OCT-3 Predicts Visual Loss In Glaucoma Suspects

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Introduction

Standard Automated Perimetry has poor sensitivity for detecting glaucoma. Clearly there is a compelling need for more sensitive glaucoma diagnostic tests. Assessing the Retinal Nerve Fibre Layer Thickness (RNFLT) could be a step forward in this direction because of the following reasons: Structural tests to assess the Retinal Nerve Fibre Layer correlates well with retinal ganglion cell loss and clinical and scientific evidence suggests that Retinal Nerve Fibre Layer loss occurs before standard visual field loss and optic disc changes. Retinal Nerve Fibre Layer assessment and documentation using Optical Coherence Tomography are vital for diagnosing and monitoring glaucoma in clinical practice. Optical Coherence Tomography 3 produces 512 A-Scans with 1024 data points per A-Scan for a total of 525,000 pixels with a resolution of 8-10 µm. Image acquisition time is < 1 sec. 512 A-Scans are used to create a single standard OCT image. OCT calculates retinal thickness which is the distance between vitreoretinal interface and junction between inner and outer segment of photoreceptors above the retinal pigment epithelium. Retinal Nerve Fibre Layer thickness is measured directly from the Scan using an automated computer algorithm and summarized by quadrants and clock hours. The overall mean thickness is also obtained using the optical coherence tomogram.

Aim

To evaluate whether peripapillary Retinal nerve fibre layer thickness loss as estimated by the Optical Coherence Tomography 3 (OCT 3) in patients labelled as glaucoma suspects, actually converted to Short Wavelength Automated Perimetry (SWAP) changes within a study period of two years and to establish that Retinal nerve fibre layer thickness loss was the earliest evidence of primary open angle glaucoma.

Materials and Methods

332 eyes of 212 Indian individuals in the age group of 30-70 years attending the glaucoma service of B B Eye Foundation over a period of two calendar years were labelled as glaucoma suspects on the basis of 1. BCVA of at least 20/20 with a correction not ≥+5 or -5 Dsph and =+2 or -2 Dcyl,(2) IOP = 22mmHg (3) Central Corneal Thickness-within normal limits (4) Asymmetrical Cupping>0.2 difference in two eyes or >0.6 in either eye (5) Open angles on gonioscopy (6) Transparent ocular media (7) Humphrey Visual Field Analysis – within normal limits(24-2 Full Threshold) (7) SWAP–within normal limits

All 332 eyes who met the inclusion criteria were subjected to SWAP(blue on yellow 24-2 Full Threshold) every month and RNFLT analysis – peripapillary 3.4mm circular scans by the OCT3 every month.

Abnormal SWAP was defined as 4 points depressed at P<5% or a cluster of 3 points depressed at P<1%. Short Wavelength Automated Perimetry average Pattern Deviation of 21 visual field zones were determined and 2 repetitive short wavelength automated perimetry fields were considered to avoid false positives.

RNFLT loss was defined as (1) 1 quadrant abnormal at the <5% level or (2) 1 clock hour abnormal at the <1% level.
Correlations between deviation from normal (thinner than 95% of normal) Retinal Nerve fibre layer thickness measurements taken at 30° sectors (12 sectors described as clock hours) and short wavelength automated perimetry average Pattern Deviation of 21 visual field zones were determined. The number of Optical Coherence Tomography measured retinal pigment epithelium sectors outside normal limits and the number of Visual field zones outside normal limits were also compared.

The Optical Coherence Tomography measured retinal nerve fibre layer thickness was analyzed and the subjects were divided based on whether nerve fibre layer loss was present or not and again subdivided based on conversion to field changes in the short wave automated perimetry (TABLE1). Out of 332 eyes which were serially followed up 274 eyes (Group α) had retinal nerve fibre thickness loss on analysis. 196 of these eyes (Group β) converted to visual field loss on the short

Fig 1. Demonstrating SWAP changes in a patient with RNLFT loss on OCT:3
wave automated perimetry. 58 eyes (Group γ) did not exhibit evidence of retinal nerve fibre thickness loss on follow up. However 10 of these patients (Group δ) converted to visual field changes on Short wavelength automated perimetry during follow up. Table (2) gives the peripapillary retinal nerve fibre layer thickness data analysis results quadrant wise.

The RNFL areas most frequently outside normal limits were the inferior and inferior temporal regions. The least sensitive Visual Field (VF) zones were in the superior hemifield. Linear regression showed OCT sectors 6 o’clock, 7 o’clock and 8 o’clock (inferior and inferior temporal) was best correlated with SWAP pattern deviation in VF zones 13, 14, & 16 (superior hemifield, central and arcuate areas).

RNFLT loss measured with OCT3 is topographically correlated with glaucomatous VF defects measured with SWAP.

The conversion time from detection of RNFLT loss to SWAP changes was 5.4 to 9.8 months. The average lead time was 7.6 months.

Conclusions

Using this study results, the positive predictive Value (diagnostic performance) of RNFL analysis, which is the most relevant index for early detection of glaucoma is 72%. RNFL areas most frequently outside normal limits are the inferior & inf temporal regions.

Least sensitive VF zones were the superior hemifield. OCT sectors 6,7, & 8 o’clock best correlated with SWAP pattern deviation VF zones 13, 14 & 16. RNFLT loss measured by OCT 3 is topographically correlated with glaucomatous VF defects measured with SWAP.

Conversion time from detection of RNFLT loss was 5.4 – 9.8 months and the average lead time was 7.6 months.

The principle finding of the study is that a statistically significant number of glaucoma suspects with RNFLT loss converted to SWAP abnormalities (p<0.01). We used SWAP VF results as the criteria since SWAP has been shown to have better sensitivity than SAP for early detection of glaucoma.

Table 1. RNFLT Analysis Results

| Group | Number of Eyes | RNFLT Loss
|---|---|---|
| α | 274 | RNFLT loss
| β | 196 | Converted to SWAP changes
| γ | 58 | No RNFLT loss
| δ | 10 | Converted to SWAP changes without RNFLT loss

Table 2. The Peripapillary OCT RNFL Thickness Data Analysis Quadrant wise

<table>
<thead>
<tr>
<th>Groups of Glaucoma suspects</th>
<th>Average</th>
<th>Superior temporal</th>
<th>Supero-temporal</th>
<th>Temporal</th>
<th>Infero-temporal</th>
<th>Inferior</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group(α) RNFL LOSS (n= 274 eyes)</td>
<td>100±10</td>
<td>120±18</td>
<td>135±15</td>
<td>93±18</td>
<td>105±10</td>
<td>85±12</td>
<td>83±18</td>
</tr>
<tr>
<td>Group(β) CONVERTERS WITH RNFL LOSS (n=196 eyes)</td>
<td>100±12</td>
<td>112±20</td>
<td>100±12</td>
<td>88±22</td>
<td>95±15</td>
<td>80±16</td>
<td>80±20</td>
</tr>
<tr>
<td>Group(γ) NO RNFL LOSS (n=58 eyes)</td>
<td>125±15</td>
<td>150±20</td>
<td>165±17</td>
<td>94±20</td>
<td>160±12</td>
<td>140±22</td>
<td>80±20</td>
</tr>
<tr>
<td>Group δ CONVERTORS WITHOUT RNFL LOSS (n=10)</td>
<td>125±15</td>
<td>150±20</td>
<td>165±17</td>
<td>94±20</td>
<td>160±12</td>
<td>140±22</td>
<td>80±20</td>
</tr>
</tbody>
</table>

Table 3. Swap Analysis

<table>
<thead>
<tr>
<th>Abnormal Swap</th>
<th>RNFLT Loss 1 Quadrant</th>
<th>RNFLT Loss 1 Clock Hr</th>
<th>RNFLT Loss &gt;1quadrant</th>
<th>RNFLT Loss &gt; 1 Clock Hr</th>
<th>No RNFLT Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Points</td>
<td>6</td>
<td>0</td>
<td>72</td>
<td>36</td>
<td>7</td>
</tr>
<tr>
<td>3 Points</td>
<td>4</td>
<td>0</td>
<td>54</td>
<td>24</td>
<td>3</td>
</tr>
</tbody>
</table>

Chi square test showed Group α : Group β (p<0.01) Group γ : Group δ (p>0.05)
Clearly there is a compelling need for more sensitive glaucoma diagnostic tests. Assessing the RNFL would lead to earlier detection of glaucoma and therefore earlier commencement of treatment and thus prevent visual loss. OCT 3 predicts visual loss in glaucoma suspects and establishes RNFLT loss as the earliest evidence of POAG.

References

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3. Imaging in glaucoma : Joel S. Schuman : Chapter 5;
5. Kwok Hei Mok etal. Retinal nerve fiber layer measurement by optical coherence tomography in glaucoma suspects with short wavelength automated perimetry abnormalities:Journal of glaucoma 2003,12:45-49