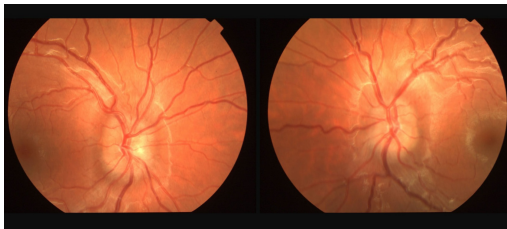


Using OCT in Pediatric Neuro-ophthalmology

By Mays El-Dairi, MD
Associate Professor
Pediatric Ophthalmology and Strabismus
Neuro-ophthalmology
Duke Eye Center

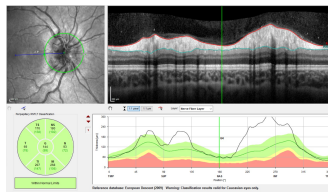
1

7 yo girl with accommodative esotropia is newly noted to have this. She is asymptomatic.



2

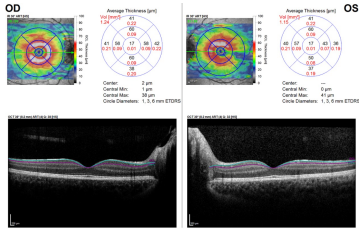
Had OCT RNFL locally



RNFL 144 μm
BMO 1.5 mm^2
Axially 1367 μm

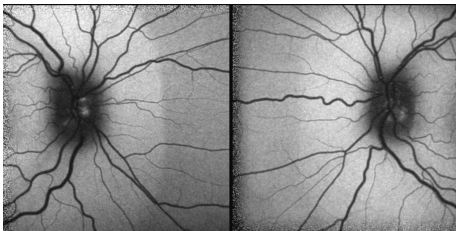
3

Macular map is normal



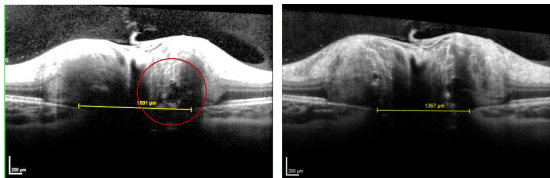
4

Autofluorescence



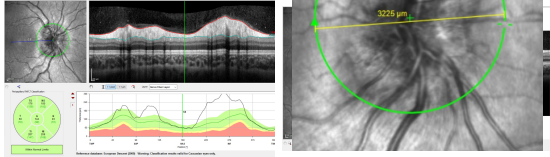
5

Scan through the nerve



6

But her RNFL is thick,
should we worry about
superimposed
papilledema?

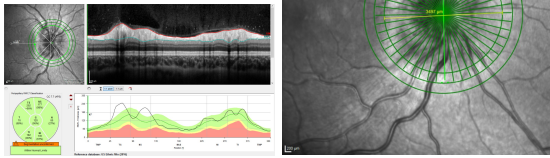


RNFL 144 μm
BMO 1.5 mm²

Size of projected circle 3225 μm

7

GMPE protocol

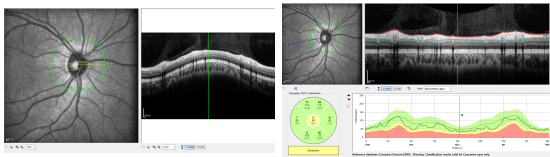


RNFL 120

Size of projected circle 3489

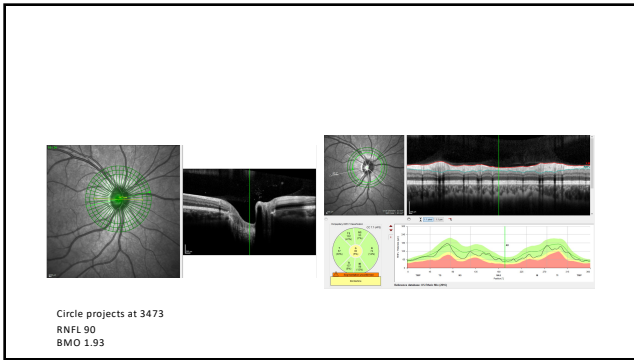
8

Another patient: 13 yo with -5 myopia



RNFL 80
Circle projecting at 3710

9



10

Final diagnosis

- Pseudopapilledema/hyperopic eye
- No need for further workup other than reexamine in 3, 6 and 12 months

11

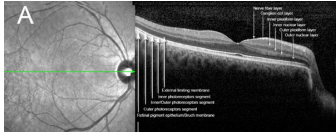
How to decide on which OCT protocol to obtain?

- RNFL: most commonly used protocol
- Macular scan
- Macular map
- Optic nerve scan
- Optic nerve map
- GMPE (Glaucoma Module Premium Edition)

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Posterior Segment OCT Protocols

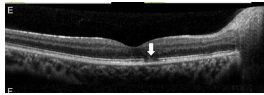
- **Retinal Scans**
 - Single line scans, easiest to obtain, will show retina pathology



13

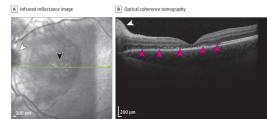
Why look at the retina in neuro-op

Papilledema



Gospe SM 3rd, Bhatti MT, El-Dairi MA. Anatomic and visual function outcomes in paediatric idiopathic intracranial hypertension. *Br J Ophthalmol.* 2016

MOG optic neuritis

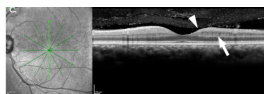


Lee AR, El-Dairi MA. Anti-Myelin Oligodendrocyte Glycoprotein Optic Neuritis or Neurorinitis? *JAMA Ophthalmol.* 2018 Oct 1;136(10)

14

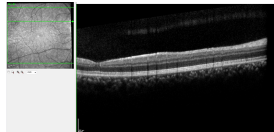
More examples of retinal changes in presumed optic nerve disease

INL cysts: optic atrophy with severe loss of GCL in the papillomacular bundle



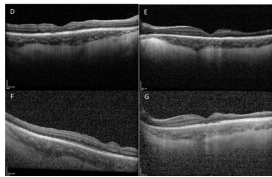
Jiramongkolchai K, Freedman SF, El-Dairi MA. Retinal Changes in Pediatric Glaucoma and Nonglaucomatous Optic Atrophy. *Am J Ophthalmol.* 2016 Jan;161:188-95

Evidence of previous retinal vasculitis



15

Even pediatric glaucoma!



- Elevated Intraocular Pressure and Microvascular Retinal Injury Identified by Optical Coherence Tomography in Two Infants with Glaucoma
- First author: Samuel A. Alvarez-Falcon
- In print JAAPOS

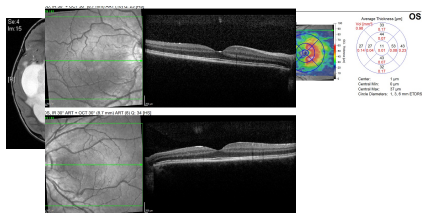
16

OCT Protocols: Macular Map

- Customizable feature that can be generated by integrating multiple single-line macular scans.
- A topographical map centered on the foveal center is created.
- ETDRS macular map

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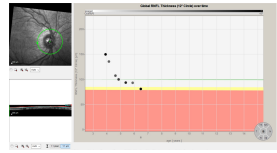
Macular map in optic tract lesion



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Retinal Nerve Fiber Layer Scan

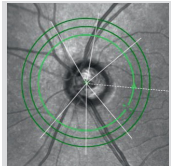
- A circular scan of 3.4-3.5 mm (machine-dependent) that is centered on the optic nerve head.
- An indirect measure of all the retrolubar optic nerve axons
- RNFL measurements were shown to correlate with severity of disc edema or optic atrophy



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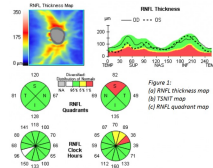
Methods of acquiring RNFL

Circular scan method



Spectralis: can correct segmentation but can't correct position. The single scan is faster to acquire

Map with the RNFL extrapolated

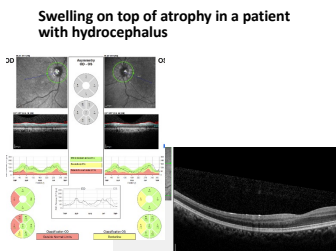


Cirrus, RTVue. Can correct circle position, cannot correct segmentation or skip lesions

20

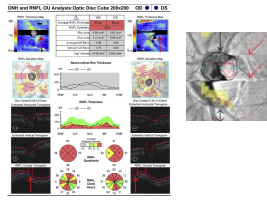
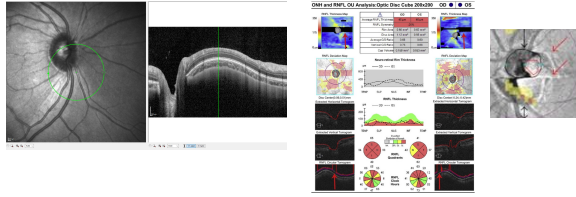
Pitfalls of the RNFL scan

- Doesn't correct for axial length as we saw in the above 2 examples
- Can't differentiate the case of papilledema on top of atrophy
- Be careful interpreting the RNFL without a macular scan



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Examples of artifacts RNFL

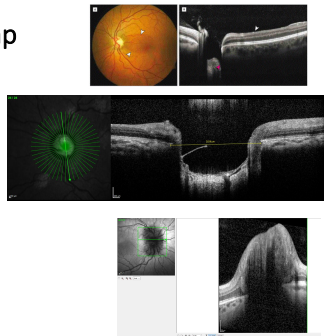


Yohannan J, Cheng M, Da J, Chapagain S, Sotimshin A, Bonham LM, Mihaljevic A, Boland M, Rattula P. Evidence-Based Criteria for Determining Peripapillary OCT Reliability. *Ophthalmology*. 2020 Feb;127(2):167-176. doi: 10.1016/j.ophtha.2019.08.027. Epub 2019 Aug 29. PMID: 31648802; PACS: PAC608237.

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Optic Nerve Head Map

- Similar to the macular map but is instead centered on the optic nerve.
- It is useful for qualitatively assessing the peripapillary area, if a lesion is suspected
- Can measure BMO manually on a single slide

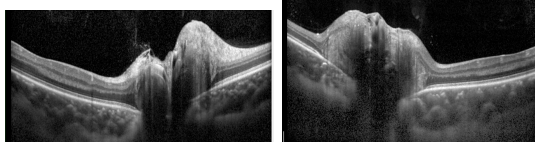


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More examples of optic nerve head scans

PHOMS

Optic nerve head drusen



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CNV in optic nerve head drusen and in congenital optic nerve anomalies

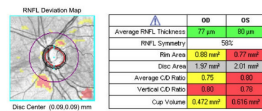


Duncan JE, Freedman SF, El-Dairi MA. The incidence of neovascular membranes and visual field defects from optic nerve head drusen in children. J AAPOS. 2016 Feb;20(1):44-8.

25

Optic disc analysis

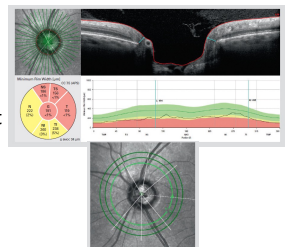
- Automatically outline of optic nerve head and cup
- Optic disc area
- Neuroretinal rim area
- Vertical cup-to-disc ratios.
- Based on the shortest perpendicular distance to ILM



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Optic nerve head Rim Analysis

- Neuro-retinal rim assessment
- Integrating measures from the Bruch Membrane opening to the nearest point on the internal limiting membrane (ILM)
- Disc area and map of MRW
- RNFL at 3 distances



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Normative data in children

10.1371/journal.pone.0248973
 REVIEW ARTICLE
 Normative data for optical coherence tomography in children: a systematic review
 Ana Banc¹, Maria I. Ungureanu¹
 Received: 14 April 2020 | Revised: 23 August 2020 | Accepted: 1 September 2020 | Published online: 14 September 2020
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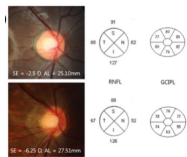
Abstract
 The purpose of this study is to systematically review the reported data of normal optical coherence tomography (OCT) results in the pediatric population. An extensive literature search was performed using the Medline, Embase, and Scopus databases using the keywords: optical coherence tomography, "pediatric", "child", "healthy", "OCT", "normal", "myopia", "hyperopia", "presbyopia". Studies with at least 10 participants were included, irrespective of the OCT equipment employed. We included the OCT topography studies or the studies investigating the choroidal thickness. Seventy-four studies were included in the final analysis and information on study design, number of participants, demographic characteristics, type of OCT equipment, OCT parameters and results was extracted. Due to the high variability of OCT parameters and parameters and the variable central thickness for each ICDHO quadrant, as provided by the studies included in the present analysis, we also report the reference of reliability, age, gender, eye dominance, ICDHO file, optical axis length, and axial length on OCT results.

- RNFL not very different from young adults.
- C.f. table 2 in "Banc, A., Ungureanu, M.I. Normative data for optical coherence tomography in children: a systematic review. *Eye* 35, 714–738 (2021)"

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What happens with growth

- As axial length increases, expect a mild drop in average RNFL (3 μm with 1 mm increase in RNFL, less than machine reproducibility)
- Effect of optic nerve tilting



Ahn YJ, Park YV, Park SH, Shin SY. Long term change of the optic disc and OCT parameters during myopic shift in children with large cup to disc ratio. *PLoS One*. 2020;15(7). Published 2020 Jul 17.

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How to prioritize OCT when we have a squirmy child

- At least a single line macular scan through the fovea especially if central vision is decreased
- RNFL
- If child can sit longer, macular map with GCL segmentation
- If really good child: GMPE

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Conclusions

- Limited scan (e.g just a macular scan) can give more information than a poor quality extensive scan with segmentation
- Pay attention to the macula look for retinal changes that may be optic neuropathy mimickers
- Pay attention to artifacts
- Pay attention to change in axial length with growth spurt and tilting of the optic nerve

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Thank you!



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