Background

- Optical coherence tomography (OCT) is widely used to diagnose and monitor optic neuropathies and retinopathies.
- Handheld spectral domain OCT (HH-OCT) can be used in young children unamenable to traditional tabletop imaging and its applications include:
  - Monitoring vision loss caused by optic nerve glioma.¹
  - Studying retinal development in vivo.²
  - Safety imaging technologies to measure the retinal nerve fiber layer as well as monitor retinopathy of prematurity (ROP) and macular edema.³

- In rapidly growing eyes of children ≤ 5.5 years, there is no normative OCT data, and we suspect it would significantly differ from that of older children and adults.
- A normative database would provide a comparison for children with abnormal e.g.: ROP, glaucoma, optic neuropathies, or exposed to certain medications like Vepatraxin.
- Herein, we report OCT measurements of the ganglion cell complex (GCC), which comprises the retinal nerve fiber, ganglion cell, and inner plexiform layers.

Objective

To build a normative database of handheld-OCT measurements in healthy pediatric eyes and to report ganglion cell complex (GCC) measurements.

Methods

- Ongoing, prospective observational study
- Inclusion criteria:
  - Healthy children ≤ 5.5 years-old with normal eyes
  - Gestational age ≥ 37 weeks
  - Normal retina, optic nerve, and anterior segment
  - Undergoing sedation or general anesthesia for examination under anesthesia (EUA) or extraocular ophthalmic surgery
- Exclusion criteria:
  - Prematurity (<37 weeks)
  - Ophthalmic disease affecting the retina or optic nerve
  - Neurologic or genetic disease affecting the optic nerve (i.e. seizure, Chiari malformation, malignancy)
- Data collected demographics, axial length (Master Vu, bioptigen, vuEau, excalibur, Lake surfaces, NV), HH-OCT macular rectangular volume scans at 0 degrees (bioptigen, inc, montville, NC)
- DOCTRAP-US (Duke-developed software) used to segment retina and analyze retinal thickness.
- All volumes reviewed and best foveal volume scan of one eye per patient selected for automated segmentation
- Each segmented volume scan was then manually corrected by study personnel
- An ETD35 map was used to eliminate scan areas of poor or unreadable quality (Figure 1).

Results

- 67 eyes (67 children) were enrolled
- Reliable HH-OCT scans were available for all 67 eyes in most quadrants:
  - Inner Inferior (n=63/67)
  - Outer Superior (n=62/67)
  - Outer Nasal (n=55/67)
  - Outer Inferior (n=54/67)
  - Outer Temporal (n=64/67)
- See Table 1 for demographic data and baseline clinical characteristics
- There was no correlation found between GCC volume and patient age (Figure 2)

Table 1: Demographic and characteristics

<table>
<thead>
<tr>
<th>Demographic Data</th>
<th>Number of Eyes*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Number of Eyes*</td>
</tr>
<tr>
<td>Male</td>
<td>31</td>
</tr>
<tr>
<td>Female</td>
<td>36</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>47</td>
</tr>
<tr>
<td>African American</td>
<td>9</td>
</tr>
<tr>
<td>Hispanic</td>
<td></td>
</tr>
<tr>
<td>More than one race</td>
<td>8</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>Age at time of scan (months)</td>
<td>30.0 ±21.2</td>
</tr>
<tr>
<td>Mean Range</td>
<td>3.4 to 70.9</td>
</tr>
<tr>
<td>Axial Length (mm)</td>
<td>21.2±1.0</td>
</tr>
<tr>
<td>Spherical Equivalent (diopters)</td>
<td>1.49 ±1.34</td>
</tr>
<tr>
<td>Mean Range</td>
<td>-2.25 to +4.25</td>
</tr>
<tr>
<td>Average GCC Volume (mm³)</td>
<td></td>
</tr>
<tr>
<td>Total Retina</td>
<td>0.28 ±0.04</td>
</tr>
<tr>
<td>Inner Ring</td>
<td>0.16 ±0.02</td>
</tr>
<tr>
<td>Outer Ring</td>
<td>0.48 ±0.07</td>
</tr>
</tbody>
</table>

Figure 1: ETDRS map used for data analysis

Table 2: Linear regression of Average Ganglion Cell Complex Volume by Age for the Total Retina (a), Inner Ring (b), and Outer Ring (c)

<table>
<thead>
<tr>
<th>a) Total Retina</th>
<th>b) Inner Ring</th>
<th>c) Outer Ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>y = 0.0002x + 0.2769</td>
<td>y = 0.0005x + 0.4664</td>
<td>y = 0.0005x + 0.4644</td>
</tr>
<tr>
<td>R² = 0.0104</td>
<td>R² = 0.0098</td>
<td>R² = 0.0026</td>
</tr>
</tbody>
</table>

Table 3: Average Total Retina GCC Volume (mm³) for Patient #75 (age: 18 months) which is tilted and (b) Patient #75 (age: 28 months) which is not tilted.

Figure 2: Average Total Retina GCC Volume (mm³) for Patient #75 (age: 18 months) which is tilted and (b) Patient #75 (age: 28 months) which is not tilted.

Conclusions

- Average GCC thickness was stable from 6-months to 5-years of age.
- Data collection and analysis is ongoing in this population of healthy children. The research provides a normative control database for comparison to children with glaucoma and other optic neuropathies.
- The changes at the level of the fovea that occur in the first year of life do not seem to affect the average GCC²

References:


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Limitations

- Small sample size
- No analysis software available for the Bioptigen machine
- DOCTRAP is difficult to use and time consuming
- No eye tracking capabilities
- Can’t adjust for image tilt (Figure 3)