Original Article

Comparison of Anatomical and Functional Characteristics of Lamina Cribrosa between Primary Open-Angle Glaucoma Patients and Controls

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ABSTRACT

Objective: To compare anatomical parameters of Lamina cribrosa (LC) with functional ophthalmological characteristics in Primary open-angle glaucoma (POAG) cases and controls.

Study Design: Case-control study

Place and Duration of Study: This study was conducted at the Al-Ain Eye Institute, Karachi from November, 2018 to February, 2019.

Materials and Methods: Expert ophthalmologist selected 57 POAG cases and 46 age-matched healthy controls. Calibration of intraocular pressure (IOP) and open angle was done using Goldmann tonometry and Slit-lamp biomicroscopy with stereoscopic ophthalmoscopy respectively. Highly specific spectral domain ocular coherence tomography (SD-OCT) was used to ascertain the anterior laminar depth (ALD), lamina cribrosa thickness (LCT) and retinal nerve fiber layer thickness (RNFLT). The functional visual field parameters of mean deviation (MD) and pattern standard deviation (PSD) were calculated using Humphrey Field Analyzer.

Results: Statistically significant results obtained for MD, with cases the range was -2.92dB ± 2.52 dB and in controls -2.21 dB ± 2.52 dB. Similar high significance shown by PSD, in cases was 7.54 dB ± 4.69 dB, and in controls it was 3.73 dB ± 2.12 dB. Anatomical characteristic of LCT revealed significant reduced measurements in cases (218.07 ± 79.80 µm) as compared to controls (271.77 ± 64.45). RNFLT elaborated alike significantly reduced calibrations in POAG cases (73.21 ± 13.63 µm) which in controls was 78.85 ± 9.01µm. Non-significant results obtained for ALCD.

Conclusion: Estimation of anatomical and functional parameters of LCT, RNFLT, MD and PSD may add heavily in diagnosis and prognosis of POAG patients.

Key Words: MD, PSD, ALCD, LCT, RNFLT, SD- OCT

INTRODUCTION

Glaucoma is adding substantial numbers to the global burden of irreversible loss of vision, with prevalence of 3.5% in 40 to 80 years of age[1]. It undoubtedly ranks second among the leading causes of blindness[2].

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Primary open-angle glaucoma is the top second reason of blindness worldwide[3], hence interventions for this grave ailment merits huge. Spectral domain ocular coherence tomography (SD-OCT) is a non-invasive imaging expertise regarded as gold standard for anatomical calibration of retina and deep structures of eye [4]. Glaucoma is known to produce Glaucomatous optic neuropathy (GON) [5], so any resource that may screen this detrimental effect ahead of time which may be non-invasive as well may be something divine. LC anatomical parameters have researched worldwide to be the preferred candidates for this problem [6]. Deepening of ALCD, thinning of LCT along with RNFLT can all be estimated way before the onset of GON and may prove highly beneficial.

In Pakistan, much had been researched regarding interventional aids for glaucoma but nothing much had been done to screen out the devastating effects of the disease. No research had ever been done in Pakistan about LC so this is a pioneer study that revolves around the estimation of anatomical variables of LC and its

comparison with the functional characteristics in cases and controls. This is a milestone study and its findings may prove valuable for our population, as ALCD, LCT estimation had never been calculated in Pakistani population and its comparison with visual field parameters never researched.

MATERIALS AND METHODS

Study design and settings: This case-control study
Study settings: 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 (ERC 60/2018).
Sample Size and Selection Criterion: Sample size of 103 (57 cases and 46 controls) was calculated using "comparing two means", the estimation of cases was based on the study done by [7] and respondents were recruited by non-probability purposive sampling technique.
Inclusion Criteria: The subjects who were enrolled as cases had:
1. Intraocular pressure (IOP) of >22mmHg calculated by Goldmann tonometry (At-900, Haag Striet, Switzerland)
2. Open angle ascertained by Slit-lamp (Topcon SL-D 7, Topcon Corporation, Tokyo, Japan) and stereoscopic ophthalmoscope (WelchAllyn, USA)
3. Having least visual acuity of >20/40
4. visual field estimation as outside normal limits on glaucoma hemifeild test, with three abnormal points with P <5% probability of being normal, 1 with P<1% by pattern deviation, pattern standard deviation of <5% on automated Humphry 50-2 VF analysis ((Medmont M 700 Automated Perimeter, fast threshold, Vermont, Australia) for visual field analysis) [8].
Exclusion Criteria: The participants with any other type 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 measured using SD-OCT with enhanced depth imaging (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[9]. ALCD was calibrated as a line between the ends of Bruch's membrane and anterior border of LC, whereas LCT was estimated by measuring the area between the anterior and posterior borders of LC.
Statistical Analysis: SPSS 23 version was used. Margin of error for sample size calculation was 5% with confidence interval for mean 95%. Mann-Whitney-U test for ALCD, RNFLT and PSD was used. Independent sample T-test was used for analysis of LCT. P-value of < 0.05 was taken as significant.

RESULTS

A total of 103 patients were recruited and segregated into POAG cases (n=56) and healthy age-matched controls (n=46).

Table No.1: Comparison of LC Anatomical characteristics between cases and controls N=103

Age (years)	Subjects		P-value
	Case (n=57)	Control (n=46)	
Retina Nerve Fiber Layer Thickness (µM)	73.21 ± 13.63	78.85 ± 9.01	0.055* §
Anterior Laminar Depth(µM)	300.87 ± 145.38	334.85 ± 154.96	0.220 §
Lamina Cribrosa Thickness (µM)	218.07 ± 79.80	271.77 ± 64.45	0.001* ⸸

P-value ≤0.05 is significant and shown with asterisk *
§- Mann Whitney-U test
⸸- Independent sample T-test
Units used: µm- micrometer

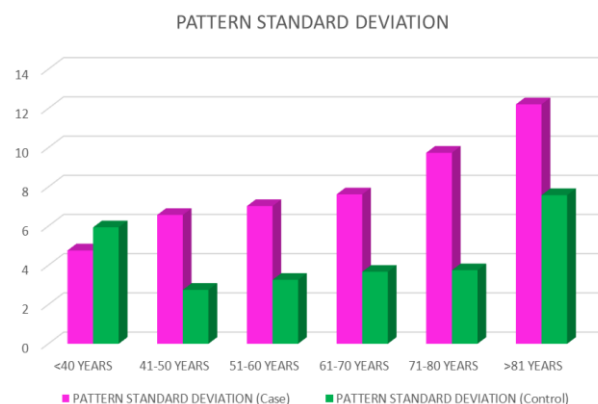**Table No.2: Comparison of general demographic characteristics between cases and controls N=103**

Age (years)	Subjects		P-value
	Case (n=57)	Control (n=46)	
Mean Deviation (dB)	-2.92 ± 2.52	-2.21 ± 2.52	0.047* §
Pattern Standard Deviation (dB)	7.54 ± 4.69	3.73 ± 2.12	0.000* §

P-value ≤0.05 is significant and shown with asterisk *
§- Mann Whitney-U test
Units used: dB- decibel

Figure No.1: Bar Chart Showing Pattern Standard Deviation (PSD) Ranges In Different Study Age Groups of Primary Open Angle Glaucoma Cases and Controls

DISCUSSION

The current study on LC is the pioneer research conducted for the first time ever in Pakistan, which estimated and compared the anatomical variables of LC with the functional ocular characteristics. Highly significant results are produced which can be compared with any international study conducted worldwide.

LCT elaborated highly significant results when imaging done using SD-OCT with extended depth imaging technique (EDI). By serial estimation of LCT, the management, progression and prognosis of POAG can be well managed[10]. Globally POAG had been associated with a thinner LC[11].

Numerous studies have associated the anatomical biomechanics of LC with visual field errors [12]. Our study has also produced similar highly significant results for MD and PSD when the POAG cases underwent standard automated perimetry (SAP). World over studies have proven that LC defects are related with progressive visual field losses [13].

RNFLT is the determinant structural factor that can be linked with LC anatomical defects and visual field impairments[12]. Statistical estimation of RNFLT revealed highly significant results when a comparison was made between POAG cases and controls[14]. RNFLT was observed to be declining with the worsening of the disease[15], so the prognosis of POAG can be linked with structural measurements of LC and RNFLT[16].

CONCLUSION

The anatomical biomechanics of LC have strong association with reduced RNFLT and impaired visual field. Serial monitoring of these variables can prove beneficial in POAG cases.

Recommendations: LC is a prosperous research aspect that had been worked upon worldwide. We need to research more over the molecular and genetic aspects of LC. Moreover a large sample size study should be done in multi-centric settings.

Author's Contribution:

Concept & Design of Study:	Ayesha Saba Naz
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