement in visual acuity to 6/8 and 6/6 was noted in all eyes but one, which remained poor at counting fingers from 2 meters. The visual improvement was associated with complete or near-complete restoration of the integrity of macular structure noted on SDOCT. The authors concluded that commercial handheld laser pointers may inflict notable macular injury and damage vision permanently. Although good visual recovery was often noted, access to commercially available laser devices is potentially hazardous, especially to minors, and public awareness should be raised.

Phenotypic Characteristics of a French Cohort of Patients with X-Linked Retinoschisis


X-linked retinoschisis (XLRS) is associated with a mutation in RS1 located in Xp22. Previous clinical studies assessed correlations between best-corrected visual acuity and OCT characteristics, such as full foveal thickness, photoreceptor thickness, or choroidal features with various results. The purpose of this study was to analyze and report clinical characteristics of XLRS in a large cohort of French patients with molecularly confirmed RS1 mutations using spectral-domain OCT and to correlate the morphologic findings with visual acuity, electroretinographic results, and patient age. Data from 52 consecutive male patients with molecularly confirmed XLRS were collected retrospectively. These patients
underwent complete clinical evaluation including best-corrected visual acuity, full-field electroretinography, fundus photography, spectral-domain OCT, and fundus autofluorescence. Spectral-domain OCT images were analyzed to determine full thickness of the retina and tomographic structural changes. One hundred four eyes of 52 patients were included. The mean age at inclusion was 24±15 years (range, 3–57 years). The best-corrected visual acuity ranged from no light perception to 0.1 logarithm of the minimum angle of resolution (mean, 0.6±0.38 logarithm of the minimum angle of resolution). Macular schisis was found in 88% of eyes and macular atrophy was found in 11% of eyes, whereas peripheral schisis was present in 30% of eyes. A spoke-wheel pattern of high and low intensity was the most frequently observed fundus autofluorescence abnormality (51/94 eyes [54%]). The b-to-a amplitude ratio on bright-flash dark-adapted electroretinography was reduced significantly in 45 of 64 eyes (70%). Spectral-domain OCT was available for 97 eyes and showed foveoschisis in 76 of 97 eyes (78%), parafoveal schisis in 10 of 97 eyes (10%), and foveal atrophy in 11 of 97 eyes (11%). Mean central macular thickness (CMT) was of 373.6±140 μm. Cystoid changes were localized mainly in the inner nuclear layer (85/97 eyes [88%]). Qualitative defects in photoreceptor structures were found in most eyes (79/97 eyes [81%]), and the most frequent abnormality was an interruption of the photoreceptor cell outer segment tips (79/79 eyes [100%]). Older age correlated well with lower CMT (correlation coefficient [CC], −0.44; P < 0.001) and with lower photoreceptor outer segment (PROS) length (CC, −0.42; P < 0.001). Lower visual acuity correlated strongly with lower PROS length (CC, −0.53; P < 0.001). This study underlined the wide variety of clinical features of XLRS. It highlighted the correlation between visual acuity, patient age, and OCT features, particularly the IZ and the PROS length, emphasizing the relevance of the OCT as potential outcome measure in clinical trials.


Familial exudative vitreoretinopathy (FEVR) is a rare hereditary disorder principally affecting retinal angiogenesis. Incomplete peripheral retinal vascularization results in ischemia and subsequent complications such as retinal neovascularization, exudation, vascular dragging, retinal fold, and retinal detachment. Although it may progress at any age with sight-threatening manifestations, visually significant FEVR most often presents in childhood, but many patients with Stage 1 to 3 remain undiagnosed. Subtle abnormalities, which are often hardly noticeable in the posterior pole, include an increased distance from the fovea to the disk, more radiating and straightened retinal vessels extending from the optic nerve head (ONH), and smaller than normal ONH size. This paper sought to explore vitreoretinal pathologies and their longitudinal changes visible on handheld optical coherence tomography (OCT) of young children with FEVR. The authors hypothesize that OCT could help detect abnormal findings at the posterior pole in earlier
stages of FEVR in infants and young children. The authors retrospectively analyzed handheld OCT images for vitreoretinal interface and retinal abnormalities and optic nerve head (ONH) elevation. From 26 eyes of 16 children (mean age 32 months) with FEVR, 10 had ONH dragging on photographs, and in these, handheld OCT revealed temporal and anterior retinal displacement, prominent vitreopapillary adhesion or traction, and retinal nerve fiber layer thickening at ONH margins with adjacent retinal elevation. Despite a nearly normal photographic appearance, handheld OCT revealed ONH elevation with vitreopapillary traction (6/16 eyes), ONH edema (1/16 eye), and retinal vascular protrusion (5/16 eyes). Handheld OCT-visualized vitreous abnormalities (18/26 eyes) were more prevalent at higher stages of disease. Handheld OCT-visualized elevation of ONH and the retina worsened over time in nine eyes and improved in 5/6 eyes after vitrectomy. Handheld OCT can detect early ONH, retinal, and vitreous changes in eyes with FEVR. Contraction of strongly adherent vitreous in young patients with FEVR appears to cause characteristic ONH dragging and tractional complications without partial posterior vitreous. Vitreopapillary dragging may be visible only on OCT and may progress in the absence of obvious retinal change on conventional examination.

Optical Coherence Tomography Angiography in Patients with Retinitis Pigmentosa.


Retinitis pigmentosa (RP) is a hereditary disease characterized by progressive retinal degeneration and loss of photoreceptors and retinal pigment epithelium with corresponding loss of function. The prevalence of RP is estimated at one case in 3,000 to 5,000 individuals. Patients with RP complain typically of night blindness and symmetric, bilateral, and progressive concentric constriction of the visual field (VF). Severity of RP can be evaluated using different examination and imaging modalities, including visual acuity (VA), VF testing, electroretinography (ERG), OCT, and fundus autofluorescence. Optical coherence tomography angiography (OCTA) is a new, noninvasive imaging technique that enables visualization and quantification of blood flow in normal and pathologic vascularization in different retinal layers and in the ONH. The authors evaluate the correlation between the flow density measured by optical coherence tomography angiography and functional parameters in patients with retinitis pigmentosa. Twenty eyes of 20 patients with retinitis pigmentosa and 21 eyes of 21 healthy subjects were prospectively included in this study. Optical coherence tomography angiography was performed using RTVue XR Avanti with AngioVue (Optovue Inc). The macula was imaged with a 6 × 6-mm scan, whereas for the optic nerve head a 4.5 × 4.5-mm scan was taken. Visual acuity, visual field parameters (mean deviation and visual field index), full-field electroretinography, and multifocal electroretinography were tested for correlation with flow density data. The flow density (whole en face) in the superficial/deep retinal OCT angiograms and in the optical coherence tomography angiography of the optic nerve head was
significantly lower in the retinitis pigmentosa group when compared with the control group (P < 0.001). The flow density in the superficial retinal OCT angiogram (fovea) correlated significantly with the visual acuity (rSpearman = -0.77, P < 0.001) and the visual field parameters (visual field index: rSpearman = 0.56, P = 0.01; mean deviation: rSpearman = 0.54, P = 0.01). Patients with retinitis pigmentosa show a decreased macular and optic nerve head perfusion compared with healthy subjects. The flow density measured using optical coherence tomography angiography correlated with subjective and objective functional parameters. Optical coherence tomography angiography is a novel technology that can help in the diagnosis and follow-up of patients with RP.

**Choroidal Structural Changes and Vascularity Index in Stargardt Disease on Swept Source Optical Coherence Tomography.**

It has become easier to study the choroidal structure with the advent of newer optical coherence tomography (OCT) techniques such as the enhanced depth imaging and the swept source OCT. Swept source OCT uses longer wavelength and faster scanning speed which allows for deep range imaging. Various studies have compared the subfoveal choroidal thickness (SFCT) in patients with Stargardt disease compared with matched normal controls. However, the studies could not reach a consensus. The authors sought to evaluate structural changes in the choroid of patients with Stargardt disease using swept source OCT scans. A retrospective comparison cohort study was conducted on 39 patients with Stargardt disease, and on 25 age and gender matched-healthy controls. SFCT was computed from the swept source OCT machine, and the scans were binarized into luminal area and stromal areas, which were then used to derive choroidal vascularity index (CVI). Choroidal vascularity index and SFCT were analyzed independently using linear mixed effects model. There was no significant difference in SFCT between the 2 groups (347.20 ± 13.61 μm in Stargardt disease vs. 333.09 ± 18.96 μm in the control group, P = 0.548). There was a significant decrease in the CVI among eyes with Stargardt disease as compared with the normal eyes (62.51 ± 0.25% vs. 65.45 ± 0.29%, P < 0.001). There was a negative association between visual acuity and CVI (correlation coefficient = -0.75, P < 0.001) and a positive association between visual acuity and SFCT (correlation coefficient = 0.21, P = 0.035). In summary, choroidal vascularity index is a novel and noninvasive imaging tool, which is a sensitive surrogate marker to monitor the choroidal angiopathy in patients with Stargardt disease. Choroidal vascularity index appears to be a more robust tool compared with SFCT for choroidal changes in Stargardt disease. A decrease in CVI was associated with a decrease in visual function in eyes with Stargardt disease. Further studies can be conducted to verify the findings in patients with genetically proven Stargardt disease.
Visual Acuity in Patients with Stargardt Disease after Age 40.
Collison Ft, Fishman GA. Retina 2018 Dec;38(12):2387-2394.

Stargardt disease is an inherited retinal disease with a prevalence of approximately 1 in 8,000 to 1 in 10,000, making it the most common juvenile onset form of macular dystrophy. Onset of symptoms in Stargardt disease occurs most often between the ages of 8 and 16 years, but onset can also occur in adulthood and even late into adulthood. In the conventional characterization of Stargardt disease, visual acuity loss often stabilizes around Snellen acuity of 20/200 to 20/400, but this observation has been expanded in studies that have demonstrated that some proportion of patients progress to worse than 20/400 vision. Some subsets of patients with Stargardt disease have been found to maintain good acuity later in life as well. The authors sought to better define visual acuity loss in patients with Stargardt disease later in life. The most recent best-corrected visual acuities in the better-seeing eye of 221 patients with Stargardt disease over 40 years of age were recorded. Also included were the age at subjective onset for symptoms and duration of symptoms. Juvenile onset was defined as onset before age 21; adult onset was defined as onset between 21 and 40 years; and late onset was defined as onset at age 41 or later. The median age of the patients with Stargardt disease was 53.1 years. Twenty-four patients (10.9%) had worse than 20/400 best-corrected visual acuity, and none had either light perception or no light perception vision. Whereas 17 of the 52 juvenile onset patients had best-corrected visual acuity worse than 20/400, only 4 of 80 adult-onset patients and 1 of 70 late-onset patients reached this level of acuity loss. Although many patients with Stargardt disease lose visual acuity to the 20/200 to 20/400 range, and some lose visual acuity beyond 20/400, none of these patients reached either light perception or no light perception. The numbers found in this study will be valuable in counseling patients with Stargardt disease and could have value in planning treatment trials.

Deep Scleral Exposure: A Degenerative Outcome of End-Stage Stargardt Disease.

Autosomal recessive Stargardt disease (STGD1; MIM #248200) is the most common inherited retinal dystrophy, responsible for mostly adolescent-onset progressive central vision loss. The causal gene, the photoreceptor-specific ATP-binding cassette transporter, ABCA4, was identified in 1997; since then >1000 disease-associated variants have been reported. The authors describe a distinct phenotypic outcome of outer retinal degeneration in a cohort of genetically confirmed patients with STGD1 and advanced degeneration. It was a retrospective case series of twelve patients, who were clinically diagnosed with STGD1 and exhibit-
ed a unique degenerative phenotype. Two disease-causing mutations were found in all patients by direct sequencing of the *ABCA4* gene. Clinical characterization of patients were defined on fundus photographs, autofluorescence images (488-nm and 532-nm excitation), spectral-domain optical coherence tomography (SD-OCT), and full-field electroretinogram (ffERG) testing. Mean age at initial presentation was 67.8 years and reported age of symptomatic onset was 14.1 years (mean disease duration = 53.8 years). Best-corrected visual acuity ranged from 20/400 to hand motion. All patients exhibited advanced degeneration across the posterior pole resulting in a reflectively pale, blonde fundus owing to unobstructed exposure of the underlying sclera. SD-OCT revealed complete loss of the outer retinal bands (external limiting membrane, ellipsoid zone, interdigitation zone, and retinal pigment epithelium) and choroidal layers. Scotopic and photopic waveforms on ffERG were nonrecordable or severely attenuated in 8 patients who were tested. In summary, an end-stage sub-phenotype of genetically confirmed STGD1 characterized by complete loss of the outer retina and choroid, resulting in widespread scleral exposure, is associated with long disease duration (> 50 years) in older patients. This clinical stage exhibits significant phenotypic overlap with aggressive chorioretinal dystrophies such as choroideremia, but can be distinguished, in addition to genetic screening, by an ocular history of central vision loss and a cone-rod pattern of functional attenuation on ffERG.

Quantitative Comparison of Near-infrared Versus Short-wave Autofluorescence Imaging in Monitoring Progression of Retinitis Pigmentosa.

Two noninvasive imaging techniques are traditionally used to monitor disease progression in patients with retinitis pigmentosa (RP): spectral-domain optical coherence tomography (SD-OCT) and short-wave autofluorescence (SW-AF). SW-AF is another classical technique that derives its signals (488 nm excitation) from retinal pigment epithelium (RPE) lipofuscin, originally formed in photoreceptors as a product of reactions involving all-trans-retinal. Patients with RP often exhibit a ring of hyperautofluorescence that encircles an area of the fundus with relatively normal autofluorescence. Studies have shown that the inner border of this hyperautofluorescent ring corresponds spatially to the lateral ends of the ellipsoid zone (EZ) line on SD-OCT. Though less widespread, the use of near-infrared autofluorescence (NIR-AF) has been expanding over the last several years, as multiple studies have applied this modality to RP and other diseases such as recessive Stargardt disease (STGD1) and Best vitelliform macular dystrophy. The authors sought to quantitatively compare NIR-AF and SW-AF as imaging modalities used to monitor RP disease progression, measured as a function of hyperautofluorescent ring constriction over time. NIR-AF and SW-AF images were acquired from 22 participants (44 eyes) at 2 clinic visits separated by an average of 2 years. On the images from each modality, the horizontal and vertical diameters and area of the hyperautofluorescent rings were measured twice, 2 weeks apart.
A progression rate for each parameter was obtained. Descriptive and comparative statistics were calculated to analyze these parameters and their respective progression rates. At both visits, the hyperautofluorescent ring exhibited a larger horizontal diameter (both visits: $P < .001$), vertical diameter (visit 1: $P < .001$, visit 2: $P = .040$), and ring area (visit 1: $P = .001$, visit 2: $P = .011$) in SW-AF vs NIR-AF images. In SW-AF, the horizontal diameter, vertical diameter, and ring area decreased yearly by $168 \pm 204 \mu m$, $131 \pm 159 \mu m$, and $0.7 \pm 1.1 \text{mm}^2$, respectively, while in NIR-AF, they decreased by $151 \pm 156 \mu m$, $135 \pm 190 \mu m$, and $0.7 \pm 1.0 \text{mm}^2$. No difference was observed in these rates between SW-AF and NIR-AF. Similar results were observed in the left eye. In SW-AF and NIR-AF images, similar rates of RP disease progression are observed. Although there is no current treatment available for RP, the recent emergence of multiple clinical trials for potential treatment methods, including but not limited to gene therapy, has augmented the need for detailed characterization of RP disease progression. Traditionally, EZ line width measurements and SW-AF have commonly been used as noninvasive tools for tracking disease progression in patients with RP. However, NIR-AF, though less commonly used, may confer greater advantages over SW-AF. In contrast to NIR-AF, patient comfort and cooperation are diminished when patients are imaged with SW-AF; while patients observe a dim, reddish light when undergoing NIR-AF scans, they experience a more intense light with SW-AF scans. Owing to diminished patient comfort, the acquisition times for SW-AF scans are longer as compared to NIR-AF. These issues are of particular importance for pediatric and photophobic patients - two populations for which obtaining SW-AF scans is challenging. Furthermore, concerns have been raised about the long-term consequences of exposure to SW-AF during clinical imaging. Thus, given that there appears to be no significant difference between NIR-AF and SW-AF as tools for measuring RP disease progression, NIR-AF may serve as a more efficient substitute for SW-AF in the clinic and in routine practice.

**Rates of Bone Spicule Pigment Appearance in Patients With Retinitis Pigmentosa Sine Pigmento.**

Retinitis pigmentosa (RP) is an inherited retinal disorder that causes progressive photoreceptor death and subsequent irreversible vision loss. There are more than 1 million affected individuals worldwide with a prevalence of 1 in 4000. The characteristic funduscopic features of RP are a pale, waxy optic nerve head; attenuated retinal blood vessels; and intraretinal pigment (bone spicule) migration in regions of photoreceptor degeneration. This bone spicule pigment corresponds to melanin-containing cells clustered around branching blood vessels in the inner retina. The origin of these cells remains controversial, but they have been interpreted as pigment-laden macrophages, Muller cells that have phagocytosed melanin granules, or translocated cells from the retinal pigment epithelium (RPE).
Previous studies have suggested that after photoreceptor death in RP, reactive RPE cells migrate to the inner retina and form remarkably polarized epithelial layers around retinal blood vessels and against the inner limiting membrane. The authors sought to determine rate of bone spicule pigmentation appearance in patients with retinitis pigmentosa (RP). A total of 240 patients were analyzed for this retrospective, observational case series. An analysis was conducted at the Electrodiagnostic Clinic at Columbia University Medical Center of all patients' medical records with a diagnosis of RP between July 2017 and January 2018. The medical records of these patients were analyzed to determine whether the patients presented with pigment migration on their first and last visit to our clinic. Among those who did not have bone spicule at first visit, we examined the time to appearance of newly formed bone spicule. The survival distribution was then estimated using the Kaplan-Meier estimator, where the event is bone spicule and time starts at first visit. From the 240 patients analyzed, 213 patients presented with intraretinal pigmentation on the first visit to our clinic, and 27 patients presented without intraretinal pigmentation. Of these 27 patients, 10 patients developed pigmentation by their follow-up, with a median time to appearance of bone spicule of 5.4 years from first visit, according to the Kaplan-Meier estimates. The timeline of bone spicule pigment appearance in RP has important implications in the natural history characterization of disease progression and application as a biomarker for interventional trials.

**Choroidal neovascular membrane in paediatric patients: clinical characteristics and outcomes**

The incidence of choroidal neovascular membrane (CNVM) is relatively small compared to adults, but when present can have a profound impact on children. The authors of this study performed a retrospective review of patients 18 years old or less with CNVM. They analyzed demographics, vision, pathology, and other parameters. 35 subjects (43 eyes) were identified with mean age of 11.2 years. The CNVMs were mostly type 2, classical, and subfoveal. The most common association was with Best vitelliform macular dystrophy (32.5%). The CNVM was active in 36 of 43 eyes. 30 of these underwent treatment, of which anti-VEGF injection was the initial therapy choice in all. Responsive eyes required a mean of 2.11 injection. 50% of recurrent CNVM stabilized with repeat injection, with the remaining requiring photodynamic therapy, laser or surgery. Mean visual acuity gain for peripapillary and subfoveal groups was 0.7752 and 0.4361 logMAR. However, mean gain in visual acuity on comparison for all CNVM subgroups was not statistically significant. The authors note that overall recurrent rate and number of recurrences were lower in children compared to adult patients, with a lower average number of injections needed for resolution.
Intraretinal Hyperreflective Foci in Best Vitelliform Macular Dystrophy


This prospective cross-sectional study reports on the presence of hyperreflective foci (HF) on spectral domain OCT in patients with Best vitelliform macular dystrophy (BVMD), and describes the relationship between HF and stages of the disease. Consecutive patients with BVMD were enrolled and, along with control subjects, underwent a complete ophthalmologic examination including best corrected visual acuity and SD-OCT. The main outcome measure was identification of HF in BVMD; the secondary outcome was assessment of the HF in each stage and correlation with best corrected visual acuity. 75 eyes of 39 patients were included in the study, Stage 1: 13%, Stage 2: 43%, Stage 3: 15%, Stage 4: 1%, Stage 5: 8%. On SD-OCT, intraretinal HF were present in 83% of all eyes, in 91% of eyes affected by clinical BVMD (Stages 2-5), and in 100% of patients in Stages 4 and 5. In 46% of clinically diseased eyes, HF were localized in the fovea and in correspondence with the BVMD lesions at the level of the outer nuclear layer and outer plexiform layer. HF were present in 16% of control eyes. The mean number of HF in eyes affected by clinical BVMD was 7.67. These were predominately small HF localized in the outer nuclear layer and presented mostly in the extrafoveal area. Analysis of HF distribution revealed that the control group and Stage 1 eyes had the fewest HF; Stage 4 displayed a significant increase in the number of HF compared to Stages 2 and 3; Stage 5 also showed an increased number of HF, a significant difference compared to Stage 3 eyes. The best-corrected visual acuity deteriorated as the number of HF increased in Stages 2 to 5.

The number of patients in this study is relatively small, though all stages of the disease were represented. Data regarding the modification of HF over a longitudinal follow-up period are not presented and could be useful. In addition, the authors acknowledge that the identification of HF can be challenging and it is possible that not all of the HF were picked up in the 19 horizontal linear B-scans that were performed. Finally, the statistical analysis included both eyes of the same patients, 20% of whom revealed a different stage in their own eyes. Nevertheless, these data suggest that HF identification is correlated with the progression of BVMD and could represent a useful biomarker or be a target in BVMD therapy. Further studies with long-term follow-up and histological examinations are necessary to evaluate the origin and nature of these HF.

Traumatic macular retinoschisis in infants and children

The purpose of this paper is to provide detailed description of pediatric traumatic retinoschisis. The medical records of children with either abusive head trauma and traumatic macular retinoschisis seen at a single center from 1993 to 2006 were reviewed retrospectively. Clinical details were extracted from the record and photographic documentation. Evaluation regarding abuse excluded ophthalmology findings to avoid circular reasoning. Of 134 patients with suspected abusive head trauma, 31 (23.1%) had retinoschisis; no other patients were identified who had retinoschisis during this time period. Mean age of these patients was 9 months. Of the 31 patients, 22 (71%) offered a history of injury, and 9 (29%) were found unresponsive without history of injury; 6 were reportedly shaken. All patients had seizures, vomiting, and/or altered responsiveness. All had subdural hemorrhage, with cerebral edema in 17 (55%). In 10 (32%), there were findings of blunt force head injuries; in 4 of these there was no impact history. Retinal hemorrhages were present in all cases. Agreement between sidedness of retinoschisis and subdural hemorrhage was poor. Two thirds of the patients had associated physical injury. One third of the patients had associated vitreous hemorrhage. Eleven patients had retinal folds, 3 of which had a hemorrhagic edge to the schisis; nine of these patients suffered from future neurological conditions or cortical visual impairment, reinforcing the fact that retinal folds are associated with worse visual and neurological outcomes. Nine patients had extracranial manifestations of abuse. Multidisciplinary team adjudications were as follows: of the 31 cases, 18 were suspicious for abuse, 11 were indeterminate, and 2 were possibly accounted for by accidental severe crush injury. Three children died, and 11 suffered neurological sequelae. The authors conclude that traumatic retinoschisis in children is highly associated with subdural hemorrhage, neurologic symptoms, and poor outcomes. Even with a conservative approach to opinion formulation, traumatic retinoschisis was associated with likely abuse.

**Unilateral retinitis pigmentosa in children**


Retinitis pigmentosa (RP) is a group of rare inherited retinal disorders characterized by diffuse progressive degeneration of the retina that typically presents bilaterally. Unilateral RP has not often been reported in children. The authors present a series of cases that illustrate discrimination between unilateral and asymmetric disease and between dystrophy and acquired degeneration. Four patients (9-15 years of age; 3 females) were referred to the authors’ institution for possible unilateral RP based on fundus appearance and unilateral symptoms. All underwent full-field electroretinography (ERG), spectral domain optical coherence tomography (SD-OCT), widefield and color fundus photography, and fundus autofluorescence (FAF) imaging. Genetic testing and a vitamin and essential fatty acids panel were also conducted in 1 patient. Unilateral retinal degeneration was confirmed in 2 patients, whose fellow eyes showed no abnormalities on ERG or imaging. The other 2 patients were found to have highly asymmetric retinal degeneration based on ERG, wide-angle images, and repeated examinations.
(range, 0.3-9.8 years). Genetic testing and blood testing in 1 unilateral case were negative. Childhood-onset “unilateral RP” remains a difficult and uncertain diagnosis. ERG testing and longitudinal and widefield fundus examination are necessary to exclude asymmetrical disease. Although unilateral degeneration may exist in some children, its inherited or acquired etiology remains poorly understood.

**Association of Vitamin A Supplementation With Disease Course in Children With Retinitis Pigmentosa**


This was a retrospective, nonrandomized comparison of vitamin A and control cohorts followed up for a mean of 4 to 5 years by the Electroretinography Service of the Massachusetts Eye and Ear Infirmary. The study included children with different genetic types of typical retinitis pigmentosa: 55 taking vitamin A and 25 not taking vitamin A. The dates for patient evaluations ranged from June 1976 to July 2016. Of note, the age-adjusted dose of oral vitamin A palmitate was ≤15 000 IU/d. Of the 55 children in the vitamin A cohort, 38 (69%) were male; the mean [SD] age was 9.1 [1.9] years; and 48 (87%) were white, 6 (11%) were Asian, and 1 (2%) was black. Of the 25 members of the control cohort, 19 (76%) were male; the mean [SD] age was 9.2 [1.7] years; and 25 (100%) were white. The estimated mean rates of change with the unadjusted model were -0.0713 loge unit/y (-6.9% per year) for the vitamin A cohort and -0.1419 loge unit per year (-13.2% per year) for the control cohort (difference, 0.0706 loge unit per year; 95% CI for the difference, 0.0149-0.1263 loge unit per year; P = .01). The adjusted model confirmed a slower mean rate of decline in the vitamin A cohort (difference, 0.0771 loge-unit per year; 95% CI for the difference, 0.0191-0.1350 loge-unit per year; P = .009). With respect to ocular safety, the mean exponential rates of change of visual field area and visual acuity and the incidences of falling to a visual field diameter of 20° or less or a visual acuity of 20/200 or less in at least 1 eye did not differ by cohort. In summary, a vitamin A palmitate supplement was associated with a slower loss of cone electroretinogram amplitude in children with retinitis pigmentosa. These findings support consideration of an age-adjusted dose of vitamin A in the management of children with the common forms of retinitis pigmentosa.

**Presentation of TRPM1-Associated Congenital Stationary Night Blindness in Children**


Over a twenty-year period at the University of Iowa from 1990 to 2015, a retrospective longitudinal case series of 7 children were evaluated. In particular, the 7 children (5 [71.4%] female) had TRPM1-associated complete Congenital Stationary Night Blindness (cCSNB) followed up for a mean (SD) of 11.1 (2.8) years. Findings included Goldmann visual field results with full I-4e, but constricted I-2e
isopter. Eight different mutations or rare variants in TRPM1 predicted to be pathogenic were detected, with 3 novel variants. In summary, children with TRPM1-associated cCSNB presented before school age with progressive myopia as well as strabismus and nystagmus (but not nyctalopia), with stable, electronegative ffERG results, mildly subnormal full-field stimulus threshold testing results, and a constricted I2e isopter on perimetry. These findings suggest that ffERG and cCSNB genetic testing should be considered for children who present with early-onset myopia, especially in the presence of strabismus and/or nystagmus, and that TRPM1-associated cCSNB may present without complaints of night blindness in childhood.

Association of Vitamin A Supplementation With Disease Course in Children With Retinitis Pigmentosa.

This article attempts to compare disease courses in children with retinitis pigmentosa taking or not taking vitamin A supplementation. It is a retrospective, non-randomized comparison of vitamin A and control cohorts followed up for a mean of 4 to 5 years by the Electroretinography Service of the Massachusetts Eye and Ear Infirmary. The study included children with different genetic types of typical retinitis pigmentosa: 55 taking vitamin A and 25 not taking vitamin A. The dates for patient evaluations ranged from June 1976 to July 2016, and the data analysis occurred in October 2016.

The main outcome is the mean exponential rates of change of full-field cone electroretinogram amplitude to 30-Hz flashes estimated by repeated-measures longitudinal regression without and with adjusting for potential confounders. Of the 55 children in the vitamin A cohort, 38 (69%) were male; the mean [SD] age was 9.1 [1.9] years; and 48 (87%) were white, 6 (11%) were Asian, and 1 (2%) was black. Of the 25 members of the control cohort, 19 (76%) were male; the mean [SD] age was 9.2 [1.7] years; and 25 (100%) were white. The estimated mean rates of change with the unadjusted model were -0.0713 loge unit/y (-6.9% per year) for the vitamin A cohort and -0.1419 loge unit per year (-13.2% per year) for the control cohort (difference, 0.0706 loge unit per year; 95% CI for the difference, 0.0149-0.1350 loge unit per year; P = .01). The adjusted model confirmed a slower mean rate of decline in the vitamin A cohort (difference, 0.0771 loge-unit per year; 95% CI for the difference, 0.0191-0.1350 loge-unit per year; P = .009). With respect to ocular safety, the mean exponential rates of change of visual field area and visual acuity and the incidences of falling to a visual field diameter of 20° or less or a visual acuity of 20/200 or less in at least 1 eye did not differ by cohort.

The authors conclude that vitamin A palmitate supplement was associated with a slower loss of cone electroretinogram amplitude in children with retinitis pigmentosa. Although the relatively small-sample, retrospective, nonrandomized design does not allow a test of causation and is subject to possible biases, these find-
ings support consideration of an age-adjusted dose of vitamin A in the management of most children with the common forms of retinitis pigmentosa.

**Early Patterns of Macular Degeneration in ABCA4-Associated Retinopathy.**


The authors describe the earliest features of ABCA4-associated retinopathy. This is a case series of children with a clinical and molecular diagnosis of ABCA4-associated retinopathy without evidence of macular atrophy. The retinal phenotype was characterized by color fundus photography, OCT, fundus autofluorescence (FAF) imaging, electroretinography, and in 2 patients, adaptive optics scanning laser ophthalmoscopy (AOSLO). Sequencing of the ABCA4 gene was performed in all patients.

Eight children with ABCA4-associated retinopathy without macular atrophy were identified. Biallelic variants in ABCA4 were identified in all patients. Four children were asymptomatic, and 4 reported loss of VA. Patients were young (median age, 8.5 years; interquartile range, 6.8 years) with good visual acuity (median, 0.155 logarithm of the minimum angle of resolution [logMAR]; interquartile range, 0.29 logMAR). At presentation, the macula appeared normal (n = 3), had a subtly altered foveal reflex (n = 4), or demonstrated manifest fine yellow dots (n = 1). Fundus autofluorescence identified hyperautofluorescent dots in the central macula in 3 patients, 2 of whom showed a normal fundus appearance. Only 1 child had widespread hyperautofluorescent retinal flecks at presentation. OCT imaging identified hyperreflectivity at the base of the outer nuclear layer in all 8 patients. Where loss of outer nuclear volume was evident, this appeared to occur preferentially at a perifoveal locus. Longitudinal split-detector AOSLO imaging in 2 individuals confirmed that the greatest change in cone spacing occurred in the perifoveal, and not foveolar, photoreceptors. Electroretinography showed a reduced B-wave-to-A-wave ratio in 3 of 5 patients tested; in 2 children, recordings clearly showed electronegative results.

Authors conclude that in childhood-onset ABCA4-associated retinopathy, the earliest stages of macular atrophy involve the parafovea and spare the foveola. In some cases, these changes are predated by tiny, foveal, yellow, hyperautofluorescent dots. Hyperreflectivity at the base of the outer nuclear layer, previously described as thickening of the external limiting membrane, is likely to represent a structural change at the level of the foveal cone nuclei. Electroretinography suggests that the initial site of retinal dysfunction may occur after phototransduction.

**Comparison Study of Fundoscopic Examination Using a Smartphone-Based Digital Ophthalmoscope and the Direct Ophthalmoscope**
The purpose of this study is to assess the ease of use of the D-EYE digital ophthalmoscope (D-EYE Srl, Padova, Italy) in retinal screening against the conventional direct ophthalmoscope. The digital ophthalmoscope used comprised a smartphone equipped with a D-EYE lens that produces digital retinal images. Twenty-five medical students were given 30 minutes of instruction regarding how to use a direct ophthalmoscope and D-EYE digital ophthalmoscope by a pediatric ophthalmologist. Afterwards, they used two methods to view the fundus under dim light on two undilated volunteer participants under supervision of the pediatric ophthalmologist. Each student had to describe their findings and show the video taken from the smartphone to the pediatric ophthalmologist. Students also completed a survey rating their experience using each method. The study showed that Ninety-two percent of the medical students preferred the D-EYE digital ophthalmoscope to the direct ophthalmoscope. Students were also able to identify the optic nerve and macula in a shorter amount of time and review the images to confirm their findings. Overall, the medical students showed a strong preference for the D-EYE digital ophthalmoscope that was statistically significant ($P < .001$). The D-EYE digital ophthalmoscope is a practical device that could be incorporated into medical education and clinical practice. Survey results revealed that most students preferred the D-EYE digital ophthalmoscope due to the recording features and larger image of the fundus.

**Diagnosis and treatment option for Achromatopsia: a review of the literature.**


Achromatopsia is a complex inherited retinal disease that affects the cone cell function. It is usually an autosomal recessive disease and is characterized by pendular nystagmus, poor visual acuity, lack of color vision, and marked photophobia. CNGA3, CNGB3, GNAT2, PDE6H, and ATF6 gene mutations have been identified as associated with this disease. New diagnostic and therapeutic tools are being investigated. Optical coherence tomography and fundus autofluorescence are important imaging techniques that provide significant information about the progression of the disease. The genetic approach for these patients is a current important issue and gene therapy in an ongoing therapeutic option already being studied in clinical trials.

**Funduscopic examination and SD-OCT in detecting sickle cell retinopathy among pediatric patients.**

The purpose of this prospective study was to compare the results of fundus examination and spectral domain optic coherence tomography (SD-OCT) in detecting retinal changes in pediatric patients with sickle cell disease. Over a period of 19 months, consecutive African American patients with sickle cell disease underwent complete ophthalmologic examination including SD-OCT images of the maculas of both eyes, these were compared to age-matched African American healthy controls. A total of 69 patients (37 males, mean age 12.89 ±4.09, 5-20 years) with sickle cell disease (SC, 26; SS, 36; Sβ+, 5; Sβ0 thalassemia, 2) were examined. Patients’ visual acuity range was 20/20 to 20/40. On funduscopic examination, 11 of 69 showed signs of retinopathy, whereas 47 of 68 showed inner retina thinning in the watershed zone temporal to the fovea on SD-OCT. On average, SD-OCT diagnosed disease 1.78 years earlier than fundus examination. Of patients <10 years of age, 1 was diagnosed with retinopathy by funduscopy, whereas retinal changes were evident on SD-OCT in 12 of 22 (54.5%). Fundus examination showed no significant difference in retinal findings between SS/Sβ0 and SC genotypes. On SD-OCT, SS/Sβ0 showed worse disease process than SC in frequency of diagnosis (82% vs 56%), bilateral involvement (87% vs 43%), and foveal involvement (18% vs 0). The authors concluded that peripheral retina could be visualized on fundus examination but not easily imaged on SD-OCT, which, however, had a higher detection rate and offered earlier diagnosis. In their patient cohort SD-OCT showed that the severity of retinal change was associated with more severe sickle cell disease genotypes (SS and Sβ0). Current NIH guidelines recommend annual or biennial eye examination for patients with SCD beginning at age 10 years. This study suggests that for the purpose of early diagnosis and close monitoring of disease process, beginning routine retinal screening examinations by 10 years of age in children with SCD as recommended by the current NIH guideline may not be adequate.

Implantation, removal and replacement of subretinal electronic implants for restoration of vision in patients with retinitis pigmentosa


The authors present a review of the RETINA IMPLANT Alpha AMS for the treatment of vision impairment in retinitis pigmentosa. The focus of the review is the surgical approach to implantation and explantation of the device. The implant is a subretinal microphotodiode-array (MPDA) that was implanted in 64 patients. Thirty-one patients had RETINA IMPLANT IMS implanted from 2010 to 2013 and was found to have a half-life of only 7 months. Since 2014 the Alpha AMS has been implanted with an improved half-life of nearly 5 years. The implant functions by relaying power to the chip (which is implanted in the subretinal space) from an induction coil im-
planted behind the patient’s ear. The advantage of the subretinal space is that it is immunologically privileged, the RPE provides adhesion forces, and the most reliable stimulation can be obtained. However, compared to epiretinal placement this implant is more difficult to place at a precise location. The authors describe the complex surgical procedure for implantation as well as the relatively safe explantation procedure. Reimplantation can be challenging. The current generation of implants provide an improved lifetime expectancy than previous versions and are promising for the future of this device.

**Multimodal Imaging of Mosaic Retinopathy in Carriers of Hereditary X-linked Recessive Diseases.**


Several X-linked recessive ocular disorders including X-linked retinitis pigmentosa (XLRP), X-linked ocular albinism (XLOA), choroideremia (CHM), congenital stationary night blindness, X-linked retinoschisis, and X-linked cone dystrophy may affect the retina and cause hereditary retinal degeneration. In addition, heterozygous female carriers of XLRP, XLOA, and CHM may on ocular examination show signs of distinctive “mosaic” retinopathy and variable phenotype. This mosaicism and variability are the result of the degree of lyonization, a phenomenon characterized by random X-inactivation. The authors investigated the clinical features in carriers of XLRP, XLOA, and CHM using multimodal imaging and to assess their diagnostic value in these three mosaic retinopathies. They prospectively examined 14 carriers of 3 X-linked recessive disorders (XLRP, XLOA, and CHM). Details of abnormalities of retinal morphology were evaluated using fundus photography, fundus autofluorescence (FAF) imaging, and spectral domain optical coherence tomography (SD OCT). In six XLRP carriers, fundus appearance varied from unremarkable to the presence of tapetal-like reflex and pigmentary changes. On FAF imaging, all carriers exhibited a bright radial reflex against a dark background. By spectral domain optical coherence tomography, loss of the ellipsoid zone in the macula was observed in 3 carriers (50%). Regarding the retinal laminar architecture, 4 carriers (66.7%) showed thinning of the outer nuclear layer and a dentate appearance of the outer plexiform layer. All five XLOA carriers showed a characteristic mud-splatter patterned fundus, dark radial streaks against a bright background on FAF imaging, and a normal-appearing retinal structure by SD OCT. Two of the 3 CHM carriers (66.7%) showed a diffuse moth-eaten appearance of the fundus, and all 3 showed irregular hyper-FAF and hypo-FAF spots throughout the affected area. In the CHM carriers, the structural changes observed by SD OCT were variable. In summary, these findings in an Asian cohort suggest that FAF imaging is a practical diagnostic test for differentiating XLRP, XLOA, and CHM carriers. Wide-field FAF is an easy and helpful adjunct to testing for the correct diagnosis and identification of lyonization in carriers of these three mosaic retinopathies.
Bullous X Linked Retinoschisis: Clinical Features and Prognosis.

A subset of patients with X-linked retinoschisis (XLRS) have bullous schisis cavities in the peripheral retina. This study describes the characteristics and prognosis of the bullous form of XLRS. A retrospective case series was performed of nine patients with molecularly proven bullous XLRS seen at a single tertiary center. All cases of bullous peripheral schisis were bilateral, with one unilateral case at presentation which developed into bilateral bullous schisis over time. The mean age of onset was 1.9 years (range: 1 month–7 years, SD: 2.1 years) and at clinical diagnosis was 5.9 years (range: 1 month–27 years, SD: 9.0 years). Mean follow-up was 11 years (range: 6 months–36 years, SD: 10.8 years). Strabismus was the most common presentation (n=7). Other presenting complaints included decreased vision, floaters and an irregularly shaped pupil. The most frequently associated ocular features were strabismus (100%), vitreous hemorrhage (4/18 eyes, 22%), nystagmus (2/9, 22%) and persistent fetal vasculature (1/18, 6%). Localized tractional detachment was seen in 2/18 (11%) eyes, total detachment that underwent surgical repair in 1/18 (6%) and pigmented demarcation lines in a further 22% of the eyes. There was one eye with exudative retinal detachment. The authors present the largest series to date describing the clinical characteristics and outcome in a series of patients with XLRS who presented with large bullous schisis. In XLRS, bullous schisis may be congenital or develop soon after birth and most commonly presents with strabismus. Cases may be complicated by some form of retinal detachment, which may be tractional or a Coats-like exudative detachment.

Progressive Expansion of the Hyperautofluorescent Ring in Cone-Rod Dystrophy Patients.

Perifoveal hyperautofluorescent rings have been reported in diseases such as retinitis pigmentosa, cone-rod dystrophy (CRD), X-linked retinoschisis, autoimmune retinopathy, and Leber congenital amaurosis and may represent an abnormal perifoveal accumulation of lipofuscin in the RPE as a result of an increased outer segment degeneration as a precursor to apoptosis. Although the presence of a hyperautofluorescent ring has already been reported in CRD patients, the optical coherence tomography (OCT) ring structure and the fundus autofluorescence (FAF) area change over time had not been described yet. The authors evaluated the expansion of the hyperautofluorescent ring and the retinal structure changes over time in CRD patients, using FAF and spectral-domain optical coherence tomography (SD-OCT). Retrospective case series study. Six eyes of three CRD patients with a parafoveal hyperautofluorescent ring were
studied. The diagnosis of CRD was established by the presence of the implicit time shift at 30-Hz flicker and prevalent decrease of photopic over scotopic responses on electroretinography. External and internal ring expansion was evaluated by measurements of its area at baseline and at 24-month follow-up using FAF. SD-OCT analyzed the retinal structure of the ring and the length of devoid ellipsoid zone (EZ) was measured over time. The mean age of study patients was 21 years old and the mean baseline visual acuity was 20/200. The external and internal FAF rings involving the fovea were identified in all study eyes. SD-OCT showed a normal retinal structure outside the ring. At the transitional zone of the ring, disorganization of both EZ and external limiting membrane (ELM) was observed. Inside the hyperautofluorescent ring, EZ and ELM were not identified. At 24-month follow-up examination, the mean % area increase of external and internal rings were 18.32% and 20.42%, respectively, and was concordant with the EZ band defect length enlargement. Progressive expansion of hyperautofluorescent macular ring with a correspondent EZ band defect enlargement was observed over time in CRD patients.


Retinal hemangioblastoma are rare benign tumors; the exact prevalence and incidence is unknown. The tumors can be sporadic or part of the hereditary multi-tumor predisposition, von Hippel-Lindau disease (vHL). Retinal hemangioblastoma are the first manifestation in up to 77% of patients with vHL, and may be the only sign of the disease. The authors aimed to determine the frequency of vHL as the underlying cause of retinal hemangioblastoma and to estimate retinal hemangioblastoma incidence and prevalence in a national cohort study. Through the national patient register and vHL research database, 81 patients diagnosed with a retinal hemangioblastoma in Denmark between 1977 and 2014 were identified. Almost all (63 of 64) participants were or had previously been tested for mutations in the VHL gene. Overall, 84% of the participants (54 of the 64) had vHL. Compared with the non-vHL patients, the vHL patients had their first retinal hemangioblastoma at a younger age (22.5 vs 40 years), and were more likely to have an asymptomatic first hemangioblastoma (80% vs 20%). Overall, 76% (41 of 54) of the vHL patients had a family history of vHL, while none of the patients without vHL did. Despite the rarity of the disease, on average more than eight new tumors are diagnosed each year due to multiple tumor development in vHL patients. The estimated prevalence of patients with retinal hemangioblastoma was up to 1 in 73,080 individuals. In the first national study in which almost all participants were genetically tested, vHL was the underlying cause of retinal hemangioblastoma in 84% of cases; more often than previously reported. It is recommended that genetic and clinical vHL screening should be performed in all patients with retinal hemangioblastoma.

Over the past decade, ultra-widefield FA (UWF FA) has proven useful in the diagnosis and treatment of retinal vascular diseases especially those involving the peripheral retina. A 30° or 50° fundus camera can image 5% to 15% of the retinal surface with a single capture of and up to 75° with multiple captures using the Diabetic Retinopathy Study seven standard field (7SF) photography protocol. In contrast, the Optos UWF system can image 200° or up to 82% of the retinal surface with a single capture. Heimann et al showed serial images of a single patient with retinal hemangioblastomas from diagnosis through multiple treatments using the Optos platform. However, no study has quantified the detection rate of vHL lesions or analyzed the clinical benefit of this technology. The authors studied the use of UWF FA in the detection and management of retinal capillary hemangioblastomas in patients with von Hippel–Lindau disease (vHL). This is a retrospective study of patients with vHL who underwent UWF FA using the Optos camera at a single center from June 2009 to May 2015. The clinical use of UWF FA was reviewed, and the number of hemangioblastomas identified on UWF FA was compared with ophthalmoscopy and a simulated seven standard field (7SF) FA montage. Twenty eyes of 10 patients were identified. Only 33% of lesions seen on UWF FA were also found on ophthalmoscopy, and 88% of lesions visualized on UWF FA were located outside the 7SF overlay. In 5 eyes that had gaze steering, 18% of lesions could be visualized only on gaze-steered images. For the 14 eyes with data available, 6 had procedures recommended and 8 eyes observed based on data from UWF FA. One of 20 eyes had a lesion on ophthalmoscopy that was missed by imaging. In conclusion, ultra-widefield FA using the Optos camera is helpful for the evaluation and management of patients with vHL. The UWF FA with gaze steering appears to detect more hemangioblastomas than ophthalmoscopy and conventional angiography.

Peripheral Pigmented Retinal Lesions in Stargardt Disease.

Fundus photography and fundus autofluorescence (FAF) have proven valuable in diagnosis and monitoring of Stargardt disease (STGD1), but these modalities are mostly used with 30- or 50-degree field imaging, limiting evaluation to the posterior pole. In the past decade, the development of ultra-widefield imaging has allowed more detailed study of the peripheral retina in a variety of diseases, including inherited degenerations such as gyrate atrophy and retinitis pigmentosa (RP). The authors investigate the prevalence of peripheral pigmented retinal lesions and associated clinical findings in patients with Stargardt disease. Records at a single academic institution were reviewed for patients with genetically confirmed Stargardt disease with peripheral pigmented retinal lesions on wide-field retinal
imaging. For this cohort the paper described demographics, clinical features, and pathogenic variants. Out of 62 patients with Stargardt disease and wide-field retinal imaging, 14 had peripheral pigmented retinal lesions. These flat, subretinal lesions were located in the mid or far periphery and had well-defined borders, resembling congenital hypertrophy of retinal pigment epithelium (CHRPE) lesions. For this group of 14 patients, median age at initial diagnosis of Stargardt disease was 9.5 years, and the median duration of disease was 21.5 years. Median Snellen visual acuity was 20/200, and median central scotoma size was 20.0 degrees. All 14 patients had electroretinographic abnormalities. Four out of 14 patients developed new lesions during clinical follow-up. Wide-field retinal imaging revealed the presence of peripheral pigmented retinal lesions resembling CHRPE lesions in a subset of patients with genetically confirmed Stargardt disease. Presence of these lesions may be associated with severe phenotypes of the disease.

Investigation of the Effect of Dietary Docosahexaenoic Acid (DHA) Supplementation on Macular Function in Subjects with Autosomal Recessive Stargardt Macular Dystrophy.

Currently, there is no treatment available to individuals affected by Stargardt macular dystrophy. Docosahexaenoic acid (DHA) is the major very long chain polyunsaturated fatty acid of the retina and is found in high concentration in the photoreceptor cells. The major source of DHA for humans is directly through the diet. The North American diet is rich in fats, but it appears that our diets are relatively poor in omega-3 fatty acids, including DHA. Deficiency of DHA has been implicated as a factor in macular degeneration. The purpose of this study was to test the effect of DHA dietary supplementation on macular function in patients with Stargardt disease. It was a single center, double-masked, randomized placebo-controlled trial of 11 subjects (2 males, 9 females) with Stargardt disease in a crossover design. Six participants were randomized to two sequences of three month periods of DHA supplementation (2000 mg/day) followed by three months of placebo. Five participants were randomized to the opposite sequence. All participants were evaluated with a food frequency and NEI-VF25 questionnaires, complete ophthalmic examination, multifocal electroretinography (ERG, primary outcome), 30-Hz flicker ERG, Humphrey 10-2 visual field, D15 color tests and serum lipid analysis. During periods of DHA supplementation, serum rose and then fell with transition to periods of placebo. None of the participants experienced greater than 20% change from baseline values of the mfERG during periods of DHA supplementation or placebo, while the average change in peak amplitude and phase angle of the flicker ERG remained similar at all visits. No significant change was observed for any of the secondary outcome measures. Eight adverse events occurred but these were not considered to be due to the treatment. The author found no perceived effect of DHA supplementation on macular function. This study will help design future studies of the effect of DHA supplementation on retinal function in cohorts with retinal dystrophies.
Retinal Detachment Surgery in a Pediatric Population


Pediatric retinal detachments (RDs) are unique in etiology, anatomy, and prognosis compared to those in the adult population. Mechanisms include tractional (TRD), rhegmatogenous RD, traumatic, and other types such as exudative or hemorrhagic. This retrospective consecutive case series of patients clinically diagnosed and undergoing surgery for RD between birth and 15 years of age during an 11 year period at a single academic institution examined visual and anatomic outcomes. 206 patients (231 eyes) were included in the study; 25 (12%) had bilateral RDs. 67 patients (29%) had TRD (ROP, PFV, or FEVR), 51 (22%) had rhegmatogenous RD (myopia, X-linked retinoschisis, or Stickler syndrome), 60 (26%) had traumatic RD, and 52 (23%) were due to other types of RD such as Coats disease or coloboma. Presenting BCVA better than 20/200 correlated with better final BCVA. Anatomical success was strongly correlated with visual acuity outcome and was significantly more likely in rhegmatogenous RD versus TRD. The likelihood of obtaining a final BCVA > 20/200 was poorer in TRD (10%) compared to rhegmatogenous RD (39%) or traumatic RD (28%).

This study is somewhat limited by its retrospective nature, lack of long-term follow-up in some patients (average time of post-operative follow-up was 48 months with range 3 months to 12.9 years), and missing or incomplete records in some patients, often as a byproduct of the tertiary nature of pediatric RD referrals coming from distant locales. Long-term sequelae of repair and involvement of the contralateral eye could often not be assessed. In addition, grouping the etiologies of the RDs was subjective, especially in cases with possible combined etiology. However, this large series of pediatric RDs confirms ROP and trauma as the most common etiologies. Although visual and anatomic outcomes vary among categories of RD, rhegmatogenous RDs were associated with the best anatomical success and globe conservation outcomes, and TRDs generally had poorer outcomes.

Retinal Detachment and Retrobulbar Cysts in a Large Cohort of Optic Nerve Coloboma


This study examined the relationship between retinal detachment and retrobulbar cysts in patients with optic nerve coloboma (ONC) and Morning Glory syndrome (MGS) referred to a specialist children’s retina service. 45 patients with ONC and 26 with MGS had an orbital B-scan ultrasound and/or MRI and were assessed independently by two ophthalmologists and a radiologist for the presence of retrobulbar cysts. Retinal detachment was identified clinically with indirect ophthalmoscopy or from fundus photographs. Retinal detachment occurred signifi-
cantly more often in eyes with MGS than with ONC (53% vs 11%). Retrobulbar
cysts were not detected more often in MGS than in ONC (24% vs 27%). Eyes
with retrobulbar cysts were more likely to be associated with retinal detachment
than those without (39% vs 13%).

This study was limited by its retrospective nature making controlling for con-
founders difficult, but it does appear that MGS has a higher incidence of both RD
and retrobulbar cysts than ONC. The role that retrobulbar cysts play in the devel-
opment of RD is uncertain.

Choroidal Thickness in Patients with Stargardt Disease


This study examined the relationship between choroidal thickness (CT), central
foveal thickness, multifocal electroretinogram (mf-ERG) responses, and best-
corrected visual acuity levels in patients with Stargardt disease (STGD). 30 eyes
of 30 patients with Stargardt disease (STGD), and 30 age- and sex-matched
healthy controls were included. The mean subfoveal CT values were 271.95 +/-
85.57 um in patients with STGD and 355.73 +/- 87.41um in the control group.
The mean central foveal thickness values were 223.56 +/- 61.38 um in patients
with STGD and 272.46 +/- 27.52 um in the control group. The mean central and
paracentral mf-ERG responses in patients with STGD were significantly lower
than the normal ranges. There was a significant correlation between subfoveal
CT and best-corrected visual acuity levels, and between parafoveal CT and inner
retinal thickness and paracentral mf-ERG responses. Paracentral mf-ERG re-
sponses were also correlated with outer retinal thickness values.

The authors conclude that the EDI mode of spectral domain OCT can identify
choroidal changes in patients with STGD, and choroidal alterations may correlate
with clinical findings and prognosis. However, further studies are needed to clari-
fy the pathophysiologic significance of choroidal thinning in patients with STGD.

Ellipsoid Zone Mapping and Outer Retinal Assessment in Star-
gardt Disease


This study attempted to quantify and correlate ellipsoid zone and photoreceptor
outer segment changes with visual acuity in 32 eyes with Stargardt disease.
Spectral domain OCT was performed, and the macular cube was then exported
into a novel analysis tool and volumetric assessment from the ellipsoid zone to
the RPE was performed. Mapping was completed with en face representation of
the height between the ellipsoid zone and RPE, providing quantification of ellip-
soid zone and photoreceptor outer segments including atrophy (ellipsoid zone to
RPE thickness = 0 um) and attenuation (ellipsoid zone to RPE thickness <20
um). These parameters were compared to visual acuity and to controls. Visual acuity ranged from 20/30 to 20/250. The central foveal B-scan area of ellipsoid and photoreceptor outer segments was significantly less than controls (0.13 vs 0.17 mm²), and the central foveal B-scan mean thickness measured 22.52 μm in Stargardt versus 30.0 μm in controls. Atrophy and attenuation were significantly higher in Stargardt patients than controls (22% vs 1%, and 43% vs 1%). Visual acuity directly correlated with ellipsoid zone/outer segment volume, and inversely correlated with attenuation and atrophy.

This study does not include assessment of longitudinal outer retinal changes, and most of the patients had advanced disease, increasing the probability of ellipsoid and photoreceptor outer segment loss. Nevertheless, this study was able to quantify significant disruption of the ellipsoid zone and outer segments and identify correlates with visual function. This novel assessment platform may allow for longitudinal surveillance for future disease monitoring and quantitative clinical trial assessments.

Normal Electrooculography in Best Disease and Autosomal Recessive Bestrophinopathy

This retrospective review evaluated the electrooculogram (EOG) in a series of patients with Best disease and autosomal recessive bestrophinopathy. Patients with Best disease or AR bestrophinopathy who had a normal or atypical EOG light rise were identified. Main outcome measures included EOG amplitude, clinical phenotype, and genotype. 113 patients were identified with likely disease-causing sequence variants in BEST1 (99 Best disease and 14 AR bestrophinopathy); electrooculograms had been performed in 75 of the patients. 20 patients (27%) had no detectable light rise (Arden ratio 100%) and 49 (65%) had Arden ratios between 100 – 165%. 6 patients (8%) had an EOG light rise > 165%. No cases demonstrated interocular asymmetry in EOG amplitude. This study demonstrates that the EOG phenotype in Best disease and AR bestrophinopathy is more variable than is currently generally appreciated. As a normal EOG has been shown to occur in the presence of a classic fundus appearance, the authors argue that consequences of a BEST1 mutation may be independently expressed and may be mediated through differential effects on intracellular calcium homeostasis.

Ultrawidefield Autofluoresence in ABCA4 Stargardt Disease

This retrospective cohort study reported ultrawidefield fundus autofluorescence (UWF-FAF) patterns in ABCA4 Stargardt disease. 58 eyes of 29 patients with a clinical diagnosis of Stargardt disease, confirmed ABCA4 genotype, and ul-
Trawidefield fundus autofluorescence imaging were included. 4 independent graders evaluated the images. UWF-FAF images were evaluated for the presence of posterior pole and peripheral findings, and were classified into 1 of 3 types: Type I: lesions confined to the macula with no peripheral findings; Type II: macular atrophy with flecks only in the periphery; Type III: macular atrophy and varying degrees of peripheral atrophy. Peripheral (outside the 55 degree view of standard nonwidefield FAF imaging) alterations on UWF-FAF were present in 76% of eyes. The UWF-FAF pattern was classified as Type I in 24% eyes (14/58), Type II in 24% (14/58), and Type III in 52% (30/58). The most common genetic mutations identified were present in 20.7% and 17.5% of patients.

Limitations of this study include its retrospective nature with clinical data and imaging collected at only one point in time. Age of onset of disease was often unavailable, and without longitudinal follow-up it is not certain whether the noted patterns represent progressive stages of STGD or rather a spectrum of disease severity. The authors note that most of the genetic testing methods used in this study were unable to detect all variants, and future sequencing of the entire 140 kb ABCA4 locus could detect additional genetic aberrations. Despite these shortcomings, the authors demonstrate via UWF-FAF that abnormalities in the peripheral retina are present in the majority of patients with STGD and would otherwise be missed on conventional nonwidefield FAF. The correlation of UWF-FAF phenotypes with ABCA4 genotypes remains a challenge, though as UWF-FAF is increasingly incorporated into patient care, the ability to stage and offer prognosis to patients with STGD will continue to evolve.

OCT IMAGING IN DISEASE

Optical coherence tomography analysis of the inner retinal layers in children

This cross-sectional study aimed to determine if there was a correlation between the optic nerve head area (ONH), the peripapillary retinal nerve fiber layer (pRNFL) thickness, and the ganglion cell inner plexiform layer (GCIPL) thickness, as measured by OCT in children. 358 eyes were included, and were measured with the Cirrus HD-OCT. The mean age of participants was 6.4 years, and they had a mean spherical equivalent of 0.22D. The average pRNFL thickness was 100.19 microns. The average GCIPL thickness was 85.29 microns. Interestingly, 38 eyes (10.6%) were deemed to have megalopapilla. A positive correlation was found between pRNFL thickness and the ONH area, the GCIPL thickness and ONH area, and the pRNFL and GCIPL thicknesses. The correlation of ONH area with pRNFL and GCIPL thicknesses supports other observations that larger discs have a higher number of ganglion cells. Therefore, because the OCT scan has a fixed diameter, the scan does not influence these measurements and any future
normative database of OCT measurements in children should adjust the pRNFL and GCIPL thicknesses with the ONH area.

### Longitudinal Changes in the Optic Nerve Head and Retina Over Time in Very Young Children with Familial Exudative Vitreoretinopathy


This single-center, retrospective case series included patients with a clinical diagnosis of FEVR who were enrolled in an observational hand-held OCT imaging study at Duke. The authors sought to explore the vitreoretinal pathologies and their longitudinal changes visible on HHOCT. Images from 26 eyes of 16 children (mean age 32 months) with FEVR were analyzed for vitreoretinal interface and retinal abnormalities and optic nerve head (ONH) elevation. 10 eyes had ONH dragging on photographs, and in these HHOCT revealed temporal and anterior retinal displacement, prominent vitreopapillary adhesion or traction, and retinal nerve fiber layer thickening at ONH margins with adjacent retinal elevation. Despite a nearly normal photographic appearance, HHOCT revealed ONH elevation with vitreopapillary traction (6/16 eyes), ONH edema (1/16 eye), and retinal vascular protrusion (5/16 eyes). HHOCT-visualized vitreous abnormalities (18/26 eyes) were more prevalent at higher stages of disease. HHOCT-visualized elevation of ONH and retina worsened over time in 9 eyes and improved in 5/6 eyes after vitrectomy.

Study limitations include a lack of standardized follow-up time for examinations, suboptimal image quality for some patients, image graders unmasked to the OCT findings, and limited data regarding visual function precluding the correlation of OCT findings with functional outcome. Nevertheless, this study demonstrates that HHOCT can detect early ONH, retinal, and vitreous changes in eyes with FEVR. Contraction of strongly adherent vitreous in young patients with FEVR appears to cause ONH dragging and tractional complications without partial posterior vitreous detachment. Vitreopapillary dragging may be visible only on OCT and may progress in the absence of obvious retinal change on conventional examination. The authors argue that the potential impact of vitreous traction on the ONH and the peripheral retinal status in FEVR is important to recognize, and this information could be valuable in preoperative assessment and clinical monitoring in young children.

### Choroidal Structural Changes and Vascularity Index in Stargardt Disease on Swept Source Optical Coherence Tomography

This retrospective comparison cohort study evaluated structural changes in the choroid of patients with Stargardt disease using swept source OCT scans. The study included 39 patients with Stargardt disease recruited from two tertiary eye centers in Southern India and 25 age and gender matched healthy controls. Subfoveal choroidal thickness (SFCT) was computed from the swept source OCT machine, and the scans were binarized into luminal area and stromal areas, which were then used to derive choroidal vascularity index (CVI). CVI and SFCT were analyzed independently using linear mixed effects model. There was no significant difference in SFCT between the 2 groups (347.20 um in Stargardt disease vs 333.09 um in the control group, p=0.548). There was a significant decrease in the CVI among eyes with Stargardt disease compared to the normal eyes (62.51 vs 65.45, p<0.001). There was a negative association between visual acuity and CVI and a positive association between visual acuity and SFCT.

This study was limited by a small sample size and the absence of genetic testing for the confirmation of Stargardt disease (genetic testing was not performed due to financial constraints). CVI was measured using one horizontal scan across the fovea, and more information may have been obtained if the technique was applied to a volume scan over a broader area of the macula. Despite these limitations, CVI is a novel and noninvasive imaging tool and may be a robust and sensitive marker to monitor the choroidal angiopathy in patients with Stargardt disease. CVI showed a negative trend with decreasing visual acuity in patients with Stargardt disease and may be considered in future studies as an end point for clinical trials.

**Diurnal Variations of Foveoschisis by Optical Coherence Tomography in Patients with RS1 X-Linked Juvenile Retinoschisis.**


Several small and nonrandomized studies have reported the use of oral and topical carbonic anhydrase inhibitors (CAIs) in the management of schisis cavities in patients with X-linked juvenile retinoschisis (XLRS). Documentation of an efficacious response to these agents is lacking in consistency. While in some patients there was a reduction of macular cavities; in others, there was no improvement and even an increase in the macular thickness. The authors evaluate diurnal variations in macular schisis cavities in patients with XLRS with pathogenic variants in the *RS1* gene using spectral-domain optical coherence tomography (SD-OCT). Three consecutive patients with a clinical diagnosis of XLRS and pathogenic variants in the *RS1* were treated with carbonic anhydrase inhibitors (CAIs). SD-OCT scans of the macula were acquired at 9 a.m., 1 p.m., and 4 p.m. within 24 h. All patients demonstrated increased measures of central foveal thickness in the morning with gradual decrease through the day (9–43%). Major changes were observed between 9 a.m. and 1 p.m. in the central foveal thickness. The authors determined the central foveal thickness varies during daytime hours in patients with XLRS. This finding may explain the inconsistent and heter-
ogogeneous responses to treatment with CAIs and necessitate standardization of measurement times in treatment trials for XLRS as well as in the routine ophthalmic evaluation of these patients.

**Retinal Vascular Impairment in Best Vitelliform Macular Dystrophy Assessed by Means of Optical Coherence Tomography Angiography.**

Best vitelliform macular dystrophy (BVMD) is a multifaceted dystrophy characterized by high phenotypic and genetic heterogeneity. Limited information is available regarding vascular impairment in BVMD. Choroidal thickness measurements on spectral domain-optical coherence tomography (SD-OCT) vary along with stage of disease, being higher in the vitelliform and lower in the atrophic/cicatricial stage, but no precise evidence exists regarding the retinal vascular flow. The authors evaluated vascular abnormalities at superficial (SCP) and deep (DCP) capillary plexuses and choriocapillaris (CC) in patients with BVMD by means of optical coherence tomography angiography (OCT-A). Sixty-six eyes of 33 patients with BVMD (16 male) and 33 controls were enrolled. Patients were subdivided into classic stages and underwent best-corrected visual acuity (BCVA), fundus autofluorescence and SD-OCT, and 4.5 x 4.5-mm swept-source OCT-A. Choroidal neovascularization (CNV) and capillary dilations were qualitatively assessed by 2 masked ophthalmologists. Foveal avascular zone (FAZ) area was measured manually; vessel density was then quantified after the exclusion of the FAZ pixels. Eyes classified as stages 3 and 4 were evaluated together. Nineteen eyes (28.8%) revealed capillary dilations at DCP, 15 of which were in stages 1 and 2. CNV was detected in 24 eyes (36.4%). Stages 3–4 and 5 carry significant impairment at both SCP and DCP compared to controls. FAZ area was enlarged at the DCP. Only DCP vessel density significantly correlated with the stage and BCVA. In summary, patients with BVMD show significant vascular impairment at both superficial and deep retinal plexuses, correlating with functional outcomes. These findings, especially at DCP, may improve our understanding about the pathogenesis, and may help in predicting BVMD treatment efficacy.

**Spectral Domain Optical Coherence Tomography Features in Different Stages of Best Vitelliform Macular Dystrophy.**

Best vitelliform macular dystrophy (VMD) is most frequently caused by autosomal dominantly inherited mutations in the BEST1 gene, and in its classic phenotypical manifestation, it is clinically characterized by a yellowish, vitelliform or egg-yolk-
like macular lesion. The most typical spectral domain optical coherence tomography (SD-OCT) features include vitelliform material, disruption and atrophy of the outer retinal layers, and fibrotic nodules under the retinal pigment epithelium. Nevertheless, no study has had a sufficient number of patients to try to examine the SD-OCT findings systematically according to the specific stage of VMD. The purpose of this study was to investigate the SD-OCT features typical of each VMD stage, analyzing the correlations with changes in visual acuity. Ninety-four eyes of 47 patients were recruited in a prospective cross-sectional study. The findings assessed included vitelliform material, neurosensory detachment, status of external limiting membrane, ellipsoid zone and retinal pigment epithelium, choroidal excavation, foveal cavitation, choroidal neovascularization, vitreomacular traction, and macular hole. The outer retinal layers were found to be more commonly disrupted in Stages 2 to 4 (range: 86%-100%), whereas their absence was more typical of Stage 5 (71%-86%). Vitelliform material was found in 100% of Stages 2 and 3, 93% of Stage 4, and interestingly in 43% of Stage 5. Eyes characterized by vitelliform material showed a greater correlation with higher best-corrected visual acuity than eyes without it. Moreover, its absence was associated with a best-corrected visual acuity of 0.5 logarithm of the minimum angle of resolution or worse. Subretinal fluid was more common in Stages 3 and 4 (72.7% and 75%, respectively) than Stages 2 and 5. Eyes with subretinal fluid were significantly associated with a visual acuity of 0.2 logarithm of the minimum angle of resolution or worse (approximately 20/32 Snellen equivalent). In summary, SD-OCT assessment primarily indicates an outer retinal layer disruption in Stages 2 to 4, along with the presence of vitelliform material extending into the more advanced clinical stages too. Eyes characterized by the persistence of vitelliform material show better best-corrected visual acuity. Future investigations based on a longitudinal follow-up are warranted to correlate SD-OCT modifications with functional responses to identify SD-OCT indicators for prognostic and therapeutic purposes.

**OCT IMAGING – DATA ON NORMAL EYES**

**COAT’S DISEASE**

Younger Age at Presentation in Children with Coats Disease is Associated with More Advanced Stage and Worse Visual Prognosis: A Retrospective Study


This retrospective study assessed the age distribution of children with Coats disease and the impact of age at diagnosis on visual prognosis. 98 consecutive Coats disease cases aged 18 years or younger at diagnosis were included. Clinical and imaging parameters were analyzed. Mean age was 5.4 years at the time
of diagnosis. Younger age at diagnosis was correlated with more severe disease stage, which was confirmed with survival analysis. Comparative analysis was performed between patients younger and older than 4 years at diagnosis. Leukocoria or strabismus was more frequent at presentation in patients younger than 4 years, and areas of peripheral nonperfusion and peripheral telangiectasia were more extensive. Foveal sparing at diagnosis was less frequent in younger than older patients (2% vs 23%). The incidence of structural complications or enucleation during mean 5.9 year follow-up was higher, and last-recorded visual acuity as lower in younger than older patients. Final logmar visual acuity was negatively correlated with age at diagnosis; multivariate analysis indicated that disease stage, but not age at diagnosis, independently influenced the last-recorded visual acuity.

This study was limited by its retrospective inclusion of patients over a long period of time and the loss of patients during follow-up, as well as by possible referral bias with a tertiary referral center possibly concentrating more severe, younger cases. However, this study showed that onset of Coats disease in children of younger age is associated with more severe manifestations, more advanced stage, and worse visual outcome. Age, correlated with disease stage, may be considered a prognostic marker in Coats disease.

Long-term Outcomes of Total Exudative Retinal Detachments in Stage 3B Coats Disease

Coats disease has a wide spectrum of presentation and its management depends on the stage of disease. Laser photocoagulation and cryotherapy are the main treatment of Coats disease once exudation becomes significant in both subtotal RD (stage 3A) and total RD (stage 3B). The purpose of this study is to evaluate the long-term outcomes of treatment 3B Coats disease and the role of vitrectomy. The authors conducted a retrospective observational study of 16 eyes in 16 patients with stage 3B disease with at least 5 years of follow-up. The primary outcome measures were visual acuity at the most recent appointment, whether there was progression to neovascular glaucoma (NVG) or phthisis bulbi, and need for enucleation. All patients received ablative treatment (photocoagulation or cryotherapy), with 8 having scleral buckling (SB) and 6 having external drainage of subretinal fluid (XD). Of the 12 patients who had pars plana vitrectomy (PPV), 8 had early PPV (EV) in the first year after presenting, and 4 of 8 in the expectant management group had late PPV (late vitrectomy) at a mean of 4.3 years post-presentation for treatment of significant traction retinal detachment (TRD). The other 4 patients of 8 in the expectant management group did not require vitrectomy. Mean follow-up overall was 9 1/2 years. At the date of last follow-up, 50% had no light perception or light perception vision, which was consistent across the subgroups that underwent EV (4/8), late vitrectomy (2/4), or no
PPV (2/4). Four of 16 patients had progression to NVG or phthisis, 1 of whom required enucleation. In this retrospective series of patients with Stage 3B Coats disease, ablative therapy with a combination of PPV, XD, or SB was effective in preventing progression to NVG or phthisis in the majority of patients, thus preserving the globe. Half of the patients (4/8) in this series who did not undergo PPV in the early vitrectomy group developed late-onset TRD, suggesting a possible role for early prophylactic vitrectomy with possible SB and XD; however, this is balanced by the other half (4/8) in the expectant management group who did not require any vitrectomy.

MISCELLANEOUS

19. RETINOBLASTOMA / INTRAOCULAR TUMORS

RETINOBLASTOMA

Ophthalmic Vascular Events after Primary Unilateral Intra-arterial Chemotherapy for Retinoblastoma in Early and Recent Eras

The purpose of this study was to assess risk factors for ophthalmic vascular events after intra-arterial chemotherapy (IAC) for retinoblastoma. Although IAC is efficacious in achieving tumor control, it can lead to thromboembolic or hemorrhagic events due to the technique itself or secondary to chemotherapy-induced toxicity. Ophthalmic vascular events include choroidal ischemia, branch or central retinal artery occlusion, ophthalmic artery spasm or occlusion, vitreous hemorrhage and others. Although early series reported ophthalmic vascular event rates as high as 35%, more recent series have described a lower rate of 1%. In this study, the authors conduct a retrospective, consecutive, comparative analysis to describe ophthalmic vascular events at a single center during two time periods: early IAC era (2009–2011) compared with the recent era (2012–2017). The study population included patients who received unilateral IAC as primary treatment for retinoblastoma from January 1, 2009, to November 30, 2017, at Wills Eye Hospital. All patients underwent complete eye exam under anesthesia prior to administration of IAC and then monthly exams were performed, which included anterior and posterior indirect ophthalmoscopy, B-scan ultrasonography, RetCam fundus photography, Fluorescein angiography, and OCTS as needed. After tumor control was achieved, the interval between examinations under anesthesia was extended. Records were reviewed for patient demographics, tumor features, IAC parameters, and treatment-related vascular events. Change in event rates over time were assessed using Poisson regression analysis, with Spearman’s rho used to test correlation. There were 243 chemotherapy infu-
Intravitreal chemotherapy consisted of melphalan (243 infusions), topotecan (124 infusions), and carboplatin (9 infusions). A comparison (early vs. recent era) revealed fewer mean number of infusions (2.6 vs. 3.4, \( P = 0.02 \)) with similar mean patient age and presenting tumor features. Event rates decreased over time (\( P < 0.01 \)), with fewer ophthalmic vascular events (early era vs. recent era) in the recent era (59% vs. 9% per eye, 23% vs. 3% per infusion, \( P < 0.01 \)), including peripheral retinal nonperfusion (5% vs. 2% per eye, \( P = 0.50 \)), vitreous hemorrhage (9% vs. 2%, \( P = 0.20 \)), subretinal hemorrhage (0% vs. 2%, \( P = 0.99 \)), branch retinal vein occlusion (5% vs. 0%, \( P = 0.29 \)), choroidal ischemia (14% vs. 4%, \( P = 0.14 \)), and ophthalmic artery spasm/occlusion (27% vs. 0%, \( P < 0.01 \)). Event rates did not correlate with patient age (\( P = 0.75 \)), tumor diameter (\( P = 0.32 \)), tumor thickness (\( P = 0.59 \)), or cumulative dosage of melphalan (\( P = 0.13 \)) or topotecan (\( P = 0.59 \)). There were no IAC-induced vascular events in 72 infusions of 21 consecutively treated eyes in 2016 to 2017. This study shows that the ophthalmic vascular events after IAC have decreased from the early era (2009–2011) through the current era (2012–2017) at this center. Experience performing this highly specialized procedure could be an important factor predicting IAC-related vascular events. There were technical changes made between the two time periods. This includes pulsatile delivery of the infusion, eliminating the guide wire and advancing the catheter only to the ostium of the ophthalmic artery. This alone does not explain the observed change. The later time period also eliminated the use of carboplatin but it does not show more toxicity compared to melphalan in non-human primate studies. The authors surmise that the technique and experience is what accounts for the reduced rate of the ophthalmic vascular events.

High-Risk Intraocular Retinoblastoma: Comparison Between Asian Indians and Americans From Two Major Referral Centers

This retrospective study sought to identify the differences in the clinical and histopathologic features in eyes with advanced intraocular retinoblastoma in a developing country (India) versus a developed country (USA). 524 patients with retinoblastoma who underwent primary enucleation were included in the study, 331 from India and 193 from the USA. Asian Indians were older at presentation (35 months vs 29 months) and had thicker tumors (13.8 mm vs 12.4 mm) compared to Americans. There was a 2-fold greater risk of high-risk intraocular retinoblastoma in Asian Indians. There were significant differences in the histopathologic features of tumors in Asian Indians versus Americans: massive (\( \geq 3 \) mm) choroidal infiltration (17% vs 6%) and optic nerve infiltration (48% vs 15%). Asian Indians had a 5-fold greater risk of having optic nerve invasion and a 3-fold greater risk of massive choroidal invasion compared to Americans. With appropriate use
of adjuvant systemic chemotherapy, the difference in rates of systemic metastasis (5% vs 2%) and related death (5% vs 0%) were not statistically significant.

This study demonstrates that high-risk intraocular retinoblastoma is more common in India than in the USA, but with appropriate adjuvant systemic chemotherapy the metastatic rate and death due to metastasis were not statistically different. However, this study includes only advanced intraocular retinoblastoma and/or cases with microscopic extraocular extension and not advanced cases with overt orbital extension. Therefore the results cannot be extrapolated to the overall rate of systemic metastasis and survival of children with retinoblastoma in India versus the USA.

**Trefoil Factor Family 1 Expression Correlates with Clinical Outcome in Patients with Retinoblastoma**


This retrospective study sought to correlate trefoil factor 1 (TFF1) expression in retinoblastoma tumors with different clinical parameters to evaluate potential involvement of TFF1 in tumor development and progression. A representative cohort of 59 enucleated eyes from patients with retinoblastoma was analyzed for TFF1 expression profile by immunostaining and real-time PCR. TFF1 expression was correlated with demographics, laterality, tumor-node-metastasis (TNM) stage, International Classification of Retinoblastoma, tumor differentiation level, and treatment. Increased TFF1 expression was found to significantly correlate with unilateral tumors diagnosed in older children and with poorly differentiated tumors and higher TNM stages.

The exact pathophysiologic role of TFF1 in RB tumor progression is not well understood, and its role as a tumor-suppressor versus an oncogene requires further investigation. There may be potential value of TFF1 as a pharmacologic treatment option for RB tumors. At minimum, this study indicates that TFF1 expression levels are potentially useful markers in the classification of tumor staging and prognosis of patients with RB.

**Strabismus in retinoblastoma survivors with long-term follow-up**


The goal of this paper was to report the long-term strabismus rate in salvaged retinoblastoma (Rb) patients and investigate possible risk factors leading to strabismus in these patients. The medical records of patients with Rb presenting at a single institution over a 9-year period were reviewed retrospectively with regard to ocular alignment outcomes after long-term follow-up. A total of 64 eyes of 42 patients (22 bilateral cases which consisted of 52% of the patients) were includ-
ed, presenting with International Intraocular Retinoblastoma Classification (IIRC) in the worse eye as follows: group A (n = 1), B (n = 16), C (n = 12), D (n = 11), no Rb (n = 2). Fifteen patients (36%) were initially referred because they had no family history of Rb. Mean age at presentation was 8.2 months (range, 0.3-58.3 months). Overall treatments in this group of patients included intravenous chemotherapy (62 eyes), intraophthalmic artery chemotherapy (10 eyes), brachytherapy (11 eyes), transpupillary thermotherapy (22 eyes), cryotherapy (47 eyes), and external beam radiotherapy (4 eyes). At final follow-up (mean, 93.7 months), 69% of patients had strabismus, with exotropia being the most common type (n = 18), followed by esotropia (n = 8), and alternate exotropia/esotropia (n = 3). On univariate analysis, the worse eye group IIRC and cTNMH, sporadic cases, strabismus, and foveal tumor at presentation were found to be significantly associated with the presence of strabismus at the final follow-up (P ≤ 0.043). On multivariate analysis, only foveal involvement was found to be significant (P < 0.001). The authors find that strabismus, exotropia in particular, is a common adverse sequela following successful conservative treatment for Rb, with 69% of the present cohort having some type of deviation after long-term follow-up, for which foveal tumor at presentation was found to be a significant risk factor. This information can be helpful in guiding parental expectations in this group of patients.

Treatment of Non-metastatic Unilateral Retinoblastoma in Children

This was a multicenter study in Latin America (Grupo de America Latina de Oncologia Pediatrica [GALOP]) with children with non-metastatic unilateral retinoblastoma. The study opened on July 1, 2008, and closed on December 31, 2014. Follow-up was updated until June 30, 2017. Stage 0 patients (without enucleation) were given conservative therapy without a protocol. Stage I patients (with enucleation and no residual tumor) were divided into a high-risk group (retrolaminar invasion and/or scleral invasion) and a low-risk group (all remaining patients). High-risk children received adjuvant chemotherapy with 4 alternating cycles of regimen 1 (cyclophosphamide [65 mg/kg/d] [plus sodium-2-mercaptoethane sulfonate], idarubicin hydrochloride [10 mg/m2/d], and vincristine sulfate [0.05 mg/kg/d]) and 4 cycles of regimen 2 (carboplatin [500 mg/m2/d, days 1 and 2] and etoposide [100 mg/m2/d, days 1-3]). Low-risk children did not receive adjuvant therapy. Children with buphthalmia received neoadjuvant and adjuvant chemotherapy for a total of 8 cycles. Among 187 children registered in the study, 175 were evaluable (92 [52.5%] female; median age, 22 months; age range, 3-100 months). Forty-two were stage 0 children, 84 were stage I low-risk children, and 42 were stage I high-risk children; there were 7 children in the buphthalmia group. With a median follow-up of 46 months, the 3-year probability of event-free survival was 0.97 (95% CI, 0.94-0.99), and the probability of overall survival was 0.98 (95% CI, 0.94-1.00). Stage 0 patients had no events, stage I low-risk patients had 1 event (orbital relapse treated with second-line therapy), stage I high-risk patients had 2 events (1 central nervous system relapse and 1
death from sepsis), and the buphthalmia group had 1 event (orbital relapse, followed by central nervous relapse and death). In summary, findings from this GALOP study suggest that adjuvant therapy may be effective for high-risk unilateral retinoblastoma but is toxic, and neoadjuvant chemotherapy for buphthalmus appears feasible.

Screening Children at Risk for Retinoblastoma: Consensus Report from the American Association of Ophthalmic Oncologist and Pathologists

This is a consensus statement for surveillance guidelines for children at risk for development of retinoblastoma. A patient "at risk" was defined as a person with a family history of retinoblastoma in a parent, sibling, or first- or second-degree relative. Of note, the majority of at-risk relatives who do not carry the RB1 mutation do not require specific retinoblastoma screening. Key recommendations are as follows: (1) Dedicated ophthalmic screening is recommended for all children at risk of retinoblastoma above the population risk. (2) Frequency of examinations is adjusted on the basis of expected risk for RB1 mutation. (3) Genetic counseling and testing clarify the risk for retinoblastoma in children with a family history of the disease. (4) Examination schedules are stratified on the basis of high-, intermediate-, and low-risk children. (5) Children at high risk for retinoblastoma require more frequent screening, which may preferentially be examinations under anesthesia. Refer to the risk stratification in the paper based on the RB1 screening.

Retinoblastoma in the United States: A 40-Year Incidence and Survival Analysis.
Arthur Gustavo Fernandes, Benjamin D.Pollock, Felicia A. Rabito
J of Ped Ophth& Strabismus. 2018; 55(3):182-188

The purpose of this study is to determine the incidence of retinoblastoma in the United States from 1973 to 2012 (40 years) and characterize the 5-year overall survival rate of the included patients. The patient data came form the Surveillance, Epidemiology, and End Results (SEER) Program( national Cancer Institute, Rockville, MD). A total of 879 cases of retinoblastoma were derived from the SEER database. Incidence rates were calculated using U.S. Census Bureau data as the standard population, and trends over time were determined using the chi-square test. Hazard ratios with a 95% confidence interval (CI) were estimated for variables associated with mortality using Cox regression models. Survival rates were calculated using the Kaplan–Meier method and compared. The study showed that the annual incidence rates of retinoblastoma for a period of 40 years were 12.14 (95% CI: 11.32 to 12.96) cases per 1 million children 4 years or younger and 0.49 (95% CI: 0.36 to 0.65) cases per 1 million children be-
tween the ages of 5 and 9 years. There was no significant trend for children 4 years or younger ($P = .6324$) or between the ages of 5 and 9 years ($P = .7695$). The 5-year overall survival rates were 97.6%, 92.7%, 91.1%, and 96.4% for children diagnosed at the first, second, third, and after the third year of life, respectively ($P = .0136$). The 5-year overall survival rates were 92.5% for bilateral and 96.3% for unilateral cases ($P = .0116$). The 5-year overall survival rates were 90.8%, 92.5%, 97.6%, 97.3% for increasing time intervals (1973 to 1979, 1980 to 1989, 1990 to 1999, and 2000 to 2012, respectively; $P = .0017$). The authors concluded that the incidence rate of retinoblastoma in the United States has remained stable for the past 40 years. Survival rate analysis indicates a significant effect of laterality of tumor, age at diagnosis, and decade of diagnosis.

The Recognition of Cavitary Retinoblastoma Tumors: Implications for Management and Genetic Analysis


This study examined 18 eyes of 17 patients (which represented 6.8% of the 250 patients seen during the 10-year study period) with retinoblastomas having ophthalmoscopically visible cavities. Goals were to further understand the clinical phenotype of cavitary retinoblastoma (CRb), the necessity for treatment, any correlation with genetic findings, and the need for adjuvant therapy once CRb is diagnosed. The mean age at diagnosis was 13 months; 5 were unilateral and 12 were bilateral. The mean number of retinoblastoma tumors per eye was 2, and the mean number of cavities per tumor was 3. Intratumoral cavities were seen in the superficial portion of the tumor in 10 eyes (55%). All patients received 4 – 6 cycles of systemic intravenous chemotherapy. The cavities became visible in 8 eyes (44%) and collapsed in 8 eyes (44%) after an average of 2 cycles of systemic chemotherapy. 2 eyes required enucleation because of relapse in noncavitary tumors. Germline mutations were detected in 14 patients (82%), of whom 4 demonstrated mosaicism (29%).

Because of its retrospective nature this study does not include pretreatment and posttreatment measurements of the cavities in CRb, and immunohistochemistry on the 2 enucleated eyes could not be performed. Only tumors with cavities that were superficially visible on presentation or became unmasked after chemotherapy were included, and OCT scanning may help to detect deeper cavities in future studies. Nevertheless, it appears that CRbs remain stable and do not require aggressive adjuvant therapy. There is no evident phenotype-genotype correlation.

Use of Femoral Artery Ultrasound During Intraarterial Chemotherapy for Children under 10 Kg with Retinoblastoma

This retrospective, consecutive, observational case series included infants <10 kg with retinoblastoma treated with intraarterial chemotherapy (IAC) to demonstrate safety and efficacy in this population. 59 injections were administered to 11 eyes of 6 patients. Femoral arterial access was obtained using a micropuncture kit and ultrasound guidance to allow direct visualization. Melphalan, topotecan, and/or carboplatin were administered, and patients underwent adjuvant therapies including laser, cryotherapy, and intravitreal melphalan if persistent disease or recurrence was observed. All eyes but one were classified as International Classification Groups C or D. Median patient weight at first IAC cycle was 9.2 kg (mean 8.9 kg). Mean diameter of the femoral artery at the catheterization site was 3.74 mm, and median follow-up was 21.4 months. All eyes were salvaged.

Although this study had a relatively small sample size, retinoblastoma is rare, and retinoblastoma patients under 10 kg at the time of their first IAC are even rarer. The use of ultrasound guidance for femoral artery access enhanced safety in this study. In addition, all but one study patient received 4 or fewer IAC sessions per eye, suggesting that younger patients with immature tumors may respond better to IAC than their older counterparts.

**NON-RETINOBLASTOMA**

Results of external beam radiotherapy for diffuse choroidal hemangiomas in Sturge-Weber syndrome.

Authors did a retrospective study to evaluated the results following external beam radiotherapy (EBRT) (20 Gy in 10 fractions) for an exudative diffuse choroidal hemangioma. Twenty-five patients (26 eyes) with retinal detachment including the macula were included. Average follow-up time was 47 months. The mean tumor thickness (4.5 mm) decreased almost 50% (2.8 mm) at first year with stability (2.7 mm) at the last visit. All except 2 patients had retinal reattachment. Authors conclude that ERBT not only can preserve visual acuity but in the long term may prevent phthisis bulbi from chronic retinal detachment.

**20. ORBIT**
Comparison of optic canal Diameter in Children with Malignant Osteopetrosis and Normal Children and the effects of Hematopoietic Stem Cell Transplantation on the Optic Canal Diameter.


The purpose of this study is to investigate the difference in the optic canal diameter between children with autosomal recessive malignant infantile osteopetrosis and normal children, and to assess the influence of hematopoietic stem cell transplantation (HSCT) on the optic canal diameter. Twenty pediatric patients with malignant infantile osteopetrosis and 22 normal control children were included in this study. Eleven patients with malignant infantile osteopetrosis underwent hematopoietic stem cell transplantation. The measurements included optical canal diameter and flash visual evoked potential. Comparisons of these measurements between patients with malignant infantile osteopetrosis and normal controls as well as before and after hematopoietic stem cell transplantation were performed. The correlation between age and optic canal diameter was analyzed using Pearson correlation analysis. The study showed that the mean optic canal diameter before hematopoietic stem cell transplantation was 1.65 ± 0.54 mm in patients with malignant infantile osteopetrosis and 3.38 ± 0.60 mm in the control group (P < .001). The mean optic canal diameter after hematopoietic stem cell transplantation was 2.72 ± 0.66 mm, which was significantly different from the pre-transplantation measurement (P < .001). The P2 latency for the flash visual evoked potential after hematopoietic stem cell transplantation (152.3 ± 36.4 ms) was significantly less than that before transplantation (165.5 ± 27.7 ms; P = .051). Pearson correlation analysis revealed a significant correlation between age and optic canal diameter (r = 0.722, P < .001). The authors concluded that the optic canal in patients with malignant infantile osteopetrosis is significantly narrower than that in normal children, and successful HSCT can relieve the progressive optic canal stenosis and control the deterioration of visual function impairment. Early HSCT is associated with favorable prognosis. Orbital 3DCT reconstruction and visual electrophysiological examination are effective methods for assessing the optic nerve damage in malignant infantile osteopetrosis and also helpful in the evaluation of the optic nerve before and after transplantation.

Radiographic Course of Medically Managed Pediatric Orbital Subperiosteal Abscesses.


The purpose of this retrospective case review was to describe the natural radiographic course of subperiosteal orbital abscesses that were managed medically in pediatric patients. Out of the 418 patients identified as having orbital cellulitis or subperiosteal abscess, 15 patients had repeat imaging and did not undergo
surgery prior to the second scan. The initial size of the empyema, size of the empyema on repeat imaging, and clinical course were recorded for each patient. The study showed that the size of the empyemas increased 240% on average in the first 2 to 3 days. Imaging up to 11 days after the diagnosis showed that 9 cases persisted; meanwhile, 4 cases had radiographic resolution, with the earliest by 21 days. Two cases recurred months later. The largest increase in size was 500% over 3 days, but the initial empyema was only 0.3 cm³. The results suggest a time between 11 and 21 days, but the sample size was limited. However, children who are improving clinically are rarely reimaged because there is no indication for a follow-up study and radiation exposure should be limited. The authors conclude that the natural radiographic course of medically managed subperiosteal empyemas in children includes initial enlargement for 2 to 3 days prior to radiographic resolution over 2 to 3 weeks. Interpretation of the size of the empyema should not guide management but, in the face of repeat imaging, this study can provide context for a normal radiographic course. Limitations of this study are the small sample size and its retrospective nature. The small sample size was a result of two factors: the frequency of surgical intervention and the infrequent nature of repeat imaging; only 15 of 418 patients had repeat imaging on our review. The retrospective nature of the study predisposes the series to a selection bias. Naturally, cases with clinical resolution would rarely undergo repeat imaging, whereas cases with a worsened clinical picture would be more likely to prompt repeat imaging. Similarly, this may explain the large proportion of cases that went on to eventual surgical management. Only one case with persistence on imaging was managed only medically.

Optical coherence tomography Thickness Measurements of the Extraocular Rectus Muscle Tendons in Graves’ Ophthalmopathy


The purpose of this cross-sectional observational study is to examine the extraocular muscle tendons in patients with Graves’ ophthalmolopathy using optical coherence tomography (OCT). Fifty five healthy control, forty five patients with inactive clinically Graves’ ophthalmopathy, and twelve patients with clinically active disease were enrolled. Scanning was performed at 3 and 9 o’clock position. The medial rectus tendon thickness was measured at 7.2 mm and 9.2 mm from the limbus and the lateral rectus tendon thickness was measured at 8.5 and 10.00 mm from the limbus. The study showed that the 9.2-mm medial rectus, 8.5-mm lateral rectus, and 10.5-mm lateral rectus tendons were thicker in the inactive Graves' ophthalmopathy group than the control group (240 ± 70, 231 ± 63, and 228 ± 54 µm vs 201 ± 71, 199 ± 53, and 200 ± 32 µm, respectively; \( P \leq .011 \)), whereas the 8.5-mm lateral rectus and 9.2-mm medial rectus tendons were thicker in patients with active Graves' ophthalmopathy than patients with inactive Graves' ophthalmopathy (274 ± 77 and 283 ± 68 µm vs 231 ± 63 and 240 ± 70 µm, respectively; \( P \leq .048 \)). A correlation was detected between lateral
rectus and medial rectus tendon thicknesses and the Graves' ophthalmopathy clinical activity score ($R = 0.252, P = .035$; and $R = 0.291, P = .013$, respectively. The authors concluded that OCT is an accurate method for measuring medial rectus and lateral rectus tendon thicknesses in patients with Graves' ophthalmopathy. The imaging tool was able to detect thicker horizontal rectus tendons in patients with inactive Graves' ophthalmopathy than in controls, and in patients with active compared to inactive disease. The study has several limitations. OCT allows visualization of the anterior part of the muscle but not of the muscle belly, making it especially difficult to examine in patients with motility restrictions. The vertical rectus muscles are also difficult to examine because of interference from the eyelids and motility restrictions, mainly in the inferior rectus. In addition, because muscle insertion distances vary between individuals, the muscle measurement points used here may not have been equivalent. Future studies are needed to explore the inferior rectus in patients with Graves' ophthalmopathy because it is the most affected extraocular muscle, and also to compare OCT findings with MRI findings. Further limitations of our study were the relatively small number of patients with active Graves' ophthalmopathy, and the fact that the posterior portion of the lateral rectus could be measured only in a few cases. Accordingly, studies including larger patient populations are needed to confirm the results of the current study.

Embryologic and Fetal Development of the Human Orbit

This paper aimed to review the recent data about orbital development and sort out the controversies from the very early stages during embryonic life till final maturation of the orbit late in fetal life, and to appreciate the morphogenesis of all the definitive structures in the orbit in a methodical and timely fashion. The authors extensively review major studies detailing every aspect of human embryologic and fetal orbital morphogenesis including the development of extraocular muscles, orbital fat, vessels, nerves, and the supportive connective tissue framework as well as bone. These interdisciplinary studies span almost a century and a half, and include some significant controversial opposing points of view which the authors hopefully sort out. The authors also highlight a few of the most noteworthy molecular biologic studies regarding the multiple and interacting signaling pathways involved in regulating normal orbital morphogenesis. Orbital morphogenesis involves a successive series of subtle yet tightly regulated morphogenetic events that could only be explained through the chronological narrative used by the authors. The processes that trigger and contribute to the formation of the orbits are complex and seem to be intricately regulated by multifaceted interactions and bidirectional crosstalk between a multitude of cellular building raw materials including the developing optic vesicles, neuroectoderm, cranial neural crest cells and mesoderm. Development of the orbit is a collective enterprise necessitating interactions between, as well as contributions from different cell populations both within and beyond the realm of the orbit. A basic under-
standing of the processes underlying orbital ontogenesis is a crucial first step toward establishing a genetic basis or an embryologic link with orbital disease.

**Extraocular Muscle Enlargement and Thyroid Eye Disease-like Orbital Inflammation Associated with Immune Checkpoint Inhibitor Therapy in Cancer Patients**


The goal of the paper to describe thyroid eye disease (TED)-like orbital inflammatory syndrome in 3 cancer patients treated with immune checkpoint inhibitors. All consecutive patients treated by the senior author who were receiving immune checkpoint inhibitors and developed TED-like orbital inflammation were included. Three cancer patients treated with immune checkpoint inhibitors developed orbital inflammation. The first patient was treated with a combination of a cytotoxic T-lymphocyte antigen-4 inhibitor and a programmed cell death protein 1 inhibitor and developed TED-like orbital inflammation with normal thyroid function and antibody levels. The second patient had a previous diagnosis of Graves disease without TED, and developed TED soon after initiating treatment with a programmed cell death protein 1 inhibitor. The third patient developed acute hyperthyroidism with symptomatic TED following treatment with an investigational cytotoxic T-lymphocyte antigen-4 inhibitor agent. All 3 patients were managed with either systemic steroids or observation, with resolution of their symptoms and without the need to halt immune checkpoint inhibitor treatment for their cancer. TED-like orbital inflammation may occur as a side effect of immune checkpoint inhibitor therapy with anti–cytotoxic T-lymphocyte antigen-4 or anti-PD-1 inhibitors. To the best of their knowledge, this is the first reported case of TED as a result of programmed cell death protein 1 inhibitor monotherapy. All 3 patients were treated with systemic steroids and responded quickly while continuing treatment with immune checkpoint inhibitors for their cancer. With increasing use of this class of drugs, clinicians should be familiar with the clinical manifestations and treatments for this adverse reaction.

**Efficacy of Propranolol Between 6 and 12 Months of Age in High-Risk Infantile Hemangioma**

Eulalia Baselga, Bozenna Dembowska-Baginska, Przemyslaw Przewratil et. al *Pediatrics* September 2018; 142 (3): e20173866.

Infantile hemangiomas (IHs) are benign vascular tumors with an estimated prevalence of 4-5% of children with 24% of these individuals experiencing complications (ulcerations, vision loss, and airway obstruction). A multi-center trial in Spain and Poland was conducted for infants ranging from 35 to 150 days with high-risk IH in the proliferative phase to determine the success and side effects of oral propranolol. High risk IHs were defined as those that were life-
threatening, at risk for functional impact, or ulcerated hemangiomas nonresponsive to standard wound care measures. The babies were treated for 6 months with 3 mg/kg per day of oral propranolol. If success had been achieved, then the propranolol was stopped and observation began. If there was re-growth of the IH, then treatment was re-initiated. If there was no success at 6 months, then treatment was continued for a total of 12 months before stopping medication. Success was defined as resolution of target IH (IH disappearance with minimal degree of telangiectasias, erythema, skin thickening, soft tissue swelling, and/or palpable component) and absence of functional impact (using Hemangioma Severity and Hemangioma Dynamic Complication scales). 45 patients were enrolled in the study. The success rate after 6 months was 47% and increased to 76% at one year. Of the patients that achieved success, 24% required retreatment. Adverse events occurred in 80% of children which included 13 treatment-emergent serious adverse events. The authors do not attribute the propranolol usage only to some of the documented infectious illnesses but 18% of the children experienced bradycardia which was most likely associated with the propranolol. None of these bradycardic children required new medications or termination of propranolol. The primary limitation of the study is the lack of a control group. In conclusion, treatment of high risk IH with 3 mg/kg per day of propranolol is an efficacious treatment modality with a satisfactory safety profile.

Clinico-radiological features and treatment outcomes in children with traumatic orbital subperiosteal hematoma

The goal of this paper was to look at the clinical findings, imaging features, and treatment outcomes in children diagnosed with traumatic orbital subperiosteal hematoma (OspH). The study involved 10 children who had a history of blunt trauma (mean age, 6.8 years; 8 males). The medical records of eligible OSpH children treated either via needle aspiration or open surgical drainage were reviewed retrospectively. Three anatomical factors (inferior globe displacement, superior orbital sulcus fullness, extraocular movements) and two functional parameters (visual acuity, pupillary reactions) were used to determine overall success. All included patients had a history of blunt trauma, unilateral presentation, inferior globe displacement, fullness of superior orbital sulcus, and raised retrobulbar resistance. Diminution of vision and restricted elevation was noted in 7 children, and 4 had a relative afferent pupillary defect. Computed tomography (CT) revealed superior OSpH in all 10 children and, additionally, orbital wall fracture in 4. Needle aspiration of the OSpH was performed in 8 children; 2 underwent open surgical drainage. At a mean follow-up of 8.5 months, all children showed satisfactory improvement in both anatomical and functional parameters: 1 child had a persistent nebulomacular corneal opacity, and 1 had minimal upper eyelid edema. The authors confirmed that the most significant anatomic factor contributing to OSpH is the presence of subperiosteal space, which is why the superior quadrant of the orbit is the most common location for OSpH. A high index of suspicion, appropriate radiology (CT of orbits), and early management
through needle aspiration of OSpH may help in early intervention and therefore to increase satisfactory anatomical and functional outcomes.

**Orbital fractures in children: clinical features and management outcomes**

This paper's purpose was to report the clinical characteristics and management outcomes of orbital fractures in children. The medical records of pediatric patients (<18 years of age) who presented with orbital fractures over a 15-year period (January 2001-December 2015) were reviewed retrospectively. The cause of injury, imaging findings, clinical features, management, and outcomes were noted. A total of 52 patients (39 males) were included in this study. Mean age at presentation was 10.9 years (range, 2-18). Road traffic accidents (18/52 [35%]) were the most common cause of the fractures with sports being the second most common cause, with the orbital floor (42/52 [81%]) being the most common fracture site with frequency occurring then in the medial, lateral, and roof in that order. The most common complaint in the patients was double vision (52%). Most patients were managed conservatively, however thirty-eight patients underwent surgical intervention, and extraocular muscle entrapment (56%) was the most common indication for surgery. Early surgical intervention within 15 days of injury resulted in complete resolution of diplopia in all the patients underwent surgery in this time frame. The authors conclude that orbital floor fracture was most common. The trapdoor type of fracture was seen in almost half of the patients, with diplopia being the most common presenting complaint. Early surgical intervention (within 15 days) was associated with complete resolution of ocular motility limitation and diplopia.

**Pediatric Orbital Primitive Neuroectodermal Tumors**

The purpose of this retrospective study is to present the clinical, radiological, histopathological, immunohistochemical features and the follow-up of orbital primitive neuroectodermal tumors (PNETs) in pediatric patients along with a review of the literature. Patients' demographic characteristics, ophthalmic findings, imaging, immunohistochemistry, metastatic work-up, treatment, globe salvation, and survival were documented and a mini literature review of orbital PNET was done. Complete remission, partial remission, and progression were diagnosed according to the Response Evaluation Criteria In Solid Tumors (RECIST) criteria. Four diagnosed cases of orbital PNET presented with proptosis and visual impairment were treated during the study period. The radiological imaging showed primary orbital involvement. There were three males and one female with a mean age of 63.75 months (range: 3 to 244 months). Histopathology of all studied patients showed round malignant cells with hyperchromatic nuclei, increased nuclear cytoplasmic ratio, and positive test results for CD99 and FLI-1. The studied patients
underwent orbital surgery for excision of tumors followed by chemotherapy. One of the patients also had external radiation in addition to chemotherapy after a second recurrence. The follow-up period of these patients varied from 1 to 5 years. Only one child who had recurrence twice was followed up to 5 years, but was lost to follow-up after that. The authors believe that most orbital peripheral PNET tumors present as well-defined masses on both imaging and perioperatively and are easily removed surgically. The apparently disguised "benign profile" of orbital PNET may prove deceptive and the shorter duration of symptoms remains a strong reminder of the malignant nature of the lesion.

**Orbital infantile hemangioma and rhabdomyosarcoma in children: differentiation using diffusion-weighted magnetic resonance imaging**


This study evaluated differences in magnetic resonance imaging (MRI) appearance between infantile hemangiomas and rhabdomyosarcomas of the orbit in pediatric patients using diffusion-weighted imaging. A multicenter retrospective review of MRIs of pediatric patients with infantile hemangiomas and rhabdomyosarcomas of the orbit was performed. MRI examinations from a total of 21 patients with infantile hemangiomas and 12 patients with rhabdomyosarcomas of the orbit were independently reviewed by two subspecialty board-certified neuroradiologists masked to the diagnosis. A freehand region of interest was placed in the mass to obtain the mean apparent diffusion coefficient (ADC) value of the mass as well as within the medulla to obtain a ratio of the ADC mass to the medulla; the medulla was chosen as an internal reference because it is reproducibly identified on MRI, it provides a precise location, and because its ADC value would be less affected by changes in myelination in children. A t test was used to compare mean ADC and ADC ratios between the two groups. Receiver operating characteristic analysis was performed to determine ADC value and ADC ratio thresholds for differentiation of infantile hemangioma and rhabdomyosarcoma. There was a statistically significant difference in the mean ADC value of infantile hemangiomas compared to rhabdomyosarcomas with the ADC value of rhabdomyosarcomas being significantly lower (1527 × 10^-6 mm²/s vs 782 × 10^-6 mm²/s; P = 0.0001) and the ADC ratio of the lesion to the medulla (1.77 vs 0.92; P = 0.0001). An ADC threshold of <1159 × 10^-6 mm²/sec and an ADC ratio of <1.38 differentiated rhabdomyosarcoma from infantile hemangioma (sensitivity 100% and 100%; specificity 100% and 100%) with area under the curve of 1.0 and 1.0, respectively. The study concludes that conjunction with conventional MRI sequences, ADC values obtained from diffusion-weighted MRI may be useful to differentiate orbital infantile hemangiomas from rhabdomyosarcomas in pediatric patients. This study was a small study and future studies with larger patient numbers will be helpful.
Intravenous Steroids With Antibiotics on Admission for Children With Orbital Cellulitis

This prospective comparative interventional study compared the outcomes of children with orbital cellulitis treated with intravenous (IV) dexamethasone and antibiotics on admission to patients treated with antibiotics alone. The study looked at forty-three children admitted to a tertiary institution with orbital cellulitis. On admission, all patients were started on broad spectrum IV antibiotics and parents were offered IV dexamethasone (0.3 mg/kg/d every 6 hours for 3 days). Patients whose parents refused steroid treatment served as the control group. Twenty-eight (65%) patients received IV steroids and antibiotics on admission while 15 (35%) received IV antibiotics alone. Children who received IV steroids had significantly shorter hospital stays than those who did not receive steroids (3.8 ± 0.2 days vs. 6.7 ± 0.3 days; p < 0.001). This was true both for children who underwent surgery for subperiosteal abscess (5/28 with steroids, 3/15 without; 5.0 ± 0.7 days vs. 7.3 ± 1.2 days; p = 0.011) and for those who did not require surgical intervention (23/28 with steroids, 12/15 without; 3.6 ± 0.6 and 6.5 ± 1.0 days; p < 0.001). Side effects of steroid treatment were considered mild (hyperactivity and insomnia) and did not require termination of therapy. Children who received steroids had a shorter hospital stay than those who did not. During follow up, all study patients had returned to their baseline health without any cases of decreased vision or disease recurrence. The results of the current study give additional evidence to the relative safety and efficacy of systemic steroid use concurrently with IV antibiotics in children with orbital cellulitis. This is the first study to recommend IV steroids on hospital admission and a standardized dosing regimen.

Lateral Rectus Muscle Expands More Than Medial Rectus Following Maximal Deep Balanced Orbital Decompression

It has been reported that extraocular muscles can enlarge following orbital decompression in thyroid eye disease. In this article, the authors studied the changes in extraocular muscles size following maximal deep lateral and medial balanced decompression in a large sample of thyroid eye disease patients. Imaging data were reviewed preoperatively and postoperatively 48 consecutive patients (75 orbits). Radiologic proptosis was assessed. Maximal axial muscle width of the medial and lateral recti was measured. Results: Data from 48 consecutive patients (75 orbits) were included. There was a significant increase in the width of both the lateral and medial recti after decompression (p < 0.01). The mean (standard deviation [SD]) change was less for the medial rectus (0.7 mm) than for the lateral (2.7 mm). This difference was significant (p < 0.01). For the lateral
rectus, 80% of all decompression surgeries were associated with an increase in width of >1 mm. Mean (SD) proptosis reduction was 8.2 mm (3.4 mm). These results suggest that the extraocular muscles enlarge in the most deep lateral wall decompressions. The authors postulate that the expanded muscles may be in a relatively stretched position preoperatively and with postoperative changes in globe position and the resultant altered vector pathway of the muscle, the central belly may appear more greatly expanded. In conclusion, for decompression as performed in this article, expansion tends to be more commonly found and of a greater magnitude in the lateral rectus compared with medial.

Combined Oral and Topical Beta Blockers for the Treatment of Early Proliferative Superficial Periocular Infantile Capillary Hemangioma.

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The purpose of this randomized, controlled comparison trial is to evaluate the safety and efficacy of combined oral and topical beta blockers for the treatment of superficial periocular infantile hemangioma at the early proliferative stage. Patients were randomly enrolled into two groups: the topical and systemic treatment and systemic treatment only groups. The topical and systemic treatment group was treated with oral propranolol (1 mg/kg per day initially, increased to 2 mg/kg per day gradually in 2 weeks) and timolol maleate 0.5% gel. The systemic treatment only group received oral propranolol (1 mg/kg per day initially, increased to 2 mg/kg per day gradually in 2 weeks) and simple eye ointment to be applied to the lesion. The Hemangioma Activity Score was used to record the proliferative activity of the hemangioma. The main outcomes of the study were the change in the hemangioma size, the proliferative activity, and the treatment side effects. At the end of the treatment period, the Hemangioma Activity Score was significantly improved in both groups from their values before treatment. However, the score obtained after treatment was significantly better in the topical and systemic treatment group (*P* < .05). Regarding the response to treatment, 10 and 3 cases in the topical and systemic treatment and systemic treatment only groups, respectively, showed a good response, with a significant difference between the two groups (*P* < .50). There were no recorded serious local or systemic complications during treatment in either group. The results from combining topical with oral beta blockers showed that topical beta blockers are of additive value in treating superficial periocular infantile hemangioma in the early proliferative stage. The limitations of this study included the small number of patients and the short follow-up period.
Efficacy of Office-Based Nasolacrimal Duct Probing.

Austin Bach, Elizabeth Ann Vanner, Roberto Warman. JPOS 2019;56(1):50-54

The purpose of this study is to analyze the efficacy of nasolacrimal duct probing conducted in the office for nasolacrimal duct obstruction. A retrospective chart review was conducted of 1,294 patients. Of those, 1,227 patients who underwent office-based nasolacrimal probing of the nasolacrimal duct at a single tertiary care center were included. A total of 82 (6.7%) patients needed reprobing. Of the 82 patients who underwent a second procedure, 35 (43%) underwent a second in-office probing with a success rate of 77%. The 8 (22%) patients who failed the second in-office probing underwent probing and Crawford stent placement in the operating room and their symptoms resolved. For the 47 (57%) patients who failed the primary in-office probing and underwent operating room probing and stent placement, only 1 (2%) needed a second operating room probing and stent placement. Logistic regression analyses indicated an increased likelihood of needing a secondary procedure with increased age at the time of the first probing. Our results showed an overall 93.3% success rate of first in-office probing and a success rate of 77% for a repeat in-office probing. We have also shown an 88.8% success rate for in-office probings for patients older than 12 months. These results are at the upper end of successful treatment when looking at both in-office probings and probings in the operating room for patients of any age in prior studies. This review of in-office probings shows the efficacy of a minimally invasive procedure on all children younger than 24 months. With proper training of staff, nasolacrimal duct obstruction can be treated quickly and safely in the office. This will save time and money for the family, ophthalmologist and his or her staff, and the insurance companies, both public and private. The study has multiple limitations: some of the patients were not observed for more than one or two follow-up appointments after the in-office probing. The failure rate only included those patients without resolution of symptoms who underwent a secondary probing performed by the same pediatric ophthalmology group and it may have missed patients who went elsewhere for further treatment. The statistics may then include patients who failed probing but went elsewhere for further treatment or who spontaneously resolved months after probing. Also, because the logistic regression analyses do not show the strongest correlation between increasing age and need for reprobing, there are likely other factors that need to be understood that were not addressed in this study. Because the data were de-identified, the logistic regression could not account for possible correlation between the bilateral probings of a single patient, but because these were only 20 of the 1,227 total probings, this is unlikely materially to affect the results.

Association between congenital nasolacrimal duct obstruction and mode of delivery at birth.

The purpose of this retrospective study was to investigate the association between mode of delivery, incidence of congenital nasolacrimal duct obstruction (CNLDO), and treatment outcomes. A total of 104 children diagnosed with CNLDO at a tertiary referral center between 2012 and 2017 were included. Patient demographics, pregnancy and birth history, clinical characteristics of CNLDO, and treatment outcomes were compared in patients delivered via cesarean section (CS) versus vaginal delivery (VD). The rates of CS, as well as full-term and premature births, were also compared to Miami-Dade County normative values to eliminate the confounding effects of prematurity. A significantly higher percentage of patients with CNLDO (61%) were delivered via CS (P < 0.0001). The authors state that among full-term babies, there was 55% greater risk (OR = 1.55; 95% CI, 0.98-2.43; P = 0.067) of CNLDO for CS birth compared to all other babies. However, this is not statistically significant. Among preterm babies, there were no significantly greater odds of CNLDO for CS compared to VD births (P = 0.575). CNLDO did not resolve spontaneously in 50 patients, including 37 CS (74%) and 13 VD (26%) patients (P = 0.007). Among those patients who failed first-line probing, 86.2% were born via CS, whereas 13.8% were born via VD (P = 0.0009). The authors concluded that CS is a risk factor for CNLDO, independent of gestational age. Children born via CS also tend to have a more complicated clinical course requiring additional surgical interventions. Despite some misinterpretations this study highlights an interesting observation.

Congenital dacryocystocele: sonographic evaluation of 11 cases.


The purpose of this retrospective case series was to describe the prenatal sonographic findings of congenital dacryocystocele. Eleven cases of congenital dacryocystocele diagnosed at a tertiary care center from 2003 to 2015 were included. No accompanying fetal anatomic anomalies were detected. Mean maternal age at evaluation was 22 years of age (range, 17-32 years). Four cases were primigravidas. The mean gestational age at evaluation was 32.6 weeks' gestational age (range, 27.2-37.4 weeks). Ten out of 11 cases occurred in female fetuses (91%). Ten cases were unilateral and 1 was bilateral. The mean diameter at evaluation was 5.1 mm (range 1-14/2 mm). Spontaneous resolution occurred in 2 cases (18%). In the remaining 9 fetuses, postnatal diagnosis of dacryocystocele were confirmed by an ophthalmological evaluation. The authors concluded that prenatally diagnosed congenital dacryocystocele may undergo spontaneous resolution before birth; However, referral to a pediatrician and pediatric ophthalmologist should be considered for complete evaluation and postnatal management. The article concentrates mainly on the prenatal diagnosis of
 dacryocystocele and would probably be more of interest to fetal-maternal-medicine physicians. It discusses nicely the approach and possible differential diagnosis of cystic lesions near the orbit.

Balloon Dacryoplasty for Congenital Nasolacrimal Duct Obstruction: A Report by the American Academy of Ophthalmology: Ophthalmic Technology Assessment

Balloon dacryoplasty has emerged as a popular option to address recalcitrant nasolacrimal duct obstructions. This technique involves passing a lubricated, inflatable balloon along a guide wire into the nasolacrimal duct and through the level of obstruction. The balloon is then inflated for 90 seconds to dilate the obstruction, deflated, and reinflated a second time, or removed. The goal of this study was to determine the efficacy and adverse events of balloon dacryoplasty. A literature search was last performed in September 2017 in the PubMed database to identify all reports of balloon dacryoplasty. All searches up to and including the last search were limited to the English language, and they yielded 104 articles that were assessed for relevancy. Thirty-six articles were selected for full review, and 8 of these were selected for inclusion in this assessment and assigned a quality of evidence rating by the panel methodologist. Three of the 8 studies included in this assessment were rated level II, and 5 were rated level III. Success rates varied from 75% to 100%. Only 2 complications were identified, and these were cases of self-limited postoperative emesis. The 2 studies that compared balloon dacryoplasty with lacrimal stenting reported that outcomes were comparable between the 2 techniques. Although level I evidence was not available, the studies that were included in the literature review indicate that balloon dacryoplasty is a safe, effective procedure to address congenital nasolacrimal duct obstruction that persists after standard probings. The outcomes of this intervention are similar to those of lacrimal stenting, and the absence of an implanted stent theoretically reduces the risk of complications. This review did not examine the age at initial probing or balloon dacryoplasty. The optimal time for balloon dacryoplasty is also not addressed. It is important to note that there was no level 1 evidence in the literature for this review.

Spontaneous Resolution and Timing of Intervention in Congenital Nasolacrimal Duct Obstruction.


This study was a retrospective medical chart review of a large cohort of 1998 consecutive infants diagnosed with congenital nasolacrimal duct obstruction
(CNLDO) from 1995 through 2004 at Mayo Clinic in Rochester, MN regarding the gender and the rate of spontaneous resolution of CNLDO. This cohort had a mean age of diagnosis at 1.2 months and 48% were girls and 89% white. Of the 1998 pediatric cases, 1669 (83.5%) spontaneously resolved, 289 (14.5%) underwent treatment, and the remaining 40 (2.0%) children were lost to follow up. By three months old, nearly half (47.3%) had spontaneously resolved and by 9 months old, 75.7% had spontaneously resolved and 78.4% had spontaneously resolved by 12 months old. Of note, CNLDO resolved in boys 0.5 months faster than girls and unilateral resolved 0.2 months faster than bilateral CNLDO. Regarding resolution after NLD probing, children probed at 15 months or older had decreased odds of resolution (odds ratio, 0.11, 95% CI, P=.04) compared to children with NLD probing between 12 to 14 months old. Limitations of this study include the retrospective analysis of medical records over 20 years in Olmstead county of a semiurban white population. The authors suggest that the rate of spontaneous resolution of CNLDO tends to plateau after 9 months of age and successful NLD probing declines after 15 months old, and therefore, it is reasonable to perform NLD probing between 9 to 12 months old. In comparison to the current general practice of probing for CNLDO after 12 months of age, the authors present a narrower and earlier time frame for consideration of surgical intervention in children with CNLDO.

Revision Surgery for Undercorrected Blepharoptosis After Frontalis Sling Operation Using Autogenous Fascia Lata
Ju-Hyang Lee, Kyung In Woo, and Yoon-Duck Kim


Undercorrected blepharoptosis can be encountered after frontalis sling operation. Revision surgery for undercorrection has commonly involved introducing a new sling material. We describe and evaluate a simple surgical technique to correct undercorrection by adjusting preexisting fascia. This is a retrospective interventional case series of patients undergoing sling revision between February 2010 and February 2017. Skin incision was made on the previous incision line. Careful dissection was performed superiorly to identify a preexisting fascia, and the dissected fascia was reattached to the tarsal plate using nonabsorbable sutures with adjustments for eyelid height and contour. The success of the procedure was defined as less than 1 mm of difference in the marginal reflex distance 1 of both eyes without any contour deformity. Twenty-one eyelids in 18 patients were included with a mean follow-up of 17.5 months (range 6–48) and a mean age of 14.7 years (range 5–57). All patients had undergone frontalis sling with autogenous fascia lata for congenital ptosis. Undercorrection due to recurrent ptosis was found in 12 eyelids, and contour deformity such as temporal ptosis was found in 9 eyelids. The mean time interval between previous frontalis sling operation and sling revision was 6.8 years. Nineteen patients (90.5%) achieved surgical success and a cosmetically acceptable appearance. Sling revision is a simple and effective method with low perioperative morbidity for cases of undercor-
rection or contour deformity following frontalis sling operation using autogenous fascia lata, even long after the primary procedure.

**Improving Outcomes of Posterior Approach Levatorpexy for Congenital Ptosis With Reduced Levator Function**


The authors present a new series of our experience using posterior approach levatorpexy for congenital ptosis with poorer levator function (LF) in comparison with our first published report. This technique avoids a skin incision or any resection in addition to no excision of tissue. A consecutive series of 16 patients was subject to a retrospective review of levatorpexy for congenital ptosis. Data included eyelid margin reflex distance 1, pretarsal show, contour, and complications, including nocturnal lagophthalmos, eyelid lag on downgaze, and dry eye. Surgery was considered successful if the following 4 criteria were simultaneously met: a postoperative margin reflex distance 1 of $\geq 2$ mm and $\leq 4.5$ mm, intereyelid height asymmetry of $\leq 1$ mm, no overcorrection compare to opposite eye, and satisfactory eyelid contour. Mean age was 10.3 years (range 1–26 years). Mean LF was 7.3 mm (2–14 mm), while 66% (12) had LF $\leq 7$ mm. Preoperative phenylephrine test was positive in 87.5% of patients. Mean preoperative and postoperative margin reflex distance 1 was 1.34 mm and 3.2 mm, respectively. Fourteen patients (87%) achieved the desired eyelid height and fulfilled our criteria set of success. Among 10 patients with LF $\leq 7$ mm, 9 (90%) achieved the desired eyelid height and fulfilled our criteria set of success. Ninety-four percent did not report nocturnal lagophthalmos. Three patients needed a further levatorpexy procedure due to undercorrection. Mean postoperative follow up was up 11.2 (range 6–36) months. Posterior approach levatorpexy is an useful first-line choice for congenital ptosis for all ranges of LF. It is popular among parents due to its avoidance of a skin incision or any resection or excision of tissue.

**Symmetry of Upper Eyelid Contour After Unilateral Blepharoptosis Repair With a Single-strip Frontalis Suspension Technique**

Patricia Akaishi, Alicia Galindo-Ferreiro, and Antonio A. V. Cruz

*Ophthal Plast Reconstr Surg* Sep/Oct 2018;34:436–439

The goal of the paper was to analyze the upper eyelid contour of patients with unilateral congenital ptosis who underwent single-strip frontalis suspension. The authors compared the upper eyelid shape of the right and left eyes of 10 patients who underwent unilateral frontalis suspension with a single strip of autogenous fascia. At a mean postoperative time of 10.1 ± 4.01 months, the image J software was used to measure the ratio between the nasal and temporal areas of the upper half of the palpebral fissure. The midpupil upper eyelid distance (MRD1) was also measured on the photos with the same software. The nonparametric Wil-
coxon signed-rank test was used to compare the data. Postoperative MRD1 ranged from 2.5 to 4.7 mm (median = 3.8) on the affected side. The MRD1 for nonoperated eyelid ranged from 1.8 to 5.0 mm (median = 3.5). On the operated side, the temporal areas ranged from 50.3 to 85.7 mm² (median 65.2) and nasal areas ranged from 41.5 to 72.3 (the median was 60.1). In the contralateral, non-operated palpebral fissures, the temporal areas ranged from 42.7 to 94.3 mm² (median = 54.5) and the nasal areas ranged from 36.8 to 86.1 mm² (median 52.3). The T/N ratio distributions were almost identical between groups, ranging from 0.9 to 1.2 (median = 1.1) in the operated eyes and from 0.9 to 1.3 (median = 1.1) in the fellow eyes. In autogenous fascia frontalis suspension procedures, the upper eyelid contour of the ptotic eyelids can be adequately normalized with a single area of traction on the tarsal plate.

Ophthalmic Pyogenic Granulomas Treated With Topical Timolol—Clinical Features of 17 Cases

Topical timolol has been increasingly demonstrated to be an effective treatment for pyogenic granulomas (PG). The authors review the treatment outcomes of 17 patients with ocular PG treated with topical timolol. Retrospective interventional study of 17 patients with ocular PGs treated with timolol 0.5% solution. Patient demographics, clinical features, treatment response, and recurrence were noted. Nine females and 8 males with a mean age of 23 years (range, 3–67 years) were included. Mean duration of disease prior to treatment was 3.81 months (range, 0.25–11 months). Etiologies included chalazia (12 cases, 71%), postsurgical (4, 24%) and trauma (1, 6%). Five patients (29%) had treatment with topical steroids prior to presentation. Fifteen patients (88%) had PG located on the palpebral conjunctiva and 2 (12%) involving the bulbar conjunctiva. Mean lesion size was 5.06 × 6.06 mm (range, 3–8 × 3–18 mm). Fifteen patients (88%) had complete lesion resolution with a mean treatment duration of 3.07 weeks (range, 2–5 weeks) and no adverse events or recurrences with a mean follow up of 9.47 months (range, 6–27 months). Two patients (12%) underwent lesion excision after 6 weeks of timolol failed to yield resolution. Topical timolol appears to be a well-tolerated nonsurgical treatment of ocular PG in both children and adults. Clinicians may wish to consider topical timolol to treat PG as opposed to topical steroids, given the inherent risk of steroid response ocular hypertension and the difficulty to measure intraocular pressure in younger children who require general anesthesia for excision.

Frontalis Muscle Flap Versus Maximal Anterior Levator Resection as First Option for Patients With Severe Congenital Ptosis
Ramón Medel, Salvador Molina, Luz Maria Vasquez, Josep Visa, et al.

The paper aimed to compare 2 surgical techniques (frontalis flap versus maximal anterior levator resection) as first surgical options for the treatment of congenital ptosis with poor levator function in patients younger than 2 years of age with a follow up of 10 years. This was a retrospective study of 58 patients (71 eyelids) with severe ptosis and poor levator function who underwent frontalis muscle flap (FMF = 47) or maximal anterior levator resection (ALR = 24) for correction of their ptosis. Eyelid measurements were taken at baseline, 1, 5, and 10 years after surgery. The presence of complications, need for reoperations, and palpebral contour were evaluated. Most patients in both groups required only one surgical procedure with a stable average margin-reflex distance 1 over the 10-year follow-up period in both groups, with no statistically significant difference between the 2 techniques in achieving an adequate palpebral height after one single procedure. Eleven eyelids treated with FMF (23%) and 12 treated with ALR (50%) needed a reoperation, with a statistically significant difference between the 2 techniques. Five ALR patients (21%) and 6 FMF patients (13%) had alterations of eyelid contour. Pop-eyelid and eyelash ptosis were observed in 8% of patients operated with FMF. Good functional and aesthetic results were obtained with both surgical techniques. FMF required fewer reoperations compared with maximal ALR, offering a better long-term result without residual ptosis.

Current Management of Childhood Ptosis
Daniel T. Weaver Curr Opin Opthalmol 2018, 29:395-400

Ptosis in the pediatric population has an incidence of 7.9/100,000 children. Most often it is congenital and unilateral as well as isolated but it can occur in association with syndromes. It is classified into four subtypes: aponeurotic- usually due to trauma, myogenic- usually due to primary levator muscle dysgenesis, neurogenic- such as Horner’s syndrome or myasthenia, and mechanical- due to a mass in the orbit or upper eyelid. Preoperative evaluation should include the assessment of the MRD, photographic documentation, measurement of the palpebral fissure before and after surgery as well as levator function. Surgical timing is dictated by the presence of amblyogenic ptosis which usually dictates repair prior to 6 months of age. The timing of nonamblyogenic ptosis is controversial. One study found that repair in children aged 2-4 was associated with no recurrence compared to 22% in other age groups. Techniques for repair include Müller’s muscle resection for Horner’s syndrome and mild cases of congenital ptosis. Levator muscle resection is usually performed in patients with moderate levator muscle function and mild-moderate ptosis. Maximal levator resection and frontalis suspension can be used in patients with poor levator function but an lead to overcorrection or corneal exposure. Materials used for frontalis suspension include sutures, as well as silicone rods, and fascia lata. Newer techniques such as the double rhomboid and two point suspension have been studied and various configurations for the sling have been suggested.
The paper discusses the timing and techniques for ptosis repair in children and reviews different techniques for repair with particular attention paid to frontalis suspension.

Perioperative use of intravenous dexamethasone in the management of congenital nasolacrimal duct obstruction with balloon dacryoplasty

This paper's purpose is to evaluate the effect of perioperative dexamethasone, presumed to reduce edema, on the success rate of nasolacrimal duct obstruction (NLDO) treatment by balloon dacryoplasty. The medical records of patients treated for NLDO using balloon dacryoplasty were reviewed retrospectively. Infants with <6 months' follow-up, genetic diseases, prior NLDO surgery, or anomalous nasolacrimal duct system were excluded. Patients either received intravenous dexamethasone perioperatively at a dose of 0.50 mg/kg (steroid group) or no dexamethasone (control group). Surgery was considered successful if there was no tearing or mucus discharge 1 month after surgery. A total of 74 patients were included in this study. In 71 eyes of 61 patients, dexamethasone was used; in 18 eyes of 13 patients, no dexamethasone was used. The mean age at treatment was 23.3 ± 15.6 months for the steroid group and was 22.5 ± 14.9 for the control group, with no difference between groups (P = 0.84). In the steroid group, 6 eyes (8.5%) had residual symptoms after surgery; in the control group 5 eyes (27.8%) had residual symptoms after surgery. There was a statistically significant higher success rate in the steroid group compared with the control group (P = 0.045; RR = 0.31 [95% CI, 0.11-0.9]). In this study cohort, use of perioperative dexamethasone was associated with a reduced rate of failure in children treated for NLDO using balloon dacryoplasty.

Long-term outcomes after cosmetic customized prostheses and dermis fat graft in congenital anophthalmia: a retrospective multicenter study.

This study evaluated the long-term outcomes of progressively enlarging cosmetic customized prostheses (CCP). Patients were treated early after birth followed by dermis fat graft (DFG). Twenty-two patients were included. All patients underwent CCP at the time of their first assessment, then was enlarged and subsequently underwent DFG. Authors analyzed the differences in vertical palpebral aperture (VPA) and horizontal palpebral length (HPL). Satisfaction with cosmetic results, prosthetic retention, and complications rate were assessed. Magnetic resonance imaging of the orbit was performed in all patients before and after surgery. Both the VPA and
HPL differences significantly decreased by 47.6% (10.5 mm, range 1-28 mm) and by 7.1% (5.8 mm, range 0-18 mm), respectively. Cosmetic outcomes proved to be very positive. Excellent retention of prostheses was observed in all cases. Authors concluded that early CCP and further DFG proved to be a valuable approach in children with CCA.

Congenital Nasolacrimal Duct Obstruction and Its Association With the Mode of Birth.
Mansha Palo, Shweta Gupta, Millind N.Naik, Mohammad Javed Ali
JPOS.2018; 55(4): 266-268

The purpose of this prospective interventional case series is to assess the association of congenital nasolacrimal duct obstruction (CNLDO) with mode of birth (vaginal or cesarean). Data from two hundred consecutive cases of CNLDO were analyzed including demographics, mode of delivery, elective or emergency cesarean section, primary or secondary cesarean sections, type of CNLDO (simple or complex), management and outcomes. Of the 200 consecutive patients, 97 (48.5%) were vaginal deliveries and 103 (51.5%) were cesarean sections. Of the 103 cesarean section patients, 57 (55.3%) were primary cesarean sections and the remaining were secondary cesarean sections. Based on the type of CNLDO, 172 (86%) were simple CNLDO. In general, the current study did not find any significant association between the incidence of CNLDO and mode of delivery. Among the complex CNLDO cohort (n = 28), a significant association was found with cesarean section delivery ($P$ = .016); however, no such association was noted when the patients were analyzed with regard to their age at presentation. The authors conclude that there is no overall significant association between CNLDO and the mode of delivery; however, the subset of patients with complex CNLDO showed a significant association with cesarean section. This study has several limitations such as lack of comparison with the general population and a smaller sample size within certain subgroups.

Pediatric Frontalis Suspension With Braided Polyester: A comparison of Two Techniques.
Andrea Molinari, Daniel T.Weaver, Todd A. Goldblum, David Silbert et al
JPOS.2018; 55(4):229-233

The purpose of this retrospective, non-randomized study is to demonstrate the benefits of using braided polyester in the management of severe or recurrent ptosis in children and young adults and to compare the efficacy of the two surgical techniques. The records of 30 patients (43 eyelid procedures) affected by congenital or acquired severe ptosis who underwent frontalis suspension with braided polyester from 2008 to 2016 were reviewed. Two surgical techniques were compared: the base-down triangle and the Fox pentagon, both of which were performed using a closed technique. Functional success was defined as
clearing of the visual axis. Complications and results were examined including over/under corrections, granuloma formation, and localized cellulitis. The postoperative effectiveness of braided polyester in elevating the upper eyelid was evaluated by determining the eyelid fissure height, the MRD1, and the recurrence of ptosis. Functional success was defined as clearing of the central visual axis resulting in a postoperative MRD1 of at least 1mm without chin-up position. The study showed that functional success was obtained in 39 eyes of 43 procedures. Marginal reflex distance increased an average of 2.51 mm with the base-down triangle technique and 1.70 mm with the Fox pentagon technique ($P = .05$). The vertical palpebral fissure height increased an average of 4.60 mm with the base-down triangle technique and 2.45 mm with the Fox pentagon technique ($P < .001$). Mean follow-up duration was 38.6 months. Complications included untied suture (n = 2), suture dehiscence (n = 1), cellulitis (n = 2), and granuloma (n = 1). The authors concluded that Braided polyester was found to be a safe, effective, easy-to-handle, and low-cost sling material for frontalis suspension and should be considered for clinical use, especially in developing countries where the cost and availability of other materials represents a significant barrier to treatment. In the authors’ experience, the base-down triangle technique appeared superior to the Fox pentagon technique. Weakness of the current study included retrospective nature, non-masked observers, and different surgeons. Although ptosis etiology was different in all cases, levator function was uniformly poor. Delayed undercorrection could also potentially occur with more prolonged follow-up.

**Double rhomboid Suture Technique for Congenital Ptosis.**

Austin Bach, Marcos Snachez-Gonzalez, Roberto Warman

*J POS.2018; 55(2): 117-121*

The purpose of this retrospective chart review was to evaluate the reoperation and complication rates of the double rhomboid suture technique for congenital ptosis. Records of 69 patients who were operated on between 2002 and 2016 were reviewed. All patients received the same operation of a double rhomboid frontalis sling using a 1-0 Supramid (S. Jackson, Inc., Alexandria, VA) (nylon) suture on patients 36 months of age and older and a 3-0 Supramid suture on patients younger than 36 months. The 3-0 suture on a Ski needle was used instead of a Wright needle because the 3-0 suture is preloaded on the Ski needle. Four patients were excluded due to missing information in their charts and 27 patients were excluded due to having less than 6 months of follow-up. For patients with more than 6 months of follow-up, there were 38 patients with 46 primary surgeries (22 [58%] males and 16 [42%] females). The average age at the first surgery was 39.34 ± 33.18 months. There was a mean follow-up time of 51.87 ± 53.79 months. There were 7 children who needed one revision and 1 child who needed a second revision, equaling a 23.9% rate of revision. Patients who had surgery before the age of 3 years had a statistically significant likelihood of needing a second surgery (chi-square test = 7.246, $P = .007$, 95% confidence
interval = 0.027 to 0.687). It was also statistically significant ($P < .05$) that, throughout childhood, older patients were less likely to need a revision. The authors conclude that the double rhomboid frontalis sling using a nylon suture is an effective technique to treat congenital ptosis. This technique is easy to master and has a low cost compared to techniques involving autografts and allografts. The authors also suggest that it is important to advise the family of the likelihood of a second surgery if there is a need to operate at a young age. This study is limited by its retrospective nature.

Nonsurgical correction of epiblepharon using hyaluronic acid gel.

The purpose of this retrospective study was to report a single-center experience with non-surgical correction of epiblepharon using hyaluronic acid gel. A total of eight consecutive patients (10 eyes) (7 girls [88%]) with symptomatic epiblepharon treated over a 3-year period with hyaluronic acid gel injection were included. Hyaluronic acid gel was injected transcutaneously into the suborbicularis plane to obliterate the abnormal skin fold or evert the eyelid margin. Successful treatment was defined as eversion of the eyelid margin as assessed by lash-cornea touch. Average age at presentation was 16.5 months (range, 1-72 months). Of 10 eyelids, 8 had a distinct skin fold with a "valley" above it. Nine of 10 eyelids had lash-cornea touch in the primary gaze; 1 in downgaze. All 10 eyes had punctate corneal epitheliopathy on fluorescein staining. An average of 0.19 ml (range, 0.1-0.3 ml) of hyaluronic acid gel was injected per eyelid. After injection, 9 of 10 eyelids showed no lash-cornea touch in downgaze, and all 10 eyelids showed resolution of symptoms and epitheliopathy. Patients remained symptom-free for an average final follow-up of 19.1 months (range, 5-42 months). No procedure-related complications were noted. The authors concluded that in their small case series, transcutaneous hyaluronic acid gel injection into the lower eyelid effectively corrected symptomatic epiblepharon; the effect was long lasting. An interesting approach to treating symptomatic epiblepharon, nevertheless due to its small sample size its safety and efficacy might not be fully appreciated.

Ocular Manifestations, Complications and Management of Congenital Ichthyoses: A New Look.

Congenital ichthyoses (CI) are rare genetic skin keratinization diseases characterized by generalized scaling and a variable degree of erythema and hyperkeratosis. Both syndromic and non-syndromic ichthyosis invariably have associated ocular abnormalities. These are varied, but usually involve the eyelids, conjuncti-
va and cornea. Ectropion with accompanied dry eye and exposure keratopathy, is a major concern, particularly in special situations such as collodion babies at birth. To date, there are no specific treatments for the ichthyoses; moreover, there are no international guidelines or consensus for the symptomatic management. Ophthalmic input should include regular slit lamp review with the primary aim to prevent a corneal epithelial defect, secondary bacterial infection, scarring or perforation. This review comprises a comprehensive update on the ocular manifestations, complications and management of ichthyoses.

**Simultaneous Versus Sequential Ptosis and Strabismus Surgery in Children**


*Ophthal Plast Reconstr Surg* 2018;34:280–283

The authors sought to compare the clinical outcomes of simultaneous versus sequential ptosis and strabismus surgery in children in a retrospective, single-center cohort study of children requiring both ptosis and strabismus surgery on the same eye. This is the first comparative study of simultaneous versus sequential ptosis and strabismus surgery. Simultaneous surgeries were performed during a single anesthetic event; sequential surgeries were performed at least 7 weeks apart. Outcomes were ptosis surgery success (margin reflex distance 1 ≥ 2 mm, good eyelid contour, and good eyelid crease); strabismus surgery success (ocular alignment within 10 prism diopters of orthophoria and/or improved head position); surgical complications; and reoperations. Fifty-six children were studied. The majority of patients had simple congenital ptosis and comitant strabismus. Of these patients, 38 had simultaneous surgery and 18 sequential. Strabismus surgery was performed first in 38/38 simultaneous and 6/18 sequential cases. Mean age at first surgery was 64 months, with mean follow up 27 months. A total of 75% of children had congenital ptosis; 64% had comitant strabismus. The majority of ptosis surgeries were frontalis sling (59%) or Fasanella-Servat (30%) procedures. There were no significant differences between simultaneous and sequential groups with regards to surgical success rates, complications, or reoperations (all p > 0.28). The authors conclude that no advantage for sequential surgery was seen. Despite a theoretical risk of postoperative eyelid malposition or complications when surgeries were performed in a combined manner, the rate of such outcomes was not increased with simultaneous surgeries. As a result, the authors feel that performing ptosis and strabismus surgery together appears to be clinically effective and safe, and reduces anesthesia exposure during childhood.

**Ophthalmic Manifestations of Facial Dog Bites in Children**


This retrospective study characterizes the ophthalmic manifestations and periocular injuries of pediatric facial dog bites. The authors report the clinical features
and management on the largest series of ophthalmic and periocular injuries associated with pediatric facial dog bites. These injuries occur in about 1 in 6 dog bites to the face and primarily involve the ocular adnexa. The study included all children younger than 18 years who sought medical attention after a dog bite to the face between January 1, 2003 and May 22, 2014 at a large tertiary pediatric hospital. A total of 1,989 children aged 0.19 to 17 years who had dog bites were identified. The average age was 4.3 years. Dog bites to the face occurred in most patients (n = 1,414 [71%]). Of those children with facial dog bite injuries, 230 (16%) suffered ophthalmic manifestations. Eyelid injuries occurred in 227 (99%) of children, 47 (20%) sustained canalicular system injuries, 3 (1.3%) suffered corneal abrasions, and 2 patients sustained facial nerve injury resulting in lagophthalmos. No patients suffered vision loss. Complications occurred in 32 patients (14%), with the most common being epiphora in 9 patients (28%), upper eyelid ptosis in 8 (25%), and prominent scar formation in 4 patients (13%). Thirteen children (5.7%) needed one or more secondary procedure to correct complications. The incidence of infection was also high at 11.8% with the majority of these patients requiring intravenous antibiotics and hospitalization. In summary, despite early and appropriate surgical management in pediatric facial dog bites, complications and the need for revision surgery are relatively common.

**22. INFECTIONS**

**Randomized, Controlled, Phase 2 Trial of Povidone-Iodine/Dexamethasone Ophthalmic Suspension for Treatment of Adenoviral Conjunctivitis**


The authors of this multicenter, randomized, vehicle-controlled, double-masked trial aimed to evaluate the efficacy and safety of a 0.6% povidone-iodine (PVP-I) and 0.1% dexamethasone suspension in patients with acute adenoviral conjunctivitis. Adults with a positive rapid adenovirus screening test were randomized to PVP-I 0.6%/dexamethasone 0.1%, PVP-I 0.6% alone, or vehicle, bilaterally, four times per day for 5 days. Patients were examined on days 3, 6, and 12 with the end points of clinical resolution and adenoviral eradication. The authors found that the proportion of eyes with adenoviral eradication at day 3 and day 6 were higher in the PVP-I/dexamethasone group than in the other two groups. Additionally, the PVP-I/dexamethasone group had a higher proportion of clinical resolution at day 6 than the other two groups (31.3% vs. 10.9 % (vehicle) and 18.0% (PVP-I)). The authors concluded that the PVP-I/dexamethasone treatment was safe and improved eradication of the adenovirus and clinical resolution. They discussed that the drop tolerability was as good in the PVP-I dexamethasone group compared to the vehicle group. And one of the major limitations...
of this study is that it was only tested on adults (though included here because it certainly is relevant to the pediatric ophthalmologist).

Neurodevelopment in Infants Exposed to Zika Virus In Utero.


182 pregnant women with confirmed Zika virus were recruited for a prospective study; their babies were followed longitudinally until age 12-18 months, when they underwent neuroimaging, eye and hearing evaluations, and developmental assessments using the Bayley scale. Abnormal findings on neuroimaging were found in 37%. Among children with abnormal findings on brain imaging, 7 of 112 (6%) had an abnormal eye examination and 6 of 49 (12%) had an abnormal hearing assessment. Among 131 children who were exposed to Zika virus in utero and who underwent imaging, neurodevelopmental assessment, sensory organ assessment, or all of these tests, 19 (14%) were found to have severe neurodevelopmental delay (2 SD below the mean score), sensory organ dysfunction, or both. The corollary is perhaps surprising, in that the majority of infants exposed to Zika virus in utero actually fared okay, without severe neurodevelopmental delay, ocular abnormalities or hearing loss.

Eye Findings in Infants with Suspected or Confirmed Antenatal Zika Virus Exposure

Irene Tsui, Maria Elisabeth Lopes Moreira, Julia D. Rossetto et al. *Pediatrics* October 2018; 142(4); e20181104

Because of the difficulty in obtaining viral confirmatory testing for Zika virus in pregnant women, the authors wanted to compare ophthalmic findings in patients with known Zika virus with those suspected Zika virus. This information could be used to guide screening recommendations in areas that commonly see patients exposed to Zika virus. After the ZIKA outbreak in Rio de Janeiro in 2015-2016, pediatric ophthalmologists performed complete eye examinations between 2016-2017 on infants known to have Zika exposure and those suspected of it. The five unique features of Zika virus syndrome include 1) severe microcephaly with partially collapsed skull, (2) thin cerebral cortices with subcortical calcifications, (3) macular scarring and focal pigmentary retinal mottling, (4) congenital contractures, and (5) marked early hypertonia and symptoms of extrapyramidal involvement. Two pediatric ophthalmologists examined each infant and were blinded to the RT-PCR results confirming or not confirming the diagnosis of Zika. If there was a discrepancy of the grading of their ophthalmologic findings, a third ophthalmologist evaluated the infants. There were 224 mother-infant pairs with 189 having RT-PCR testing of which 82.5% were positive for the Zika virus and 68 pairs who were diagnosed based on clinical findings. 21.8% of the RT-PCR-positive group and 38.2% of the unconfirmed RT-PCR group had ocular abnor-
malities. Of the 224 infants, 19.6% had optic nerve abnormalities and 16.5% had retinal findings (chorioretinal atrophy or pigment mottling). Uncommon ocular findings included microcornea, iris coloboma, ON coloboma, microphthalmia, retinal vessel attenuation, and optic atrophy. 52% of infants had repeat testing and there was no evidence of worsening, ongoing activity or regression of ophthalmic lesions. Of the 224 evaluable infants, 40.2% had CNS abnormalities including microcephaly. Eye abnormalities were found in 54.4% of the patients with CNS abnormalities suggesting that there may be a correlation between ophthalmic and neurologic changes. The RT-PCR positive group and the RT-PCR unconfirmed group differed in their frequency of eye abnormalities and CNS abnormalities; with higher incidence of eye findings observed in the suspected, laboratory unconfirmed group. This difference likely reflects the referral pattern with more affected infants in the RT-PCR unconfirmed group being referred for findings consistent with ZIKA virus. Given the findings of the study, the authors highly recommend universal newborn eye screening in infants with potential antenatal ZIKV exposure. The early identification of eye abnormalities will facilitate early low-vision interventions to improve visual function and outcomes in these children.

Visual function in infants with antenatal Zika virus exposure

Zin A, Tsui I, Rosetto JD, Gaw SL, et al. JAAPPOS. Dec 2018;22(6):452-456.e1

The purpose of this paper is to report the findings of a cross-sectional study of visual function in infants with confirmed or suspected antenatal Zika virus (ZIKV) infection seen at a single referral center in Rio de Janeiro. Infants were examined following the ZIKV outbreak period at Instituto Fernandes Figueirra/FIOCRUZ. Visual function was considered abnormal if an infant could not fix and follow a standardized high-contrast target (10 cm) by 3-6 months of age. Visual function and associations with structural eye abnormalities, central nervous system (CNS) abnormalities, microcephaly, and nystagmus were assessed. Sensitivity and specificity of screening criteria for structural eye abnormalities was assessed. A total of 173 infants met inclusion criteria for this study. 85 (49.1%) of the infants had abnormal CNS findings. Abnormal visual function was found in 52 infants (30.0%) and was significantly associated with eye abnormalities (40/52; OR = 44.2; 95% CI, 16.6-117.6), CNS abnormalities (50/52; OR = 64.0; 95% CI, 14.7-277.6), microcephaly (44/52; OR = 31.5; 95% CI, 12.7-77.8), and nystagmus (26/52; OR = 120.0; 95% CI, 15.6-924.5). Using microcephaly as screening criteria for the detection of eye abnormalities provided a sensitivity of 88.9% (95% CI, 76.0-96.3) and specificity of 82.8% (95% CI, 75.1-88.9). Using both abnormal visual function and microcephaly increased sensitivity to 100% (95% CI, 92.1-100.0) and decreased specificity to 80.5% (95% CI, 72.5-86.9). The authors recommend that infants with suspected antenatal ZIKV infection and reduced visual function should be referred to an ophthalmologist.
The authors conclude that visual function assessments are helpful in screening for antenatal ZIKV exposure in resource-limited settings and can identify infants who may benefit from visual habilitation.

**Resistant Infantile Bacterial Conjunctivitis in Egypt: A microbiology Study.**

The purpose of this study is to investigate the microbiological aspects of infantile bacterial conjunctivitis resistant to empirical topical antibiotic therapy in Egypt. Ninety-two eyes of 86 infants with bacterial conjunctivitis were included in this prospective study. They all failed to show evidence of clinical improvement after 2 weeks of empirical topical antibiotic therapy. Conjunctival swabs were obtained from all patients for bacterial culture and antibiotic sensitivity testing. The age of the participants ranged from 4 to 6 months. Culture results revealed infection with a solitary organism in 48.9% of eyes. Mixed bacterial growth was reported in 47.8% of eyes, whereas 3.3% of eyes showed no bacterial growth. The most commonly isolated organisms were Staphylococcus aureus, Streptococcus pneumoniae, and Pseudomonas aeruginosa. These organisms were highly sensitive to fluoroquinolones (levofloxacin, ciprofloxacin, ofloxacin, and norfloxacin), followed by chloramphenicol, vancomycin, and amikacin, and were resistant to carbapenems (imipenem and meropenem), fusidic acid, and pipracillin. According to the results of antibiotic sensitivity found in this study, it is recommended to change the current empirical antibiotic eye drops used in infantile conjunctivitis in Egypt from tobramycin or fusidic acid to other agents such as chloramphenicol, which is safe, inexpensive, readily available, and more effective. These results also provide strong evidence that fluoroquinolones can be reserved for resistant cases of bacterial conjunctivitis as long as other safe and effective agents are available.

**Visual impairment evaluation in 119 children with congenital Zika syndrome.**

The purpose of the prospective observational study was to assess the visual function of a large sample of infants with congenital Zika syndrome (CZS) and to compare it with healthy controls using the same assessment protocol. A total of 119 infants with confirmed diagnosis of CZS were recruited. A total of 85 healthy infants matched for age, sex, and socioeconomic status were enrolled as controls. All infants underwent comprehensive ophthalmologic evaluation including visual acuity, visual function assessment, and visual developmental milestones. At examination, the mean age of the CZS group was 8.5 ± 1.2 months (range, 6-13 months); of the controls, 8.4 ± 1.8 months (range, 5-12 months; P = 0.598). Binocular Teller
Acuity Card (TAC) testing was abnormal in 107 CZS infants and in 4 controls (89.9% versus 5% [P < 0.001]). In the study group, abnormal monocular TAC results were more frequent in eyes with funduscopic alterations (P = 0.008); however, 104 of 123 structurally normal eyes (84.6%) also presented with abnormal TAC results. Binocular contrast sensitivity was reduced in 87 of 107 CZS infants and in 8 of 80 controls (81.3% versus 10% [P < 0.001]). Infants with CZS did not achieve the expected visual developmental milestones compared to controls (P < 0.001). The authors concluded that infants with CZS present with severe visual impairment. A protocol for assessment of the ocular findings, visual acuity, and visual developmental milestones tested against age-matched controls is suggested. Despite some limitations with study design and group composition, the study contributes to our understanding of the visual impairment in infants with CZS, which is essential for optimizing early intervention strategies.

Azithromycin to Reduce Childhood Mortality in Sub-Saharan Africa.


The authors had previously observed that Ethiopian communities receiving azithromycin for trachoma control had lower childhood mortality rates. The authors hypothesized that mass distribution of a broad-spectrum antibiotic to preschool children would reduce mortality in areas of sub-Saharan Africa. In this cluster-randomized trial, they assigned communities in Malawi, Niger, and Tanzania to four twice-yearly mass distributions of either oral azithromycin or placebo. These were communities which would otherwise not have received azithromycin for trachoma control. Children 1 to 59 months of age were identified in twice-yearly censuses and were offered participation in the trial. Vital status was determined at subsequent censuses. The primary outcome was aggregate all-cause mortality; country-specific rates were assessed in prespecified subgroup analyses.

A total of 1533 communities underwent randomization, 190,238 children were identified in the census at baseline, and 323,302 person-years were monitored. The mean (±SD) azithromycin and placebo coverage over the four twice-yearly distributions was 90.4±10.4%. The overall annual mortality rate was 14.6 deaths per 1000 person-years in communities that received azithromycin (9.1 in Malawi, 22.5 in Niger, and 5.4 in Tanzania) and 16.5 deaths per 1000 person-years in communities that received placebo (9.6 in Malawi, 27.5 in Niger, and 5.5 in Tanzania). Mortality was 13.5% lower overall (95% confidence interval [CI], 6.7 to 19.8) in communities that received azithromycin than in communities that received placebo (P<0.001); the rate was 5.7% lower in Malawi (95% CI, −9.7 to 18.9), 18.1% lower in Niger (95% CI, 10.0 to 25.5), and 3.4% lower in Tanzania (95% CI, −21.2 to 23.0). Children in the age group of 1 to 5 months had the greatest effect from azithromycin (24.9% lower mortality than that with placebo; 95% CI, 10.6 to 37.0).
The authors conclude that among postneonatal preschool children in sub-Saharan Africa, childhood mortality was lower in communities randomly assigned to mass distribution of azithromycin than in those assigned to placebo, with the largest effect seen in Niger. Studies regarding why mortality was lower – was it due to decrease in malaria, diarrheal disease or respiratory disease, are ongoing. Evaluation of selection for antibiotic resistance is also ongoing. This is a ground-breaking study showing how an ophthalmological intervention goes on to reduce childhood mortality. It is reminiscent of the studies on vitamin A supplementation in curing corneal blindness, but also, with dietary measures and measles vaccination, reducing childhood mortality. This study also shakes one of the basic tenets of public health: do not give antibiotic indiscriminately. The authors caution that any implementation of a policy of mass antibiotic distribution would need to strongly consider the potential effect of such a strategy on antibiotic resistance.

23.PEDIATRICS/ INFANTILE DISEASE/ SYNDROMES

Ocular manifestations of Marfan syndrome in children and adolescents.

The authors performed a retrospective comparative cohort study to compare ocular findings in 52 patients with confirmed Marfan syndrome versus controls to clarify the salient ocular findings in this condition. Primary findings included flatter cornea, higher astigmatism, thinner central cornea, and higher myopia than controls. Patients with Marfan syndrome had transillumination defects in 19.6% of patients and ectopia lentis was defected in 49% of patients. This study serves to further highlight eye findings in children with Marfan syndrome.

The Phenotypic Spectrum of Albinism.

This retrospective cohort study aims to describe the phenotypic spectrum of a large cohort of albino patients, to investigate the relationship between the ocular abnormalities and the visual acuity (VA), and to define diagnostic criteria for the white population. The authors also estimated the prevalence of albinism in The Netherlands. They investigated the phenotype of 522 patients with albinism from the databases of Bartiméus (452 patients), Leiden University Medical Center (44 patients), and the Academic Medical Center Amsterdam (26 patients). Collected data included clinical, genetic, and electrophysiologic data of patients.
with albinism. Grading schemes for iris translucency, fundus hypopigmentation, and foveal hypoplasia were utilized. The main outcome measures were visual acuity, nystagmus, iris translucency, fundus pigmentation, foveal hypoplasia, and misrouting.

Nystagmus was absent in 7.7% (40/521), iris translucency could not be detected in 8.9% (44/492), 3.8% (19/496) had completely normal fundus pigmentation, 0.7% (3/455) had no foveal hypoplasia, and misrouting was not established in 16.1% (49/304). The VA varied from -0.1 to 1.3 logarithm of the minimum of angle of resolution (logMAR). The foveal hypoplasia grading correlated best with the VA (r = 0.69, P < 0.001), whereas iris translucency, fundus pigmentation, and misrouting did not predict the VA significantly. The authors estimated a prevalence of albinism in The Netherlands of at least 1:12,000.

The authors conclude that none of the characteristics of albinism were consistently present in this cohort. To be able to distinguish albinism from other conditions with similar ocular features, especially in northern and western European countries, they propose major and minor clinical criteria. Major criteria would be (1) foveal hypoplasia grade 2 or more, (2) misrouting, and (3) ocular hypopigmentation, either iris translucency or fundus hypopigmentation grade 2 or more. Minor criteria would be (1) nystagmus, (2) hypopigmentation of skin and hair, (3) grade 1 fundus hypopigmentation, and (4) foveal hypoplasia grade 1. They propose that 3 major criteria or 2 major and 2 minor criteria are necessary for the diagnosis. In the presence of a molecular diagnosis, 1 major criterion or 2 minor criteria will be sufficient.

Joubert Syndrome: Ophthalmological Findings in Correlation with Genotype and Hepatorenal Disease in 99 Patients Prospectively Evaluated at a Single Center


Ocular involvement in Joubert Syndrome (JS) varies from mild to severe, often depending on genetic cause; sometimes, variability can be noted even within the same genotype. Ocular involvement can be developmental (e.g., coloboma) or degenerative (e.g., retinal dystrophy). This variability makes it difficult to predict the functional visual trajectory for individual patients. This study describes the varying ocular phenotypes in JS patients, with correlation to systemic findings and genotype. All patients were systematically and prospectively examined at the National Institutes of Health (NIH) Clinical Center in the setting of a dedicated natural history clinical trial. All ninety-nine patients underwent genotyping for JS, followed by complete age-appropriate ophthalmic examinations. Color and fundus autofluorescence imaging, Optos wide-field photography (Dunfermline, Scotland, UK), and electroretinography (ERG) were performed when possible. The VA (with longitudinal follow-up where possible), ptosis, extraocular muscle function, retinal and optic nerve status, and retinal function as measured by ERG.
Among patients with JS with quantifiable VA (68/99), values ranged from 0 logarithm of the minimum angle of resolution (logMAR) (Snellen 20/20) to 1.5 logMAR (Snellen 20/632). Strabismus (71/98), nystagmus (66/99), oculomotor apraxia (60/77), ptosis (30/98), coloboma (28/99), retinal degeneration (20/83), and optic nerve atrophy (8/86) were identified. Based on the findings, the authors recommend regular monitoring for ophthalmological manifestations of JS beginning soon after birth or diagnosis. We demonstrate delayed visual development and note that the amblyogenic time frame may last significantly longer in JS than is typical. In general, patients with coloboma were less likely to display retinal degeneration, and those with retinal degeneration did not have coloboma. Severe retinal degeneration that is early and aggressive is seen in disease caused by specific genes, such as CEP290- and AHI1-associated JS. Retinal degeneration in INPP5E-, MKS1-, and NPHP1-associated JS was generally milder. Finally, ptosis surgery can be helpful in a subset of patients with JS; decisions as to timing and benefit/risk ratio need to be made on an individual basis according to expert consultation. Because this study required a week-long, on-site evaluation, this may had led to sampling bias toward families who were able to make accommodation. Very severely affected JS patients, who require intensive care, including as mechanical ventilation, may be under represented in this study.

Adrenal Suppression in Infants Treated with Topical Ocular Glucocorticoids

Increasingly, clinical evidence suggests that the any treatment with glucocorticoids (GC) may suppress adrenal function and cause Cushing's syndrome irrespective of administration route. Adrenal suppression after topical ocular GCs is not well documented. The main objective of the study was to analyze the incidence of adrenal suppression and the glucocorticoid (GC) dose per kilogram body weight in infants treated with standard protocol for topical ophthalmic GCs after congenital cataract surgery. The authors analyzed retrospectively collected data from patients younger than 2 years of age who underwent operation for congenital cataract between January 2011 and May 2015 in a single center. Standard regimen after cataract surgery was subconjunctival injection at the time of surgery 0.5 to 1.0 mL methylprednisolone acetate 40 mg/ml (Depo-Medrol, Pfizer, Belgium). This was followed by topical administration of dexamethasone 1 mg/ml (Maxidex, Alcon, UK) eye drops 6-8 x/day for the first week, then 4 to 6 drops for the second week then tapering by one drop per week, hence up to 6 weeks of administration of drops. A standard ACTH provocation test was scheduled approximately 1 month post-operatively whenever possible. Among 26 consecutive infants, 15 (58%) were tested while they were still on GC treatment. Ten of these 15 infants (67%) had adrenal suppression, 2 of whom had obvious clinical signs of Cushing's syndrome and 1 of whom had signs of Addisonian crises during general anesthesia. Eleven of the 26 infants (42%) were tested at a median time of 21 days (range, 6–89) after treatment cessation, and
they all had normal test results. Infants with suppressed adrenal function had received cumulative GC doses per body weight that were significantly higher the last 5 days before testing compared with children with normal test results. Infants with adrenal suppression were treated with hydrocortisone replacement therapy. Adrenal function recovered after a median of 3.1 months (range, 2.3 months to 2.3 years). In conclusion two thirds of the infants tested during treatment with a standard GC protocol after congenital cataract surgery showed adrenal suppression. There was a significant association between the cumulative daily dose of GCs and the test result. Because adrenal suppression is a serious but treatable condition, the authors recommend a systematic assessment of adrenal function in infants treated with doses of topical ocular GCs comparable to our regimen and careful evaluations of other treatment regimens.

**The Major Causes of Death in Children and Adolescents in the United States.**

Cunningham R.M., Walton M.A., and Carter P.M.

This epidemiological report based on 2016 CDC data provides the top causes of death for children and adolescents ages 1-19 years in the United States. Motor vehicle crashes are the leading cause of death, representing 20% of all deaths, followed by firearm injuries (homicide>suicide>unintentional) at 15%, and malignant neoplasms at 9%. Leading causes of death vary by age: drowning for children age 1 to 4 years, malignant neoplasm for children ages 5 to 9 years, and motor vehicle crashes for children ages 10 to 19 years. The leading childhood causes of death in 1900 were infectious diseases: pneumonia, tuberculosis and diarrhea or enteritis, but in 2016 none of these are among the 10 leading causes of childhood mortality.

From 1999 to the present, the major decline in childhood death is due to a decrease of approximately 40% in motor vehicle crash related deaths, attributed to widespread adoption of seat belts, child safety seats, improved vehicle safety standards, better constructed roads, graduated driver licensing programs, and reduced teen drinking and driving. Unfortunately, there is a reversal in this trend in 2013 to 2016, possibly related to texting and driving, or marijuana use and driving.

The report also provides comparisons, such as the sobering one that childhood firearm deaths are 36.5 times higher in the United States than other high income countries. Motor vehicle deaths are also higher in the United States compared to other high income countries; deaths from malignant neoplasm are no better. The urban/suburban/rural comparison is notable for many more deadly motor vehicle crashes in rural areas compared to urban areas, even when controlling for miles
driven. Males have a higher rate of death compared to females, with the disparity widening with increasing age. With regard to ethnicity and race, mortality is highest among blacks, followed by Native Americans, then whites, then Asians or Pacific Islanders.

We pediatric ophthalmologists should be aware of the leading causes of mortality for children and support the American Academy of Pediatrics and other groups in advocating for public health measures to reduce them.

**Macular and Retinal Nerve Fibre Layer Thinning in Xeroderma Pigmentosum: A Cross-sectional Study**

Anna M. Gruener and Ana M. S. Morley *Neuroophth* Dec 2018, 42(6), 356–366

The purpose of this study was to evaluate retinal thickness in different Xeroderma Pigmentosum (XP) complementation groups using spectral-domain optical coherence tomography (SD-OCT). This was a cross-sectional pilot study of 40 patients with XP. All patients had healthy-looking retinas and optic nerves on slit lamp biomicroscopy, and subtle or no neurological deficits. Patients were divided into two groups based on the known tendency for neurodegeneration associated with certain XP complementation groups. A third control group was obtained from a normative database. Using SD-OCT, we compared peripapillary retinal nerve fibre layer (pRNFL) and macular thickness between the groups. XP patients with a known tendency for neurodegeneration were found to have a statistically significant reduction in both pRNFL (p < 0.01) and macular thickness (p < 0.001) compared with healthy controls. In contrast, there was no statistically significant difference between pRNFL and macular thickness in XP patients not expected to develop neurodegeneration compared to the same control group. When both XP groups were compared, a statistically significant reduction in total pRNFL (p = 0.02) and macular thickness (p = 0.002) was found in XP patients predisposed to neurodegeneration. Our results suggest that pRNFL and macular thickness are reduced in XP patients with a known tendency for neurodegeneration, even before any marked neurological deficits become manifest. These findings demonstrate the potential role of retinal thickness as an anatomic biomarker and prognostic indicator for XP neurodegeneration.

**Functional and cognitive vision assessment in children with autism spectrum disorder**


This paper’s goal is to assess functional vision in children with autism spectrum disorder (ASD) with a cognitive visual function battery in addition to standard ophthalmic examinations. For this study, subjects were recruited from a school for children with ASD. In addition to a comprehensive ophthalmic examination, all children underwent cognitive vision assessment at a tertiary ophthalmological care center in India. A total of 30 children were included in the study. The distri-
bution of the number of children with mild to moderate versus severe ASD was nearly equal based on CARS autism scores. The majority of subjects had normal color vision (16/18), contrast (24), shape discrimination (26), and perception of directionality (28). Most were not able to identify optical illusions or differentiate tests of emotions. Ocular pursuits, saccades, and recognition of size differences were often abnormal. Poor visual closure was noted in (11) subjects. The duration of fixation to Heidi face target was inversely proportional to the severity of ASD. The study further established that cognitive visual impairment was present in children with ASD irrespective of their severity of ASD. In examining autism patients, it is important that many of these patients will have some form of cognitive visual impairment independent of ASD severity.

Changes in refractive errors in albinism: a longitudinal study over the first decade of life

The goal of this study is to analyze longitudinal changes in refraction in patients with albinism. The medical records of 481 patients were reviewed retrospectively to identify patients who had cycloplegic refractions at three ages: visit A, 0-18 months old; visit B, 4-6 years old; visit C, 8-10 years old. The authors recorded refraction, type of albinism, glasses wear, and best-corrected visual acuity at visit C. Only right eyes were analyzed. A total of 75 patients were included in this study. Of these, 73 wore glasses and 73 presented with nystagmus. Mean best-corrected visual acuity at visit C was 20/72 (range, 20/25-20/200). Mean spherical equivalent was 2.81 ± 2.4 D at visit A, 2.53 ± 3.4 D at visit B, and 2.15 ± 4.0 D at visit C. These values did not differ significantly from visits A to C (P = 0.0578). Mean astigmatism for the three time points was 1.60 ± 1.00 D, 2.50 ± 1.14 D, and 2.87 ± 1.45 D; these values did differ significantly from A to C (P < 0.0001). Subgroup analysis for OCA1A (16 eyes), OCA1B (20 eyes), and OCA2 (30 eyes) showed an increase in astigmatism from A to C, with a significant difference in means (P < 0.0001, P < 0.0001, and P = 0.0001, resp.). Worse best-corrected visual acuity and higher mean astigmatism at visit C were found for OCA1A (20/104 and +4.08 ± 1.34) compared to OCA1B (20/59 and +2.30 ± 1.36; P < 0.0001) and OCA2 (20/66 and +2.53 ±1.21; P < 0.0001); OCA1A patients also had the highest rate of increase of astigmatism with age. The authors note that their results corroborate the presence of impaired emmetropization in patients with albinism and recommend that children with albinism require periodic cycloplegic refraction, because astigmatism often increases within the first 10 years of life. They conclude that the refractive error in the first 10 years of life in persons with albinism follows a unique trend with increasing hyperopia with WTR that increases with little change in the spherical equivalent and axis. The most severe type of albinism (OCA1A) has higher astigmatism and worse visual acuity compared to the other types.
Patient-derived questionnaire items for patient-reported outcome measures in pediatric eye conditions

The purpose of this paper is to identify specific health-related quality of life (HRQOL) and functional vision concerns of children with eye conditions, and create comprehensive lists of potential questionnaire items as a first step in developing patient-reported outcome measures. Children experiencing a range of pediatric eye conditions, along with one of their parents, were interviewed to identify specific concerns. Transcribed interviews were reviewed, and specific HRQOL and functional vision concerns were coded independently by two reviewers. Coded concerns were reviewed to formulate questions to address specific child concerns (derived from child and parent interviews) and specific parent concerns. Questions were grouped into bins of like questions. Two comprehensive lists of questions were formulated, one addressing child-related concerns and one addressing parent-related concerns. This study included 180 children and 328 parents. A total of 614 individual child questions were grouped into 36 bins (eg, appearance, coordination, glasses, learning), and 589 parent questions were formulated and grouped into 61 bins (eg, having to assist the child, worry about deterioration, time off work, safety). Using rigorous methods based on individual interviews, we identified a comprehensive list of patient- and parent-derived questionnaire items that address functional vision and HRQOL concerns of children with eye conditions and of their parents. The authors plan to use this large pool of potential questionnaire items to develop a formal set of pediatric outcome measures, and this pool of questions may also be a resource for future research. The authors will be presenting the future stages of creating and testing these questionnaires in future studies.

Functional vision and quality of life in children with microphthalmia/anophthalmia/coloboma—a cross-sectional study

The goal of this study was to determine the child's and parental perception of functional visual ability (FVA), vision-related and health-related quality of life (VR-QoL, HR-QoL) in children with microphthalmia/anophthalmia/coloboma (MAC). Between June 25, 2014, and June 3, 2015, the authors carried out a cross-sectional observational study at Moorfields Eye Hospital, London, UK, enrolling 45 children 2-16 years of age with MAC attending our clinics, and their parents. To assess FVA, VR-QoL, and HR-QoL they asked participants to complete three validated tools, the Cardiff Visual Ability Questionnaire for Children (CVAQC), the Impact of Vision Impairment for Children (IVI-C) instrument, and the PedsQL V 4.0. The main outcome measures were the FVA, VR-QoL, and HR-QoL scores, reported by children and parents. In children with MAC, FVA is
moderately reduced, with a median CVAQC score of −1.4 (IQR, −2.4 to 0.4; range, −3.0 [higher FVA] to +2.8 [lower FVA]). VR-QoL and HR-QoL are greatly reduced, with an IVI-C median score of 63 (IQR, 52-66; normal VR-QoL, 96), a median self-reported PedsQL score of 77 (IQR, 71-90; normal HR-QoL, 100) and parental score of 79 (IQR, 61-93), and a family impact score of 81 (67-93). A greater number of surgeries was found to be associated with worse HR-QoL scores reported by both children and parents. Psychosocial well-being scores are lower than physical well-being scores in this group of patients. Additionally, parents and children have a different perception of the impact of the condition on the child's HR-QoL. MAC has a significant impact on a child's FVA and QoL, similar to that described by children with acute lymphoblastic leukaemia and chronic systemic conditions. Physicians should consider that children and families with microphthalmia/anophthalmia/coloboma may benefit from psychosocial support.

Ocular phenotype and electroretinogram abnormalities in Lafora disease: A "window to the brain"
Ajoy Vincent, Angelo Macrì, Anupreet Tumber, Nikolas Koukas, et al.

In this case series of 4 patients, the authors provide insight into the ophthalmic manifestations of Lafora disease, a neurodegenerative disorder with a typical age of onset in teenage years, which is believed to cause bipolar cell atrophy within the retina. The analysis focused on retinal findings with specific focus on fundus photography, fundus autofluorescence, OCT, and ERG findings. The primary conclusion in this small cohort of patients was that amongst these different modalities, only ERG appeared to demonstrate any abnormality. Changes included bipolar cell dysfunction as evidenced by abnormalities on scotopic ERG in several patients and photopic ERG in all patients in this study. Other methods of retinal assessment were normal. The authors therefore propose ERG as a method for monitoring disease progression in Lafora disease.

Relevance of Abusive Head Trauma to Intracranial Hemorrhages and Bleeding Disorders

Because children with abusive head trauma (AHT) and bleeding disorders both present with unexplained intracranial hemorrhaging, it is crucial to be able to accurately diagnose to prevent morbidity in both medical problems. Previously, the American Academy of Pediatrics published recommendations for evaluating bleeding disorders in the setting of possible AHT. The strategy was based on the
probability of an intracranial hemorrhage (ICH) occurring in a child with a given congenital bleeding disorder. The authors wanted to improve their understanding of ICH in different bleeding disorders because the prior recommendations were based on studies of older children, did not contain information about all bleeding disorders, and did not specify type of ICH. The researchers used the Universal Data Collection database which contains information on ICH in subjects with bleeding disorders, including age and history of trauma. The study reviewed subjects <4 years of age and calculated the prevalence and probability of types of ICH for each type of bleeding disorder. In the 3717 subjects, 6.9% had ICH and 5.5% had nontraumatic ICH. The highest prevalence of ICH was in severe hemophilia A and B. 1.1% had spontaneous subdural hemorrhages (12 cases of severe hemophilia and one subject with type 1 von Willebrand disease. In this one subject with von Willebrand disease, the findings were not consistent with AHT. In congenital bleeding disorders, nontraumatic ICH is most commonly associated with severe hemophilia and the ICH of patients with von Willebrand disease did not mimic findings in AHT. Unlike the prior AAP recommendations, the authors do not support the testing for factor VIII and IX in situations concerning for AHT to detect mild or moderate hemophilia particularly in cases with no history of trauma because of the low occurrence of ICH in these subtypes.

The Eye Examination in the Evaluation of Child Abuse


In this clinical report, the authors outline the current knowledge regarding retinal hemorrhages (RHs) in abusive head trauma (AHT) as well as provide recommendations for the examination of children suspected of AHT. Because RHs occur in approximately 75% of victims of AHT and can lead to significant visual loss, it is imperative that ophthalmologists examine these children in a timely fashion and report their findings to the medical team and state agencies. Injuries related to child abuse may be external such as periorbital ecchymoses, frontal and orbital roof fractures, and subconjunctival hemorrhages. Internal injuries can include corneal abrasions/lacerations, traumatic hyphemas, traumatic cataracts, and ruptured globes. For more than 30 years, the key ocular indicator of abuse has been known to be RHs. Approximately 25% of victims of AHT have no RH, and one-third of all cases have mild to moderate RH. In general, the number and severity of RHs correlate with the severity of neurologic injury and are infrequently found in neurologically normal children. RHs that are too numerous to count, multilayered, bilateral, and extend to the ora serrata are highly specific for AHT. Retinal folds, retinoschisis, and retinal detachments can also be observed in AHT. The timing of the RHs cannot be accurately timed. Intra-retinal hemorrhages resolve more quickly than pre-retinal hemorrhages and may last only a few days. Therefore, it is advisable for an ophthalmologic exam to optimally oc-
cur within 24 hours of suspicion. The differential diagnosis for RHs include meningitis, leukemia, coagulopathy, and retinal disorders but these are often confined to the posterior pole of the retina. The birth process also can result in RHs (vacuum assisted delivery >70% and routine cesarean delivery at <20%). The flame hemorrhages related to birth resolve by 2 weeks and the dot or blot hemorrhages resolve by 6 weeks. Research shows that the RHs in ART are related to the vitreoretinal traction sustained during the repetitive acceleration and deceleration mechanism. These forces cause the RHs and macular retinoschisis. 40% of AHT victims have visual problems that are most often related to the occipital cortical damage and/or optic nerve injury. The RHs generally resolve without sequelae but in more severe cases can lead to macular scarring or fibrosis, retinal detachment, and amblyopia. Because of the key information found in an ophthalmologic exam in cases of AHT, it is critical that a child suspected of abuse undergo as thorough of an ocular examination as possible.

**Ophthalmic Findings of Rosai-Dorfman Disease.**

Rosai-Dorfman disease (RDD), also known as sinus histiocytosis with massive lymphadenopathy (SHML), is a rare histiocytic proliferative disorder. Eleven percent of patients have ophthalmic manifestations, most commonly an orbital mass. Other reported ophthalmic manifestations include epibulbar mass, compressive optic neuropathy, uveitis, scleritis, serous retinal detachments, corneal lesions, lacrimal duct obstruction, and choroidal mass. The etiology of RDD is currently poorly understood, and debates on its pathogenesis center around an immunologic reactive process vs a neoplastic process. The authors describe the ophthalmic, pathologic, and *BRAF* V600E mutation status of RDD. A retrospective review of all cases of RDD seen at Mayo Clinic from 1992 to 2016 identified patients with ophthalmic manifestations (n=8) was performed. Immunostain for *BRAF* and molecular studies for *BRAF* V600E mutation were performed on cases with tissue available. Of 76 patients with RDD, 15 had eye examinations; of those, 8 (5 female and 3 male) had ophthalmic manifestations. In RDD patients with ophthalmic manifestations compared to RDD patients without ophthalmic manifestations, the respective median (range) age in years was 42 (15-70) and 56 (32-79) and median (range) logMAR visual acuity was 0.048 (0.000-1.824) and 0.000 (L 0.124 to 0.301). Of the 8 patients with ophthalmic manifestations, 4 had ocular involvement and 4 had orbital masses. Patients with ocular involvement had multiorgan disease including tracheal, aortic, renal, skeletal, and soft tissue lesions (n=4). Patients with orbital masses had no systemic involvement (n=2), skeletal involvement only (n=1), or multiorgan disease (n=1). *BRAF* immunostaining and molecular studies were negative in all available specimens (n=6). In this series of patients with ophthalmic manifestations of RDD, those with ocular involvement had multiorgan disease while those with orbital masses had more limited systemic disease. Patients with ophthalmic manifestations tended to
be younger and have worse visual acuity. Additionally, ophthalmic RDD does not seem to be associated with BRAF mutation.

**Ocular findings in Loeys-Dietz syndrome.**

Loeys-Dietz syndrome (LDS), an autosomal-dominant connective tissue disorder, is characterized by systemic manifestations including arterial aneurysm and craniofacial dysmorphologies. Although ocular involvement in LDS has been reported, detailed information on those manifestations is lacking. This is a retrospective chart review of patients with diagnosed LDS and comparison with age-matched control patients. The authors found patients with LDS less frequently had iris transillumination, cataract and glaucoma compared with controls. Scleral and retinal vascular abnormalities were not found in any of the LDS eyes. Ectopia lentis was found in one patient with LDS. The eyes of patients with LDS tended to be more myopic and longer. Central corneal thickness was significantly reduced in LDS eyes. Corneal curvature and interpupillary distance did not differ significantly between both groups. Visual acuity was similar between both groups. This paper revealed that decreased central corneal thickness and a tendency towards mild myopia and increased axial length were most characteristic findings in LDS. In contrast to previous reports, hypertelorism, scleral discoloration and retinal vascular abnormalities were not associated with LDS.

**24.UVEITIS/ SYSTEMIC**

**What is New in Paediatric Uveitis**

Pediatric uveitis is most commonly an anterior, nongranulomatous, chronic uveitis that is noninfectious (67.2-93.8% of cases). JIA is the most common systemic association with VKH, Behcet disease and TINU common in Asian and European studies. Pars planitis is common in the Middle East. Infection uveitis is less common (6.2-32.9 % of cases) with toxoplasmosis one of the most widely reported. In addition toxocariasis, viral and TB infections occur. Treatment includes a number of modalities. Steroids should be used in the initial control of uveitis, flares and as a bridge to steroid sparing agents (SSAs). Topical prednisolone acetate 1% most commonly used. Chronic use of steroids can lead to cataract and glaucoma. The use of steroid implants has been shown in some case reports to provide good control alt-
hough there is an increased risk of glaucoma and cataract. Antimetabolites such as methotrexate have been used for a long time with good long-term data on safety and efficacy. Mycophenolate sodium is also effective at controlling inflammation. Biologic agents such as TNF-alpha are another class of medication. Adalimumab is 80% effective in controlling refractory uveitis although adverse events such as infection were a concern. Interleukin-1 and interleukin-6 blockade is a newer area of treatment but there are only small number of studies looking at the efficacy. This paper reviews the different treatment modalities currently being used for the management of pediatric uveitis.

**Ocular complications in a young pediatric population following bone marrow transplantation.**


The purpose of this retrospective study was to investigate ocular complications associated with bone marrow transplant and associated continued maintenance therapy in a preschool population. The medical records of patients <7 years of age were reviewed. Patient charts were screened for cataract formation, dry eye, and other anterior and posterior segment disease. A total of 270 cases were reviewed, 91 met inclusion criteria. Mean age at diagnosis was 3.17 years. Average follow-up was 5.8 years (range, 1.9 months-14.1 years). Of the 91, 37 patients developed cataracts (41%) over a 14-year period. Cumulative incidence corrected for competing event (death before cataract) for the study population was found to be 58.4% after 14 years. Univariate analysis for cataract formation showed statistical significance for total body irradiation dose, age at diagnosis, race, donor type (related vs unrelated), product type, diagnosis type, survival status, calcineurin inhibitor use, and bisulfan, cytarabine, and thiotepa use. Multivariate analysis for competing event (death), showed that total body irradiation dose was not statistically significant; however, when studied in a binary logistic regression model, total body irradiation dose was statistically significant. Notably, steroid use and presence of graft-versus-host disease did not show statistical significance for cataract development. No other ocular complication was found in sufficient quantities to allow statistical analyses. The authors proposed that screening examinations by a pediatric or general ophthalmologist be completed at least annually. due to the high incidence of cataract formation in this population, especially those enduring a treatment regimen with total body irradiation. They also urged a low threshold for treatment of dry eye syndrome. This study presents a relatively large cohort of young children who underwent allogeneic BMT with a relatively long follow-up period.

**Intravenous dexmedetomidine augments the oculocardiac reflex.**
Dexmedetomidine is a selective alpha-2 adrenergic agonist affording sedation with minimal respiratory depression. It is helpful for dose-dependent prevention of emergence agitation and postoperative nausea. A previous retrospective report had indicated that premedication with nasal dexmedetomidine was associated with a more intense oculocardiac reflex (OCR). This case-control interventional study was conducted to test the authors’ hypothesis that IV dexmedetomidine potentiates OCR. A total of 33 patients were enrolled. Oculocardiac reflex (greatest change heart rate/baseline heart rate) was prospectively monitored with 10-second, square-wave 200g tension on the inferior rectus or other muscles during strabismus surgery. Between the first and second muscle, intravenous (IV) dexmedetomidine 0.5 µg/kg was delivered. Intrasubject comparison was performed before and after exposure to dexmedetomidine. All patients had no anticholinergic agents. A total 842 historic control patients (median age, 5.5 years) with no dexmedetomidine exposure, experienced an average first OCR percentile of 75% ± 24% (SD) and the second OCR percentile of 77% ± 22%. The 33 study patients (median age, 5.6 years) experienced the first OCR 84% ± 16% and the post dexmedetomidine second OCR of 66% ± 25% for a bradycardia augmentation of 18% ± 19% (P < 0.01 [Mann-Whitney]). The authors concluded that intravenous push of dexmedetomidine augmented the bradycardia associated with extraocular muscle traction. Despite some weaknesses with the study’s design and its control group, it increases the reader’s awareness to the possible detrimental effect that the alpha-2 agonist sedative dexmedetomidine may have on the oculocardiac reflex.

Blau Syndrome – Associated Uveitis: Preliminary Results from an International Prospective Interventional Case Series

The authors of this study sought to look at baseline and follow up eye findings in a large multi centered trial of the rare disease Blau Syndrome. There were 25 centers worldwide who provided baseline data for 50 patients. These patients were also followed for 1, 2, or 3 years after enrollment and their data recorded, when available. The median age of the onset of eye disease was 60 months and most of these patients had uveitis (78%) (almost always bilateral) and 21% of patients had moderate to severe visual impairment. Over half of patients had panuveitis with multifocal choroidal infiltrates. Other findings included optic disc pallor, peripapillary nodules, and anterior chamber inflammation. Patients who had panuveitis had a longer disease duration. Most patients were on topical steroid and most received systemic steroids and immunomodulatory therapies. A large percentage of patients had complications of chronic inflammation (band keratopathy, cataract, synechiae, retinal detachment, macular edema, etc). Many patients had persistent eye inflammation despite topical and systemic
treatments. The authors point out the important conclusion with this paper is that the uveitis in this rare disease is found frequently and is very severe, warranting close eye follow up.

Safety of Oral Propranolol for Infantile Hemangioma

Catherine Droitcourt, Sandrine Kerbrat, Caroline Rault, et al. **Pediatrics** June 2018; 141(6); e20173783

In 2010, oral propranolol was approved for proliferative infantile hemangiomas and a risk management plan was implemented. The risk factors included cardiovascular disorders including atrioventricular block, bradycardia, hypotension; respiratory disorders including bronchospasm and/or bronchial hyperactivity; metabolic disorders including hypoglycemia or related seizures, and hyperkalemia for ulcerative infantile hemangiomas. The objective of the study was to assess the safety of oral propranolol using observational data from the French national medico-administrative exhaustive database. The researchers performed an observational study on existing data comparing subjects <3 years of age who had and who had not used propranolol identified in the Systeme National Inter-Régime de l’Assurance Maladie (SNIRAM). 1934 children had at least one delivery of Hemangiol (oral propranolol) between July 2014 and June 2016. The mean age of medication delivery was 5.7 months. 1753 children had at least 2 deliveries of Hemangiol with 1484 being healthy children and 269 having an underlying disorder. These disorders included 133 with cardiovascular disease, 49 children with respiratory disease, 139 with metabolic disease. The study calculated the standardized morbidity ratios (SMRs) for patients on Hemangiol. The main outcome was hospitalizations for cardiovascular, respiratory, and metabolic events identified through ICD coding. In the healthy population, the authors found 2 cardiovascular events (SMR = 2.8), 51 respiratory events (SMR = 1.7), and 3 metabolic events (SMR = 5.1). In the unhealthy group, they observed 11 cardiovascular events leading to an SMR of 6.0. SMRs were not significantly raised for respiratory or metabolic events in the nonhealthy population. The increased cardiovascular SMR is likely due to the usage of Hemangiol in patients with Tetralogy of Fallot that could not be excluded with the given database because Hemangiol is given to this population as well. The strengths of the study include a very large study population, virtually no selection bias, and a quality comparative pediatric population. The weaknesses include an inability to relate side effect cause to the propranolol, understand true usage of medication consumption, and no recording of medical events outside of hospitalization. The data confirm the overall good safety profile of oral propranolol in children with hemangiomas. It is advised to avoid propranolol in children with lower respiratory infections or low food intake. The study also recommended a cardiovascular monitoring system during the titration phase to identify cardiovascular issues. The study provides valuable information regarding the safety profile of oral propranolol.
Positive results bias in pediatric ophthalmology scientific publications.


Positive results bias is a type of publication bias, in which editors are more likely to accept studies that exhibit positive results than negative ones. An association was previously demonstrated in several fields of medicine, including general ophthalmology, between the results of a trial and the impact factor (IF) of the journal in which it was published. The authors hypothesized that randomized clinical studies in pediatric ophthalmology with positive results have a greater chance of publication in journals with a higher IF than those with negative results. They analysed 174 randomized, controlled trials conducted in the field of pediatric ophthalmology, which were published between January 1, 1997, and January 1, 2017 and appeared on Pubmed. Each study was classified as having either a positive or a negative result. A positive result was defined as a study in which there was a statistically significant difference between groups (P < 0.05). No difference in IF was found between negative and positive outcomes, after statistically adjusting for the number of subjects and year of publication. The authors concluded that, unlike general ophthalmology, positive results bias probably does not occur in the field of pediatric ophthalmology. The study included only RCTs; Therefore, its conclusion might not be relevant to other study types in pediatric ophthalmology.

Outbreak of Adenovirus in a Neonatal Intensive Care Unit: Critical Importance of Equipment Cleaning During Inpatient Ophthalmologic Examinations.


Adenovirus is a common cause of respiratory infections and conjunctivitis in children and adults. Although these infections are often benign and self-limited, they can have severe complications and even death in vulnerable populations. In this report, the authors describe an outbreak of adenovirus in neonatal intensive care units (NICUs) due to contaminated handheld ophthalmologic equipment used during retinopathy of prematurity (ROP) screening and describe the investigation, response, and successful containment of an adenovirus outbreak in a NICU. A total of 23 hospitalized neonates, as well as NICU staff and parents of affected infants were included in this epidemiologic investigation. In August 2016, a routine surveillance identified an adenovirus outbreak in a level IV NICU. Epidemiologic investigation followed, including chart review, staff interviews, and observations. Cases were defined as hospital-acquired adenovirus identified from any clinical specimen (NICU patient or employee) or compatible illness in a family member. Real-time polymerase chain reaction (PCR) and partial- and whole-
genome sequencing assays were used for testing of clinical and environmental specimens. A total of 23 primary neonatal cases and 9 secondary cases (6 employees and 3 parents) were identified. All neonatal case-patients had respiratory symptoms. Of these, 5 developed pneumonia and 12 required increased respiratory support. Less than half (48%) had ocular symptoms. All neonatal case-patients (100%) had undergone a recent ophthalmologic examination, and 54% of neonates undergoing examinations developed adenovirus infection. All affected employees and parents had direct contact with infected neonates. Observations revealed inconsistent disinfection of bedside ophthalmologic equipment and limited glove use. Sampling of 2 handheld lenses and 2 indirect ophthalmoscopes revealed adenovirus serotype-3 DNA on each device. Sequence analysis of 16 neonatal cases, 2 employees, and 2 lenses showed that cases and equipment shared 100% identity across the entire adenovirus genome. Infection control interventions included strict hand hygiene, including glove use; isolation precautions; enhanced cleaning of lenses and ophthalmoscopes between all examinations; and staff furlough. The authors recommended that ophthalmologists performing inpatient examinations take measures to avoid adenoviral spread from contaminated handheld equipment.

Trends in US Emergency Department Visits for Pediatric Acute Ocular Injury

This was a retrospective cohort study of care in emergency departments (EDs) from 2006 to 2014 at the Nationwide ED sample, with a total of 376,040 children ages 0 to 17 years with acute traumatic ocular injuries. Between 2006 and 2014, pediatric acute ocular injuries decreased by 26.1% (95% CI, -27.0 to -25.0). This decline existed across all patient demographic characteristics, injury patterns, and vision loss categories and for most mechanisms of injury. There were increases during the study in injuries related to sports (12.8%; 95% CI, 5.4-20.2) and household/domestic activities (20.7%; 95% CI, 16.2-25.2). The greatest decrease in high-risk injuries occurred with motor vehicle crashes (-79.8%; 95% CI, -85.8 to -74.9) and guns (-68.5%; 95% CI, -73.5 to -63.6). This study showed a decline in pediatric acute ocular injuries in the United States between 2006 and 2014. Understanding these trends can help establish future prevention strategies regarding pediatric ocular trauma.

Wrong site surgery in Pediatric ophthalmology.
Lauren Maloly, Linda A. Morgan, Robin High, Donny W. Suh JPOS. 2018; 55(3): 152-158

The purpose of this study is to determine the prevalence of pediatric ophthalmologists who have performed wrong-site surgery, propose risk factors leading to these errors, and assess the effectiveness of the Universal Protocol in pre-
venting them. Approximately 1,000 listserv members of the Pediatric Ophthalmology Interest Group were invited from June to July 2015 to complete an anonymous 10 questions survey. Respondents were divided into two groups: those who performed or attempted wrong-site surgery (wrong-site surgery group) and those who had never performed a wrong-site surgery (intended surgical site group). The risk factors (ie, marking procedure, years in practice, surgical experience, adherence to the Universal Protocol time-out, and operating room factors) were compared between groups. Of the 156 respondents, 56.4% never performed, 9% attempted, and 34.6% performed a wrong-site surgery. The use of any procedure to mark the eye decreased the likelihood of a wrong-site surgery by 61% (odds ratio [OR] = 0.39; \( P = .069 \)). A lower likelihood of error occurred when a single individual led the time-out and multiple individuals participated in checking the accuracy of the time-out. Surgeons in practice for less than 15 years had a lower likelihood of performing a wrong-site surgery (OR = 0.37; 95% confidence interval [CI] = 0.19 to 0.72; \( P = .003 \)). Factors not significantly associated with wrong-site surgeries were the number of surgeries performed per year (OR = 0.66; 95% CI = 0.35 to 1.24; \( P = .20 \)) and the number of operating rooms used. The authors conclude that marking the surgical site, direct involvement in the time-out by the surgeon, active engagement of multiple individuals in checking the time-out for accuracy, and indicating procedure type and laterality can potentially decrease the risk of surgical error as evidenced by the current study.

The current study is limited in that data were self-reported and subject to recall bias. Also, many of the interpretations may have been statistically significant had there been a higher response rate. The authors did not isolate the types of errors committed (eg, wrong eye vs wrong muscle vs wrong procedure) and their relation to the safety factors analyzed. Future studies need to be planned that will incorporate additional questions such as when in the physician's practice did the wrong-site surgery occur. Additionally, the response rate was not as high as it was anticipated in this study.

Additional factors not addressed that may contribute to wrong-site surgeries and warrant further review include surgeons’ emphasis on efficiency, less contact time with patients, and unfamiliarity with electronic medical record systems.

Ophthalmic imaging in children: current practice patterns and perceived barriers.

Developments in ophthalmic imaging technology have revolutionized the delivery of ophthalmic care. Although these technologies are routinely used in the management of adult patients, pediatric ophthalmology has been slower to adopt new imaging technologies. In this study pediatric ophthalmologists were surveyed to determine current practice patterns regarding ophthalmic imaging for children and to identify perceived barriers to the adoption of imaging technologies in their practices. Some form of imaging was available in the majority of practices (94%), but its use varied
widely among different clinical scenarios. The two most frequently per-
ceived barriers to performing imaging in children were cooperation and
lack of sufficient data supporting ophthalmic imaging in clinical practice.
The authors suggest that practice guidelines are necessary to develop a
systematic approach to pediatric ophthalmic imaging, as well as increased
educational efforts at national and international meetings to improve effec-
tive utilization.

Chlora Hydrate Administered by a Dedicated Sedation Service
Can Be Used Safely and Effectively for Pediatric Ophthalmic Ex-
amination

The goal of this study is to determine the safety and efficacy of oral choral hy-
drate sedation in the outpatient pediatric ophthalmology setting for procedures.
This is a prospective interventional case series of 324 children aged 1 month to 5
years who were undergoing choral hydrate sedation (CHS) for ocular imaging or
evaluations. The authors excluded patients whose weight was <3kg or greater
than 20kg, who had ocular surface disease or infection, or who had a medical
contraindication to CHS including patients who were ill. There was one ophthal-
mologist and one pediatrician who reviewed the records prior to enrollment and a
“dedicated sedation provider” who administered the medication and monitored
the patient. The patients did have NPO requirements similar to those used for
general anesthesia. Patients less than 6 months received 50mg/kg dose and the
other patients received 100mg/kg. Patients vital signs were monitored every 10
minutes for a mean of 85 minutes total. 300 children (92.9%) had all of the
planned procedures completed during the sedation. There was a decrease in
heart rate by a mean of 13.8 beats/minutes, respiratory rate 1.2 breaths/minutes,
and oxygen saturation 0.9%. The median time between CHS and discharge
was 90 minutes. There were no serious adverse effects. The authors discuss
the fact that this study was performed on a Saudi Arabian population and thus
the results may not be generalizable to a different population. Importantly, CHS
is not approved by the FDA for use in children because of the potential of poten-
tially severe side effects. However, the authors of this paper propose CHS is
safe and effective when administered by a dedicated sedation service in a select
group of patients for outpatient pediatric ophthalmology procedures.

Guidelines for the cleaning and sterilization of intraocular surgi-
cal instruments (Review/ Update)
David F. Chang, MD, Nick Mamalis, MD, Ophthalmic Instrument Cleaning and
Sterilization Task Force Journal of Cataract and Refractive Sur-
gery;2018;44(6):765-773.

Postoperative infectious endophthalmitis and toxic anterior segment syndrome
are rare but potentially sight-threatening complications of intraocular surgery. The
small volume of the eye and its sensitivity to minute amounts of chemical or micro-
bial contaminants means that improper instrument cleaning or sterilization
practices might pose a significant risk to patients. A 3-year collaborative effort by
the Ophthalmic Instrument Cleaning and Sterilization (OICS) Task Force recently
produced evidence-based, specialty-specific guidelines for the cleaning and steri-
lization of intraocular instruments. A large outbreak of toxic anterior segment
syndrome (TASS) in 2006 was the impetus for these updated guidelines as was
subsequent regulatory pressure on high-volume cataract surgeons in adult am-
bulatory surgery centers. The OICS designed a study that established the safety
and acceptability of short-cycle ophthalmic instrument processing for sequential
same-day surgery, even when the dry cycle is interrupted, if allowed by the in-
structions for use for the sterilizer. The use of enzymatic detergents to clean in-
traocular instruments was also studied as enzymatic detergents have been asso-
ciated with TASS outbreaks. Thorough rinsing reduced but did not eliminate en-
zymatic residue on phaco tips in one study. Therefore, the new guidelines state
that if intraocular surgical instruments are thoroughly rinsed with critical water
promptly after each use, the routine use of enzymatic detergents is unnecessary
and should not be required for the routine decontamination of intraocular instru-
ments. The findings of these studies and resulting OICS guidelines are relevant
for instruments used in other intraocular surgical procedures and may be useful
to pediatric ophthalmologists in educating and assisting surgical staff in imple-
menting appropriate practices for the cleaning and sterilization of intraocular sur-
gical instruments.

Routine Orthoptic-led Paediatric Fundus Digital Imaging: Bene-
fits to Patients and Healthcare System

Ocular fundus digital imaging is a widely used screening modality in many
areas of ophthalmology including diabetic retinopathy, retinopathy of
prematurity, retinoblastoma, and non-accidental abusive head trauma. The
authors demonstrate the effectiveness and safety of orthoptic-led non-
mydriatic fundus digital imaging which can be both time and cost effective.
Imaging was obtained in 97% of the 616 patients it was attempted on, 87%
of which did not require dilation prior to imaging. The authors conclude
that fundus imaging is a safe, speedy, and accurate way to examine chil-
dren without distressing the patient. The authors note that fundus imaging
does not bypass the need for cycloplegic refraction, detailed ophthalmos-
copy, or peripheral retinal examination.