Assessment of Choroidal Thickness In Patients With Primary Angle Closure Glaucoma In Comparison to Non-glaucoma Subjects Using Enhanced Depth Imaging Spectral Domain Optical Coherence Tomography

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ABSTRACT

Objective

To compare the choroidal thickness of non-glaucoma eyes subjects with the patients of primary angle closure glaucoma (PACG) using enhanced depth imaging spectral domain optical coherence tomography.

Study design

Comparative, cross sectional study.

Place & Duration of study

Layton Rahmatulla Benevolent Trust (LRBT) Hospital Karachi, from January 2024 to December 2024.

Methods

The patients with primary angle closure glaucoma (PACG) were compared with a group of subjects who had mild to moderate cataract. Enhanced depth imaging-optical coherence tomography (EDI-OCT) was used for the assessment of choroidal thickness. Data were entered into IBM SPSS version 27. The mean±SD were used to describe numeric variables, and percentages along with frequencies for the qualitative variables. Independent sample t-test was used to compare the means between the groups.

Results

A total of 200 participants were enrolled. PACG patients were significantly older in age as compared to the non-glaucoma subjects (p<0.05). PACG patients had significantly higher intraocular pressure (IOP -19.36±7.21 mmHg - p<0.05), larger cup-to-disc (C:D ratio - 0.43±0.24 - p<0.05), shorter axial length (21.09±1.10mm - p<0.05), and thicker subfoveal choroid (281.53±8.40um, p<0.05).

Conclusion

The findings of the study underscore structural differences in PACG patients and highlight the diagnostic value of enhanced depth imaging spectral domain OCT. The patients with PACG had thicker subfoveal choroid compared to the non-glaucoma subjects.

Key words

Angle closure glaucoma, Spectral domain OCT, Choroidal thickness, Intraocular pressure, Cup-to-disc ratio.

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INTRODUCTION:

Primary angle-closure glaucoma is a condition that cause optic nerve damage and is considered as an optic neuropathy.[1] It is mainly characterized by optic disc cupping and visual field loss. This is related to high intraocular pressure resulting from the blockage of the eye's drainage angle.[1] PACG accounts for approximately half of the cases of blindness secondary to glaucoma.[2] Around 67 million people are affected by this disease worldwide with roughly 6.7 million suffering from bilateral blindness.[3]

The prevalence of PACG varies with race and region.[4] PACG is more frequently found in Asian population.[2] It has been postulated that primary angle closure (PAC) is higher in Asians than African and Europeans and accounts for approximately 80% of PACG in Asia.[4,5] A shallow depth of anterior chamber, short axial length, small corneal diameter, increased lens thickness and anteriorly positioned lens iris diaphragm are implicated in the pathogenesis of PACG.[6-8] Recent studies have implicated choroid in the pathogenesis of PACG. The choroidal expansion pushes the iris lens diaphragm forward and initiates or causes progression of angle closure.[9] Thickness of the choroid can be assessed in a noninvasive manner with the use of enhanced depth imaging spectral domain OCT. [10-12]

Primary angle closure is due to the anterior chamber angle being appositionally or synechially closed. There are many subtypes of primary angle closure including primary angle closure glaucoma (PACG), primary angle closure suspect (PACS), and acute primary angle closure (APAC).[13] In this study the usefulness of enhanced depth imaging optical coherence tomography was assessed to measure the thickness of the choroid at the macula in cases of PACG. The purpose was to get a better understanding of the role of this modality in finding out the characteristics of choroid in angle closure subtypes and the relationship between primary angle closure and choroidal thickness.

METHODS:
Study design, place and duration: This was a comparative, cross sectional study conducted at Layton Rahmatulla Benevolent Trust (LRBT) Hospital Karachi, from January 2024 to December 2024.

Ethical considerations: IRB approval was taken (LRBT/TTEH/ERC/4501/14) and informed consent obtained.

Sample size estimation: Based on the data from previous study by Zhou et al,[14] 100 eyes in each group was be required to detect a significant difference of atleast 34.2um between angle closure glaucoma and normal eyes at a significance level of 0.05 and a power of 0.80 for a SD of 78.30.

Inclusion criteria and exclusion criteria: Patients above 18-years of age with clear ocular media for better and precise assessment of choroidal thickness, were included in the study. These patients were not using any anti-glaucoma medications. The following subtypes of angle closure were enrolled

in our case group.[15]

1; PACS: the presence of pigmented trabecular meshwork that was not visible for more than 180 under static gonioscopy and there was no concurrent evidence of glaucomatous optic nerve damage or peripheral anterior synechiae (PAS).

2; PAC: Presence of narrow angles, peripheral anterior synechiae (PAS), and/or raised intraocular pressure (IOP), which was defined as being higher than 21 mmHg, nevertheless, there was no sign of optic nerve damage or visual field deficits. The aberrant adhesions of the iris that are classified as PAS are those that are attached at or above the level of the anterior trabecular meshwork. PAS that persisted despite apposition between peripheral iris and angle structures and could not be broken with indentation gonioscopy.

3;PACG: A vertical cup-to-disc (C:D) ratio greater than 0.7 or an asymmetry in the C:D ratio between the two eyes greater than 0.2, along-with focal notching and associated visual field loss, as evaluated by static automated perimetry utilizing the SITA standard algorithm on the Humphrey Field Analyzer with the 24-2 test pattern, the indicators of PAC in conjunction with glaucomatous optic neuropathy. The findings met the reliability test criteria (fixation losses <20%, false positives <33%, and false negatives <33%) and were further defined as a glaucoma hemi-field test outside normal limits, exhibiting an abnormal pattern and standard deviation with p<5%.

Patients with angle closure secondary to uveitis, intumescent cataract, trauma, tumor, neovascularization, were excluded from the study. Additionally, participants who had a high refractive error (+6 or -6), systemic hypertension, diabetes mellitus, retinal pathology like choroidal neovascular membrane, pigment epithelial detachment, myopic atrophy, were not enrolled. Patients who were unable to tolerate gonioscopy, had a significant media opacity like cataract, were also excluded.

Age related healthy subjects were randomly assigned. These subjects had no significant pathology except for mild to moderate cataract. In these individuals just one eye was allocated at random to each individual.

Study protocol: All study participants underwent a thorough examination at the slit lamp and the IOP, gonioscopy findings, and the status of optic nerve head with the help of lens of 90-D, were recorded. In addition, the axial length was also calculated.

Demographic information such as age, blood pressure, and gender were recorded. An experienced technician with expertise in the field who remained unaware of the participants' disease status, conducted the EDI-OCT examination. The Heidelberg Spectralis equipment was used in order to carry out the choroidal imaging procedure. In order to determine the thickness of the subfoveal choroidal layer, measurements were taken using both vertical and horizontal sections that crossed at the center of the fovea. The imaging of the choroid was carried out by averaging one hundred images using the eye-tracking and automated averaging features of the instrument. The choroidal thickness was determined by subtracting the retinal thickness, which is the distance from the internal limiting membrane to the retinal pigment epithelium, from the total thickness of the choroid and retina, measured as the distance between the internal limiting membrane and the choroid-scleral interface. The choroidal thickness was evaluated by a single independent grader who remained unaware of the diagnosis.

Statistical analysis: Data were analyzed using SPSS version 26. Mean ±SD were used to display quantitative variable. Frequency and percentage were used to present qualitative variables. The independent sample t-test was used for the comparison of means between the groups. A p-value < 0.05 was considered as statistically significant.

RESULTS:

The study included 100 newly diagnosed primary angle closure glaucoma and 100 matched subjects for comparison. The mean age of the patients with primary angle closure glaucoma was 61.23±3.79 years and 58.96±4.41 years in the matched group. There were 31 (31%) male patients and 45 (45%) matched subjects. In addition 69 (69%) female patients and 55 (55%) matched subjects for comparison in the study. The comparison of different study variables is given in table I.

DISCUSSION:

In this study shallow anterior chamber depth (ACD), short axial length, thicker and more anteriorly positioned lens were found that are known ocular factors for the angle closure. Demographic variables including female gender and older age are also in congruence with previously conducted studies.[16-18] Other physiological parameters, like increased iris volume due to dilatation and choroidal expansion, have been related to primary angle closure development.[9,19]

According to the findings of our study, the thickness of the choroidal layer was much higher in patients than the matched subjects which was statistically significant. Similar findings were reported in a study by Yeluguri et.al in which choroidal thickness in PACG group was 383.81±53.06 and in comparison with the control group; 173.65±28.19 with p<0.05.[20] It should be noted that prior studies have also shown a significantly increased choroidal thickness in PACG patients compared to healthy eyes.[21] Furthermore, our study reported significant difference between the axial length of two groups. A study from Nepal has reported similar outcomes.[22]

A study found that choroidal thickness at the subfoveal location was increased in PACS, PAC and PACG but no significant differences found among groups. In our study we did not include the APAC patients as clear ocular media is required for the acquisition of EDI-OCT images which would not have been possible in the given scenario. Also, in APAC decrease in IOP contributes to hyper-perfusion of choroidal vasculature resulting in choroidal expansion which may contribute to even greater choroidal thickness.[7,21] In our study PACG group showed high IOP which is also reported earlier.[20]

Limitations of the study: It was a single center study with limited number of patients. There was a significant difference in the ages between the groups at enrollment. Similarly, gender distribution was also unequal in both the groups. The measurement of choroidal thickness with EDI OCT was done manually which is a limitation. In addition, the choroidal

Table I: Comparison of Different Study Variables			
Variable	PAC Group	Matched Group	p-value
IOP (mmHg)	19.36±7.21	17.27±1.38	0.005*
Axial length (mm)	21.09±1.10	23.23±0.63	0.001*
Systolic BP (mmHg)	121.06±7.89	118.95±9.22	0.084
Diastolic BP (mmHg)	84.64±5.66	85.57±4.57	0.203
Subfoveal Choroidal Thickness (μm)	281.53±8.40	248.49±7.61	0.001*

measurement was done only in the subfoveal plane and other areas of posterior pole or periphery were not considered. Choroidal thickness was not adjusted for age or gender which may have further implications. Also, the choroidal thickness is affected by the circadian rhythms and body position hence measurements taken at a fixed time and a habitual body position could help in achieving more precise results.

CONCLUSION:
Primary angle closure resulted in a significant increase in subfoveal choroidal thickness as compared to the eyes of matched subjects. This association is therefore important variable when planning treatment and counseling the patients.

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