Retinal Nerve Fiber Layer thickness and Optic Nerve Head Parameters by Spectral OCT - Implications in Pediatric Ophthalmology

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Poll Question 1

- What is your current position?
  1. Pediatric Ophthalmologist
  2. Comprehensive Ophthalmologist
  3. Fellow/Resident
  4. Medical Student
  5. Ophthalmic technician / Allied Health
Measurements provided by each of the commercially available devices differ, cannot be used interchangeably.
• **Analysis of studies on normative data of**
  - RNFL thickness
  - Optic nerve head parameters
  - Interocular asymmetry in pediatric population.

*Role of Spectral OCT in pediatric glaucoma,*

*pediatric neuroophthalmology.*
Introduction - Evolution of OCT

- Non contact, Non invasive
- Diagnostic imaging technique - provides cross sectional images of human retinal morphology in vivo.
- Role of OCT in adults - well established.

- Advances in OCT technology - Most utilized imaging technology
Adult - normative values of retinal thickness across age distributions, ethnicities, and ocular disease states.

Retinal thickness changes with age and ethnicities.

Less is known about normative RNFL thickness values in children.

Limitations -- single age group/ or a single race.


Generational Leap

- 1st Generation OCT
- 2nd Generation OCT
- 3rd Generation Time Domain
- 4th Generation Spectral/Fourier Domain

- FD-OCT speed 50-100x faster than TD-OCT
Time Domain Vs Spectral Domain

- Moving mirror
- 810nm
- Longer Scan acquisition time
- 400 axial scans
- 512 A scans taken per B scan
- 8-10um resolution
- ILM – photoreceptor junction

- No moving part - broadband source
- Spectrometer
- Light Source Super luminescent diode 840nm
- Faster Scan
- 25000-100000 axial Scans per second
- 256 B scans
- 3-7 um axial resolution
- ILM-RPE
Commercially available Current SD OCT devices

- **Spectral Domain**
  - **Cirrus HD OCT** (Carl Zeiss Meditec, Dublin, CA, USA)
  - **Spectral OCT/SLO** (Opko, Miami, FL, USA)
  - **3D-OCT 2000** (Topcon, Tokyo, Japan)
  - **RS-3000 NIDEK** (Nidek, Gamagori, Japan)
  - **RTVue-100** (Optovue, Fremont, CA, USA)
  - **Spectralis** (Heidelberg Engineering, Heidelberg, Germany)
  - **Bioptigen Hand held Spectral OCT** (Bioptigen, Research Triangle Park, NC, USA)

- **Swept OCT**
- **OCT - A**

Proposed Lexicon for Anatomic Landmarks in Normal Posterior Segment Spectral-Domain Optical Coherence Tomography  

The INOCT Consensus
Poll Question 2

Do you have OCT in your hospital/clinic?

- Yes
- No
Reproducibility, Sensitivity and Specificity

- Children well agreement-Intravisit and intervisit reproducibility of measurements of peripapillary RNFL thickness and ONH parameters.

- Spectralis spectral-domain-OCT - good for both RNFL and macular thickness measurements in glaucoma/glaucoma suspect eyes of pediatric subjects.

References:


OCT pitfalls

- Age
- Ethnic variation
- Cooperation
- Artifacts
- Segmentation error
- Different machine
- SNR
- Media opacity
Types of artifact and Errors

- Technical – improperly calibrated machine, poor optics
- Scan centration – poor signal strength, off center scan decenteration
- Motion and blink artifacts
- Software related segmentation errors
- Truncation/missing scan areas
- Patient head tilt
- Ocular factors – refractive errors, Floor effect
Poll Question - 3

- Do you take in account age and ethnicity in considering Retinal Nerve Fiber Layer Thickness and optic nerve head parameters evaluation in various ocular diseases?
  - Yes
  - No
Why Normative Data is required?

- No internal standards with which to compare the results.
- Adult reference OCT data cannot be used.
RNFL THICKNESS ANALYSIS

Scan protocol –Cirrus optic disc cube protocol, which is a three-dimensional scan of a $6 \times 6\text{mm}^2$ area centered in the optic disc.

Stratus - 3.4 mm diameter circles for RNFL thickness

Rim width is widest Inferiorly, followed by Superior, Nasal and Temporal position:

“ISN’T rule”
CIRRUS HD OCT

SPECTRALIS

Thickness map
RNFL Deviation map
TSNIT parameters
### Table 3: Comparison of studies reporting OCT-measured global RNFL thickness (µm) in normal pediatric subjects

<table>
<thead>
<tr>
<th>Author</th>
<th>Ethnicity</th>
<th>Number of children</th>
<th>Age range (years) (mean±SD)</th>
<th>Global RNFL thickness (µm) (mean±SD)</th>
<th>OCT version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our study</td>
<td>Indian</td>
<td>120</td>
<td>5-17 (10.8±3.24)</td>
<td>106.11±9.5</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Salchow et al. [14]</td>
<td>92% Hispanic, 8%, African American, 1%, Caucasian</td>
<td>92</td>
<td>4-17 (9.7±2.7)</td>
<td>107±11.1</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Huynh et al. Sydney childhood eye study [12,13]</td>
<td>White and East Asian</td>
<td>1765</td>
<td>6</td>
<td>103.7±11.4</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Gupta et al. [15]</td>
<td></td>
<td>18</td>
<td>6-13</td>
<td>100±2.64</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Freedman et al. [16]</td>
<td>Black</td>
<td>286</td>
<td>3-17</td>
<td>108.27±9.8</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Parikh et al. [17]</td>
<td>White</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ahn et al. [18]</td>
<td>Asian Indian</td>
<td>59</td>
<td>5-20</td>
<td>100.15±10.8</td>
<td>Stratus OCT</td>
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<tr>
<td>Larsson et al. [19]</td>
<td>Swedish</td>
<td>56</td>
<td>5-16</td>
<td>98.4±7.88</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Leung, et al. [18]</td>
<td>Hong Kong Chinese</td>
<td>97</td>
<td>9.75 (6.08 to 17.58)</td>
<td>113±9.8 RE 113.1 LE</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Zhang et al. [17]</td>
<td>Chinese (63%)</td>
<td>199</td>
<td>5-18</td>
<td>112.36±9.21</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Repka et al. [20]</td>
<td>White, Black, Hispanic, Latino</td>
<td>37</td>
<td>7-12</td>
<td>109.6</td>
<td>Stratus OCT</td>
</tr>
<tr>
<td>Samarakkrama et al. Sydney childhood eye study (incorporating the Sydney myopia study) [21]</td>
<td>European Caucasians</td>
<td>3382</td>
<td>6</td>
<td>101.95</td>
<td>Stratus OCT</td>
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<tr>
<td></td>
<td>East Asian</td>
<td></td>
<td>12</td>
<td>104.57</td>
<td></td>
</tr>
<tr>
<td>Tur et al. [22]</td>
<td>Turkish</td>
<td>107</td>
<td>6-16</td>
<td>106.45±9.41</td>
<td>Spectralis OCT</td>
</tr>
</tbody>
</table>

OCT: Optical coherence tomography, RNFL: Retinal nerve fiber layer, SD: Standard deviation of the mean
<table>
<thead>
<tr>
<th>Author</th>
<th>Ethnicity</th>
<th>Number of children</th>
<th>Age Mean ±SD</th>
<th>Global RNFL Thickness ± (Mean SD) μm</th>
<th>OCT Version</th>
<th>ISNT/ISTN/SITN Rule</th>
<th>Interocular symmetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noemi Elia et al, 2012</td>
<td>Spanish</td>
<td>344</td>
<td>6-13</td>
<td>98.46±10.79</td>
<td>Cirrus HD OCT</td>
<td>ISNT</td>
<td>Not studied</td>
</tr>
<tr>
<td>Yanni et al 2012</td>
<td>North American</td>
<td>83</td>
<td>5-15</td>
<td>107.6±1.2</td>
<td>Spectralis SD OCT</td>
<td>ISNT</td>
<td>Not studied</td>
</tr>
<tr>
<td>Tsai et al 2012</td>
<td>Taiwan</td>
<td>400</td>
<td>7-12</td>
<td>109.4±10.0</td>
<td>RTVue-100</td>
<td>ISNT</td>
<td>Not done</td>
</tr>
<tr>
<td>Zhu et al 2013</td>
<td>Chinese</td>
<td>1955</td>
<td>12</td>
<td>103.0±9.01</td>
<td>Ivue-100 SDQCT</td>
<td>ISTN</td>
<td>Not done</td>
</tr>
<tr>
<td>Barrio et al 2013</td>
<td>Spanish</td>
<td>283</td>
<td>4-17</td>
<td>97.40±9.01</td>
<td>Cirrus</td>
<td>ISNT</td>
<td>Not done</td>
</tr>
<tr>
<td>Chen et al 2013</td>
<td>Chinese</td>
<td>2324</td>
<td>6-17</td>
<td>106.89±12.84</td>
<td>OCT – IVue 100</td>
<td>SITN</td>
<td>Not done</td>
</tr>
<tr>
<td>Dalglish et al 2015</td>
<td>White, East Asian, South Asian, Middle East</td>
<td>1500</td>
<td>16-19</td>
<td>RE 99.3</td>
<td>Cirrus HD OCT</td>
<td>ISNT</td>
<td>9.3 μm in average RNFL(with 2.5% to 97.5% limits)</td>
</tr>
<tr>
<td>Turk et al 2012</td>
<td>Turkish</td>
<td>107</td>
<td>6-16</td>
<td>106.4±9.41</td>
<td>Spectralis SD OCT</td>
<td>ISNT</td>
<td>Not done</td>
</tr>
<tr>
<td>Dave et al 2015</td>
<td>Indian</td>
<td>126</td>
<td>5-18</td>
<td>100.3±8.3</td>
<td>Spectralis SD OCT</td>
<td>ISNT 30 eyes IST 66 eyes</td>
<td>Not done</td>
</tr>
<tr>
<td>Rao et al 2013</td>
<td>Indian</td>
<td>74</td>
<td>4-17</td>
<td>94±10.9 RE 93±10.6 LE</td>
<td>Cirrus HD OCT</td>
<td>SITN</td>
<td>Not done</td>
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<tr>
<td>Al Haddad 2014</td>
<td>Lebanese</td>
<td>108</td>
<td>6-17</td>
<td>95.6±8.7</td>
<td>Cirrus HD OCT</td>
<td>ISNT</td>
<td>Interocular symmetry studied, Significant differences in superior, nasal, temporal quadrant ONH</td>
</tr>
</tbody>
</table>
# Optic Nerve Head Parameters

<table>
<thead>
<tr>
<th>n</th>
<th>Age</th>
<th>Average RNFL (μm)</th>
<th>Superior RNFL (μm)</th>
<th>Temporal RNFL (μm)</th>
<th>Inferior RNFL (μm)</th>
<th>Nasal RNFL (μm)</th>
<th>Rim area (mm²)</th>
<th>Disc area (mm²)</th>
<th>C:D area ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>344</td>
<td>6–13</td>
<td>98.46±10.79</td>
<td>123.65±10.49</td>
<td>69.35±11.28</td>
<td>130.18±18.13</td>
<td>71.30±13.45</td>
<td>1.59±0.33</td>
<td>2.05±0.39</td>
<td>0.43±0.19</td>
</tr>
</tbody>
</table>

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**Retinal Asymmetry in Children Measured With Optical Coherence Tomography**

Irene Altemir, Daniel Oros, Noemí Elía, Vicente Polo, Jose M. Larrosa, and Victoria Pueyo

**Normal reference ranges of optical coherence tomography parameters in childhood**

Noemí Elía, Virginia Pueyo, Irene Altemir, Daniel Oros, Luis Emilio Pablo
The range of peripapillary retinal nerve fibre layer and optic disc parameters in children aged up to but not including 18 years of age, as measured by optical coherence tomography: protocol for a systematic review

Alexandra L. Creavin¹, Cathy Williams², Kate Tilling³, Nicholas Timpson³ and Julian P. T. Higgins⁴
AGE & SEX

- RNFL thicknesses - similar in boys and girls.

- Huynh et al - thicker average RNFL ($P = 0.007$) and inferior quadrant RNFL ($P = 0.02$) in boys than in girls after adjusting for age, height, axial length, ethnicity, and cluster sampling.

- Zhu et al - average RNFL thickness, the temporal and inferior quadrants were significantly greater in girls.

REFRACTION AND AXIAL LENGTH

• Inconsistent results.

• Huynh et al, Salchow et al, and Qian et al reported a positive correlation of the average RNFL thickness with refractive error in children.

• Huynh et al.- thinner RNFL with longer axial length in 6-year-old children

Interocular asymmetry in children by OCT

Retinal Asymmetry in Children Measured With Optical Coherence Tomography
IRENE ALTEMIR, DANIEL OROS, NOEMI ELÍA, VICENTE POLO, JOSE M. LARRROSA, AND VICTORIA PUEYO

Symmetry of Retinal Parameters Measured by Spectral-domain OCT in Normal Young Adults
James D. Dalgliesh, BSc (MoBT), MBBS, Yasser M. Tariq, BSc, MBBS,
George Burlutsky, MStat, and Paul Mitchell, MD, PhD, FRANZCO

Interocular symmetry in retinal and optic nerve parameters in children as measured by spectral domain optical coherence tomography
Christiane Al-Haddad,¹ Rafic Antonios,¹ Hani Tamim,² Baha’ Noureddin¹
Qian et al --thicker RNFL in the left eye.
Al-Haddad et al -thicker nasal and temporal quadrant in right eyes and a thicker superior quadrant in left eyes
Altemir et al -RNFL in the right eyes was thicker in the temporal and nasal quadrants, whereas the left eyes showed thicker RNFL in the superior quadrant
Interoculor Symmetry of Retinal Nerve Fiber Layer and Optic Nerve Head Parameters Measured by Cirrus HD-OCT in a Normal Pediatric Population

Neeleman Pavaar1, Rengaraj Venkatesh2, Rengepula Ramakrishnan3, Meenakshi4, Devendra Maheshwar4
1. Aravind Eye Hospital, Tirunelveli, India, 2. Aravind Eye Hospital, Pondicherry, India

INTRODUCTION
► There exists some difference between the paired organs of the human body. Certain degree of asymmetry can be a normal variation in healthy eyes.
► Presence of even small asymmetry could be pathogenic. Underlying pathologic change and assessment of this asymmetry could be used in the diagnosis of glaucoma, pediatric neuroophthalmology, pediatric retinal disorders. Only a few previous studies in the literature documented the presence of non-pathologic interocular differences in children <16 years.
► This study aimed to examine interocular symmetry of OCT measured RNFL and optic nerve head parameters in healthy children. Seventy normal Indian children ages 5-17 years presenting to the Pediatric Clinic were included in this observational cross-sectional study. All subjects underwent a comprehensive ophthalmologic examination and an evaluation of the retinal nerve fiber layer (RNFL) and optic nerve head by Cirrus OCT.

PURPOSE
► To determine interocular differences in retinal nerve fiber layer and optic nerve head parameters in a pediatric population using Cirrus HD-OCT.

METHODS
► This was an observational cross-sectional study. In 70 healthy children aged 5-17 years with no ocular abnormality except refractive error (RNFL and optic nerve head measurements were performed using the Cirrus OCT machine). Main outcome measures were interocular differences and their correlations with age, gender.
► Optic disc cube 200-200 Protocol were utilized to assess peripapillary retinal nerve fiber layer thickness (RNFL) (512 points). RNFL thickness (of four quadrants: superior, nasal, inferior, and temporal, average, and 12 clock hours). RNFL symmetry rim area, disc area, average C/D ratio and vertical C/D ratio and cup volume were recorded. For the clock hour RNFL thicknesses, twelve 30° sectors were defined in clockwise order for the right and anti-clockwise for the left eye.
► Statistical analysis
  - Differences between right and left eyes were calculated and values were compared by means of a paired t-test. Descriptive statistics were reported as means and SDs, t test, with p values for continuous variables and frequency and percentage for categorical variables. Mean differences for all parameters were calculated by subtracting right eye parameters from right eye parameters and then respective p values reported using the paired sample t-test. Mean values of ocular parameters were compared by using unpaired t-test.

RESULTS
► Differences in the average RNFL between right and left eyes were not statistically significant (P=0.06).
► Superior quadrant RNFL was thicker in left eye and temporal quadrant was thicker in right eye.
► Among optic nerve head parameters there was no statistically differences except vertical C/D ratio which was significant (P=0.007). Mean interocular retinal nerve fiber layer thickness differences in superio, superior nasal, and temporal superior quadrants were 18.61 (P=0.001), 12.37 (P=0.001), 4.46 (P=0.002), respectively. Intercocular nerve fiber layer thickness differences were not significantly correlated with age or sex except for inferior and nasal inferior in below and above 10 years of age, P= 0.007 and P= 0.007 respectively.
► Values corresponding to the central 95 percentiles should be considered normal. Therefore, the values below the 2.5th and above the 97.5th percentiles represent outliers, and pathology should be considered.

CONCLUSION
► The average measured RNFL thickness in the right and left eyes of children differed in previous studies. Qian et al found that the RNFL was thinner in the left eye. Al-Haddad et al and Almeiri et al also reported thicker nasal and temporal quadrant in right eye and a thicker superior quadrant in left eyes while differences in the average RNFL between right and left eyes were not statistically significant similar to our study except nasal quadrant.
► Qian et al and Lue et al (Sydney childhood eye study) used Stratus OCT for interocular differences in RNFL parameters.
► For average RNFL, the current study had 6.6% from normal range (95% CI limits).
► Limitations of our study include the relatively small number of subjects and only Indian pediatric subjects so it may not be applicable to other ethnic population.

Table 1: Interocular Differences in RNFL parameters and ONH parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean Difference (μm)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average RNFL (μm)</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Superior RNFL (μm)</td>
<td>18.61</td>
<td>0.001</td>
</tr>
<tr>
<td>Superior nasal RNFL (μm)</td>
<td>12.37</td>
<td>0.001</td>
</tr>
<tr>
<td>Temporal RNFL (μm)</td>
<td>4.46</td>
<td>0.002</td>
</tr>
<tr>
<td>Vertical C/D ratio</td>
<td>0.007</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Percentile Distribution of Interocular Differences, Right Eye/Lefl Eye in RNFL, Thickness and ONH Parameters

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Right Eye</th>
<th>Left Eye</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5th</td>
<td>30.1</td>
<td>30.0</td>
<td>0.1</td>
</tr>
<tr>
<td>97.5th</td>
<td>31.7</td>
<td>31.5</td>
<td>0.2</td>
</tr>
</tbody>
</table>

REFERENCES
► Al-Haddad C, Antoniou R, Tanski R, Narendran R. Intercocular symmetry in retinal and optic nerve parameters in children aged 5-17 years using the Cirrus HD-OCT.

CONCLUSION
► In this study, we report the degree of interocular symmetry of RNFL and ONH parameters measured by Cirrus HD-OCT in a pediatric population.
► Normal variation in interocular symmetry does exist. Our results can contribute to establish a standard reference for interocular differences in OCT parameters in children aged 5-17 years using the Cirrus HD-OCT.

No financial disclosures
Dr. Neeleman Pavaar, Aravind Eye Hospital, Tirunelveli, India. Email: drneet@gmail.com,

A R A V I N D  E Y E  C A R E  S Y S T E M
Poll Question 4

- What is your routine /preferred choice of Spectral OCT?
  1. Cirrus HD OCT
  2. Spectralis
  3. Optivue
  4. Rtvue
  5. Topcon
  6. Spectral OCT/SLO
  7. Others
Li J et al. in their meta-analysis of 28 clinical trials involving 408 patients observed that pRNFL thickness in the amblyopic eyes was thicker than in the fellow eyes (P = 0.016).

Implications in Pediatric Ophthalmology

- Diagnostic and imaging tool with regard to pediatric optic nerve pathology including Pediatric Glaucoma
- Optic nerve atrophy
- Optic nerve hypoplasia
- Papilledema
- Pediatric IIH
- Pediatric Optic Neuritis

Complex Art

Provision of normative data facilitate age specific interpretation of pediatric OCT imaging
OCT in glaucoma—Novel insights

- In primary congenital and juvenile open angle glaucoma - RNFL thickness and cupping reversal in response to surgical intervention.

- Preoperative cupping observed in pediatric glaucoma reflects true RNFL damage rather than change in optic nerve compliance.


Papillary retinal nerve fiber layer thickness measurement using optical coherence tomography in children with ocular hypertension and juvenile glaucoma. Article in Journal francais d'ophtalmologie 33(4):249-57 · March 2010
Pediatric Glaucoma Diagnosis
12 year Indian Origin female, VA 20/20
JOAG, Dorzox –T BD OU, HFA unreliable,
IOP 23 OD, 25 OS mmHg,
CCT 519 microns.
Open angle OU
RE CDR 0.7, LE 0.8 inferior rim thinning, inferior NFLD, LE trab and trab
Post trabeculectomy and trabeculotomy at age of 2 years OU, Reversal of cupping

OU 20/20
Poll Question 4

- Do you prefer to do OCT routinely in cases of pediatric Optic Neuritis, optic nerve head drusen, papilledema?

1. Always
2. Sometimes
3. Very Rare
4. Cannot comment
LAZY V (SHYPS) in Papilledema vs Lumpy bumpy contour of ON Drusen

Differentiating Optic Disc Edema From Optic NerveHead Drusen on Optical Coherence Tomography

Poll Question - 5

- What is the diagnosis based on OCT of this pediatric patient?

1. Optic Nerve Head Drusen
2. Optic Atrophy
3. Papilledema
4. Pseudopapillidema
Idiopathic Intracranial Hypertension-IIH

- To diagnose and monitor pediatric pseudotumor cerebri
- Visual prognostic tool indicator
3 year male- vomiting, headache since 6 days
Squinting and turning of face since 3 days
OU full movements, Esotropia 20PD. Fundus – Disc edema OU, MRI suggestive of IIH.
Cirrus OCT - Pre and post treatment with Acetazolamide

Vision -6/6 with Cardiff card in each eye
• Anterior segment – WNL,
• Fundus- no disc edema, within normal limits

Obviates need of repeated Lumbar puncture. A discrepancy between OCT and visual field testing can be helpful.
Serial OCT imaging and perimetry can be the standard in monitoring papilledema.
Congenital optic disc anomalies

- ONH Hypoplasia, Optic Disc Pit, ONH coloboma

- Vigabatrin toxicity

Retinopathy of Prematurity—ROP

- Akerblom and associates attributed thinner RNFL thickness by lower gestational age to thinner RNFL in the children with a history of severe ROP.

- Pueyo and associates found thinner RNFL measured in school-age children with a history of early prematurity and ROP treatment.


Optic nerve Glioma

- RNFL Loss from optic atrophy secondary to optic nerve glioma in older children with neurofibromatosis type1.
- OCT may be a valid substitute when patients are unable to perform perimetry.

*Visual Outcomes, Visual Fields, and Optical Coherence Tomography in Paediatric Craniopharyngioma*

*Soraya Mediero, Susana Noval, Luciano Bravo-Ljubetic, Inés Contreras, Fernando Carceller*  

Optic Neuritis

- Thickening of the peripapillary RNFL on OCT during the acute phase in ON, later thinning

- Leber Hereditary Optic Neuropathy – LHON
  - Vision OU 20/200
  - Ishihara plates - first plate
  - MRI - Normal
  - Fundoscopic exam revealed the development of temporal optic nerve pallor with loss of hyperemia OU
  - OCT showed thinning of the RNFL OS > OD
  - Started on IDEBENONE 25mg BD
OCT in Craniosynostosis

- Peripapillary RNFL thickness measured by SD-OCT provides adjunctive evidence for identifying optic neuropathy in patients with craniosynostosis and appears more sensitive at detecting optic atrophy than papilledema.

CNS Development indicator

- Optic nerve parameters predictive of CNS development and pathology with larger Vcdr being associated with Lower Bayley Scales of Infant Development scores.

- Weak association - larger vertical cup diameter and Vcdr with periventricular leukomalacia and shallower cup with post hemorrhagic hydrocephalus.


Rare Cases

Unilateral optic nerve aplasia (ONA)
the morphologic changes of the retina in ONA
OCT-documented optic atrophy in nonsyndromic craniosynostosis and lacunary skull

Neelam Pawar, S. Padmavathy, Devendra Maheshwari, Meenakshi Ravindran, R. Ramakrishnan  Feb 2017 : 21; 78–81

**ONH and RNFL OU Analysis: Optic Disc Cube 200x200**

<table>
<thead>
<tr>
<th></th>
<th>OD</th>
<th>OS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average RNFL Thickness</td>
<td>37 μm</td>
<td>36 μm</td>
</tr>
<tr>
<td>RNFL Symmetry</td>
<td>64%</td>
<td></td>
</tr>
<tr>
<td>Rim Area</td>
<td>1.76 mm²</td>
<td>1.91 mm²</td>
</tr>
<tr>
<td>Disc Area</td>
<td>2.25 mm²</td>
<td>2.07 mm²</td>
</tr>
<tr>
<td>Average C/D Ratio</td>
<td>0.45</td>
<td>0.27</td>
</tr>
<tr>
<td>Vertical C/D Ratio</td>
<td>0.41</td>
<td>0.36</td>
</tr>
<tr>
<td>Cup Volume</td>
<td>0.023 mm³</td>
<td>0.000 mm³</td>
</tr>
</tbody>
</table>

**Neuro-retinal Rim Thickness**

Disc Center (-0.09,0.06) mm

**Extracted Horizontal Tomogram**

**Extracted Vertical Tomogram**

**RNFL Circular Tomogram**

**Normative data is not available. Patient age < 18.**

**RNFL Quadrants**

**RNFL Clock Hours**

**eSupplement 1.** Peripapillary retinal nerve fiber layer thickness measured by spectral domain optical coherence tomography at presentation.
Future of OCT – Pediatric Ophthalmology

OCT – Diagnostic tool

Ethnic and pediatric age parameters in machine.!!!!!!!!!!

More implications

OCT sees what your eyes donot see
No MACHINE is better than human eye and brain
Thank you
Minutes before leaving........

- WELCOME TO QUESTIONS ????????