Association between sectorial retinal nerve fiber layer thickness with anatomical variables of Lamina Cribrosa- A comparative study

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**ABSTRACT**

Objective
To compare sectorial retinal nerve fiber layer thickness (RNFLT) with anterior Lamina Cribrosa depth (ALCD) and Lamina Cribrosa thickness (LCT) in primary open-angle glaucoma (POAG) cases and healthy age-matched controls.

Methodology
This was a case-control study. Senior ophthalmologist recruited 57 POAG cases and 46 age-matched healthy controls. Calculation of intraocular pressure (IOP) and open angle carried out using Goldmann tonometry and Slit-lamp biomicroscopy with stereoscopic ophthalmoscopy respectively. Extremely precise spectral domain ocular coherence tomography with enhanced depth imaging (EDI-OCT) utilized to determine ALCD, LCT and RNFLT.

Results
RNFLT in various sectorial regions displayed statistically significant results (p-value of 0.001) when compared with controls in a case control study. Superior retinal sector revealed the highest ranges of thickness (75.50 ± 9.64 μm), while thin retina was observed in global measurements (48.40 ± 0.84 μm). Enhanced ALCD was seen (545.50 ± 3.5 μm) among 15 POAG cases. Least thickness of LCT documented in the four POAG cases in inferior retinal sector (204.57 ± 79.04 μm).

Conclusion
Assessments of RNFLT, ALCD and LCT provides valuable knowledge that can be utilized for the management and predicting the course and prognosis of POAG.

Key words: Retina, Lamina Cribrosa, Glaucoma, Tonometry, Ocular coherence tomography

**INTRODUCTION**

Glaucoma is a plethora of visual disorders, whose pathogenesis revolves around the imbalance in the production and drainage of aqueous humor. It is a protracted ocular condition, typically affecting both eyes that occur in middle to advanced age groups.1 Worldwide it is adding heavily to the prevalence of cases in middle to old aged population.2 Glaucoma ranks second in causing irreversible loss of vision 3 and POAG is also the second leading cause of blindness worldwide 4 and in Pakistan as well.5 Glaucoma being an immense factor for disability, in our already socioeconomically affected country; it is adding more financial and health burden in our population. Glaucoma initiates a cascade of deleterious events that lead to glaucomatous optic neuropathy (GON) 5 that causes thinning of RNFLT which ultimately leads to loss of vision. World over researchers had proved LC to be the site for the initiation to retinal ganglion cell damage and to have strong association with the progression of glaucoma.6,7 Glaucoma causes retinal ganglion cell damage8 that leads to the progression of optic neuropathy, ultimately leading to development of GON. Lamina cribrosa (LC) is the posterior most part of sclera and is the spot from which the optic nerve exits the globe of the eye, due to which LC appears like a sieve. LC withstands the developing increasing intraocular pressure (IOP), which is the main pathogenesis in glaucoma.9 Thinner lamina cribrosa thickness (LCT), normal thickness being 378.1 ± 117.8 μm (median, 360 μm)10 and deepening of anterior lamina cribrosa depth (ALCD), normal being 449.3 μm 10 had strongly been advocated to be linked with thinner RNFLT10 (The normal RNFLT measured by Spectral domain ocular coherence tomography (SD-OCT) had been calculated to be around 100 μm 10 by numerous globally conducted studies. Interventional options for glaucoma have been paid more attention rather than focusing towards primary measures of timely screening and halting the progression of glaucoma. LC anatomical measurements, like ALCD and LCT can be an answer to it .11 Despite of a high prevalence of POAG in Pakistan, such novel variables had never been researched upon, which could introduce non-invasive tools for timely decision taking in management of POAG and thus it may lessen the burden of disabilities caused by...
this deleterious disease. This work is a pioneer research in regards of studying LC anatomical variables and comparing it with the RNFLT, and expects it to add valuable information regarding new investigatory modalities for POAG.

**METHODOLOGY**

This case-control study was conducted at Al-Ain Eye Institute, Karachi, from November 2018 till February 2019 after receiving permission from ERC from Bahria University Medical and Dental College. Sample size of 112 (56 cases and 56 controls) had been planned using “comparing two means” and the estimation of cases was based on the study done by and non-probability purposive sampling technique employed to select the subjects after taking their consent. The cases included had

1. Intraocular pressure (IOP) of >22mmHg measured by Goldmann tonometry (AT-900, Haag Streit, Switzerland)
2. Open angle calibrated by Slit-lamp (Topcon SL-D 7, Topcon Corporation, Tokyo, Japan) and stereoscopic ophthalmoscope (WelchAllyn, USA)
3. Had least visual acuity of >20/40

The subjects with other variants of glaucoma, moderate to severe cataract, head trauma, neurological, autoimmune defects, diabetic and hypertensive retinopathies were all excluded from the study.

ALCD and LCT were calculated by EDI-OCT (REVO nx/SOCT Copernicus REVO OPTOPOL Technology, Wavelength 830nm, Axial resolution 2µm, scan speed 1,10,000 scans/sec, scan time 1.37seconds, OPTOPOL Technology Sp. Z o.o, ul. Zabia 42, 42-400 Zawiercie, Poland), with standard guidelines. ALCD was calculated as a line in the middle of the ends of Bruch’s membrane and anterior border of LC. LCT was assessed by measuring the width sandwiched between the anterior and posterior borders of LC.

For Statistical analysis of the study, SPSS version 23 was utilized. Margin of error for sample size calculation was 5% with confidence interval for mean 95%. Kruskal –Wallis test for ALCD and RNFLT were employed. One way ANOVA was used to estimate LCT..p-value of < 0.05 was taken as significant.

**RESULTS**

The study included 57 cases of POAG and 46 age-matched healthy controls. 9 respondents were dropped due to poor image quality, obscured view of LC or inability to follow the instructions. Age and gender did not show any significant association with POAG. 56.1% subjects were males and 43.9% were females. Maximum numbers of cases reported were in the age group of 61-70 years. The cases were diverse; some new cases and some were old. Segregation of retina into sectors was according to the standard set by the EDI-OCT into superior, inferior, superior-inferior, nasal, superior, inferior, nasal and global (Table 1).

**Estimation of RNFLT in different retinal sectors in POAG cases**

Calibration of RNFLT and anatomical parameters of LC were ascertained in the POAG cases (n=57). Majority of the respondents were observed to have superior as well as superior-inferior RNFLT defects (n=15). Small number of cases (n=2) had shown defects in other sectors of retina. Maximum RNFLT was found out in the superior sector (75.50 ± 9.64 µm), while most thinning was seen in the global RNFL defects (48.40 ± 0.84 µm). Table 1 shows the overall RNFLT which had shown statistically significant result. Maximum LCT was exhibited in the superior-inferior sector (226.99 ± 136.23 µm) which parallels with the RNFLT defect as well, whereas the minimum LCT was found out in the inferior sector (204.57 ± 79.04 µm). Maximum ALCD was shown by the global retinal sector (545.50 ± 3.53 µm) and minimum ALCD observed in inferior defects (265.08 ± 64.51 µm). ALCD and LCT when compared with RNFLT in cases produced insignificant results.

Retinal nerve fiber layer thickness in different age groups in POAG cases and controls

Such highly significant findings of RNFLT prompted us to explore it in different age groups among the cases and controls. Declining RNFLT can clearly be observed in advanced age groups as shown in figure 1.

**DISCUSSION**

Studies regarding the prophylactic approaches in the management of POAG had not been touched upon in Pakistan. LC had been researched worldwide in this context, but in Pakistan it had never been explored. This study can thus be regarded as the first research ever conducted in Pakistan over the anatomical parameters of LC. World over ALCD and LCT had strongly been linked with the onset and progression of glaucoma. LC proves to be an exciting focus directed towards the non-invasive progression measure of POAG. The findings of this study can thus be paralleled with any research conducted worldwide. It had been documented by researchers worldwide that progression of POAG relates well with waning of RNFLT. Retina is the neuro-sensitive layer of eye involved with the image formation, and retinal ganglion cells are the cells responsible for...
Assessments of RNFLT, ALCD and LCT provides valuable knowledge that can be utilized for the management and predicting the course and prognosis of POAG.

### Table 1: Evaluation of Sectorial Retinal Nerve Fiber Layer Thickness (RNFLT) With Anterior lamina cribrosa depth (ALCD) and lamina cribrosa thickness (LCT) in Primary Open-Angle Glaucoma (POAG) cases. n=57. p-value of ≤0.05 is significant and shown with asterisk*  

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Superior (n=15)</th>
<th>Inferior (n=4)</th>
<th>No retinal defects in cases (n=19)</th>
<th>Superior and inferior (n=15)</th>
<th>Superior, inferior, nasal (n=2)</th>
<th>Superior, inferior, temporal and nasal (n=2)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RNFLT (µm)</td>
<td>75.50 ± 9.64</td>
<td>67.45 ± 11.61</td>
<td>82.24 ± 9.24</td>
<td>67 ± 13.87</td>
<td>53.10 ± 8.62</td>
<td>48.40 ± 0.84</td>
<td>0.001*</td>
</tr>
<tr>
<td>ALCD (µm)</td>
<td>288.86 ± 83.91</td>
<td>265.08 ± 64.51</td>
<td>288.27 ± 138.86</td>
<td>284.1 ± 59.3</td>
<td>458.83 ± 431.57</td>
<td>545.50 ± 3.53</td>
<td>0.410</td>
</tr>
<tr>
<td>LCT (µm)</td>
<td>205.04 ± 66.98</td>
<td>204.57 ± 79.04</td>
<td>226.04 ± 136.23</td>
<td>223.25 ± 72.08</td>
<td>226.99 ± 136.23</td>
<td>214.33 ± 91.45</td>
<td>0.985</td>
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**Conflict of Interest:**
The authors declare no conflict of interest.

### REFERENCES


**CONFLICT OF INTEREST**

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