Original article:

Central Corneal Thickness-An important variable for prognostication in Primary Open Angle glaucoma; A Kolkata based study in Eastern India

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Abstract:

Introduction: Few studies have been conducted to find out any relationship between central corneal thickness (CCT) and other parameters of Glaucoma. In the present work we have tried to find out any possible relationship between CCT and severity of visual field loss in Primary Open Angle Glaucoma(POAG)patients and we have used Glaucoma Staging System for categorizing the POAG patients under study according to visual field loss.

Methods: Informed consent was taken from all patients selected for the study. 50 patients diagnosed as having POAG were included in the study and both eyes were examined as POAG is a disease affecting both eyes. Patients who were one-eyed or one eye not matching the inclusion criteria of this study were excluded. These were all under treatment for POAG in the Glaucoma Clinic of Regional Institute of Ophthalmology, Kolkata.

Conclusion: Patients with thinner CCT showed worse visual field damage than those with thicker CCT..Patients with worse visual field loss had thinner CCT than those with better visual fields.Strong negative correlation between visual field damage and CCT was noted.

Keywords: central Corneal Thickness, POAG, Prognostication

Introduction

Glaucoma is a chronic progressive optic neuropathy causing damage to retinal ganglion cells and thereby retinal nerve fiber layer.[1] It is a leading cause of blindness all over the world. Primary open angle glaucoma (POAG) is a common form of glaucoma encountered in practice. POAG can be considered a chronic, progressive, anterior optic neuropathy that is accompanied by characteristic cupping and atrophy of optic disc, visual field loss, open angles, an IOP too high for the continued health of the eye and no obvious causative ocular or systemic conditions. Glaucoma Staging System (GSS) was designed to provide a reliable and comprehensive staging system and it allows accurate staging of 100% of Glaucoma patients based on their visual field loss.[2] Results of Ocular Hypertension Treatment Study[3] was in univariate analyses, baseline factors that predicted the development of POAG included older age, race (African-American), sex (male), larger vertical cup-disc ratio, larger horizontal cup-disc ratio, higher intraocular pressure, greater Humphrey visual field pattern standard deviation, heart disease, and thinner central corneal measurement. . But few studies have been conducted to find out any relationship between central corneal thickness (CCT) and other parameters

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of Glaucoma. It is proved that CCT has effect on measuring intra-ocular pressure by applanation tonometry and 1mm Hg correction is needed for every 25micron deviation from CCT 550 micron.[4]Several recent studies have shown that eyes of POAG patients with thinner cornea had worse progression of visual field loss which can not be explained solely by the effect of CCT on applanation tonometry.

In the present work we have tried to find out any possible relationship between CCT and severity of visual field loss in POAG patients and we have used Glaucoma Staging System for categorizing the POAG patients under study according to visual field loss.

Aims and objectives

1) To find out any difference in severity of visual field loss in patients with CCT<540 micron and in patients with CCT>540 micron.

2) To find out any difference of CCT in different GSS stages of these patients

3) To find out any correlation between CCT and severity of visual field loss of the POAG patients under study.

Materials and methods

It is a hospital based prospective case series study conducted in Regional Institute of Ophthalmology, Kolkata

Informed consent was taken from all patients selected for the study. 50 patients diagnosed as having POAG were included in the study and both eyes were examined as POAG is a disease affecting both eyes. Patients who were one-eyed or one eye not matching the inclusion criteria of this study were excluded. These were all under treatment for POAG in the

Glaucoma Clinic of Regional Institute of Ophthalmology, Kolkata.

DIAGNOSIS OF POAG:

For diagnosis of patients of POAG following criteria were used:

- Medical and ophthalmological history
- Slit lamp examination
- Intraocular pressure by Goldmann Applanation Tonometry
- Gonioscopy by Goldmann two mirror goniolens
- Fundoscopy with Volk 90D lens and slit lamp biomicroscope
- Standard automated perimetry Swedish Interactive Threshold Algorithm (SITA) standard 24-2/30-2
- Central corneal Thickness(CCT) estimation using Ultrasound Pachymeter(Pacscan 333 P Digital Biometric Ruler)

INCLUSION CRITERIA:

- Best corrected visual acuity > 20/200 (6/60)
- Bilateral POAG
- Anterior chamber angle open on gonioscopy
- Reliable automated perimetry
- Informed consent

EXCLUSION CRITERIA:

- Spherical refractive error > 5D and cylindrical error > 2.5D
- Concomitant ocular disease leading to raised IOP
- Contact lens wearer
- Corneal pathology
- Cloudy optical media interfering in fundus evaluation
- H/O neurological disease
- Ocular trauma

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- H/O intraocular surgery

GLAUCOMATOUS EYES:

POAG patients were diagnosed by presence of abnormal visual field, presence of raised IOP (>22 mmHg) in previous records even if that is controlled by drugs at the time of evaluation, evidence of glaucomatous optic neuropathy by disc examination like asymmetry of disc between 2 eyes of VCDR 0.2, NRR thinning, notching, excavation or RNFL defects.

GLAUCOMA STAGING SYSTEM:

In GSS staging for glaucoma patients 6 stages are there. But our study population was between stage1 to stage 4. Because stage 0 includes patients who have no visual field defect, they were not included in this study. Whereas stage5 or end stage disease includes patients who had no Humphrey visual field in the worse eye attributable to the visual acuity of 20/200 or worse, which doesn't fit in our inclusion criteria for the study.

MD was the primary measure for assigning stages. Three additional criteria for stage adjustment are CPSD/PSD and hemifield test for stage 0 to stage 1, dB plot for stage 2 to stage 4 and pattern deviation plot for stage 1 to stage 4. If a patient meets the MD criteria for a particular stage (stage 1 to stage 4) but fails to meet one of the additional criteria for that stage, then the patient is categorized in the preceding stage; if a patient meets MD criteria for a particular stage (stage 1 to stage 4) and meets one of the additional criteria for succeeding stage then the patient is categorized in the succeeding stage; if a patient meets the MD criteria for a particular stage (stage 1 to stage 4) and meets one or more of the additional criteria for the preceding stage as well as one or more criteria for the succeeding stage then the patient is categorized in the original stage based on MD criteria.[5]

Results

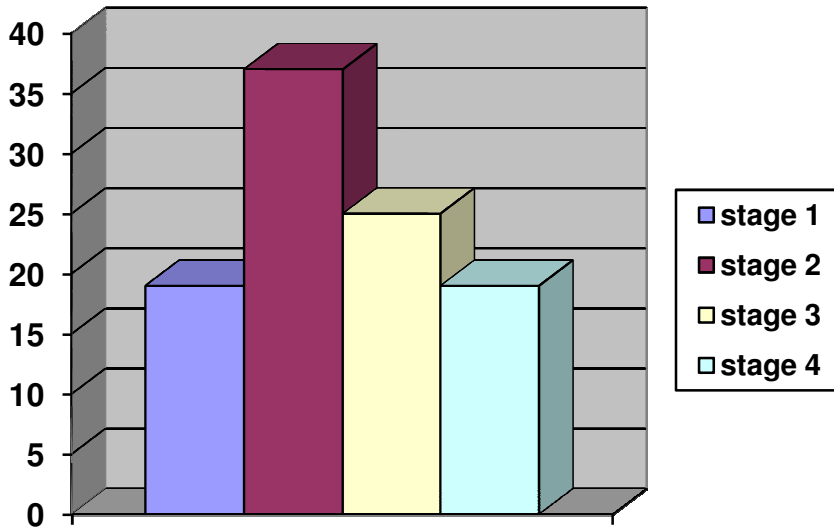Total study population: 50 , Male: 34 , Female: 16

Table 1

Age	30-40yr	40-50yr	50-60 yr	60-70yr	70-80yr	>80yr
Male	4	5	9	11	4	1
Female	1	7	5	3	0	0
Total	5	12	14	14	4	1

Total eyes under study: 100

CCT<540 micron: 59   CCT>540 micron: 41

Fig 1: Distribution of POAG patients under study according to Glaucoma Staging System:

Total eyes under study = 100

Eyes in GSS Stage 1 = 19

Eyes in GSS Stage 2 = 37

Eyes in GSS Stage 3 = 25

Eyes in GSS Stage 4 = 19

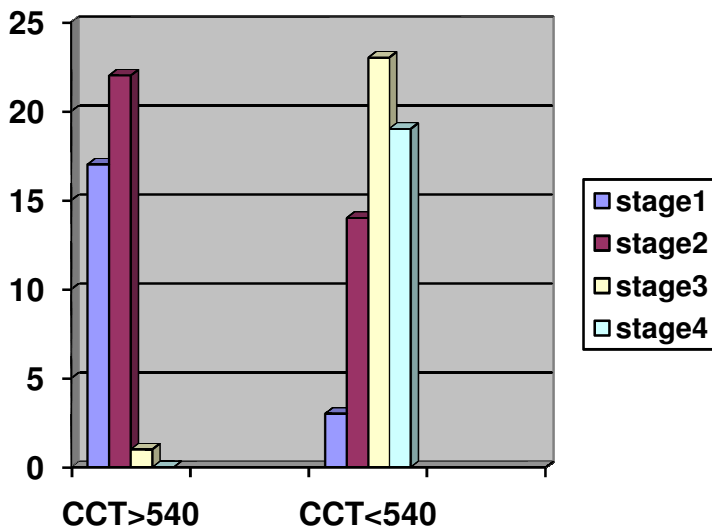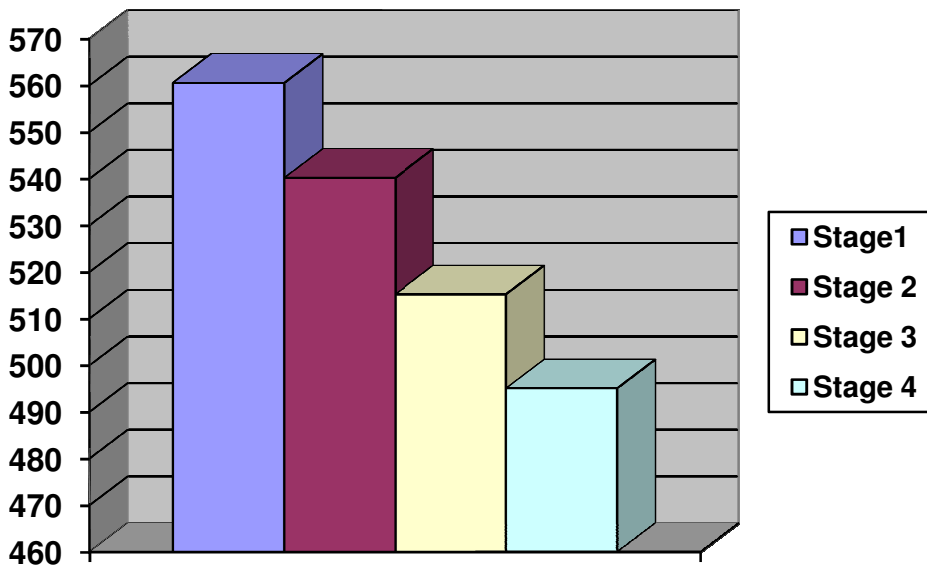Fig 2: Distribution of patients according to CCT & GSS stage:

Table 2: Analysis of CCT in different stages of GSS in POAG patients

Stage	Stage 1	Stage 2	Stage 3	Stage 4
Avg CCT	560.55	540.19	515.24	495.05
SD	19.06	24.91	24.20	14.92

Fig 3: Average CCT in different GSS stages of POAG patients:

T-test is done to find out statistical differences of CCT between different stages:

Table 3:

Differences in CCT	Statistical significance	P value
Between stage1 & stage2	present	0.0014
Between stage2 & stage3	present	0.0003
Between stage3 & stage4	present	0.0016

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Table 4:

Differences in MD & PSD in eyes with CCT>540 micron & CCT<540 micron:

	Avg MD	SD	N
CCT<540 micron	16.09	7.45	59
CCT>540 micron	6.19	3.18	41

There is statistically significant differences between mean MD in these two groups (p<0.05)

Table 5

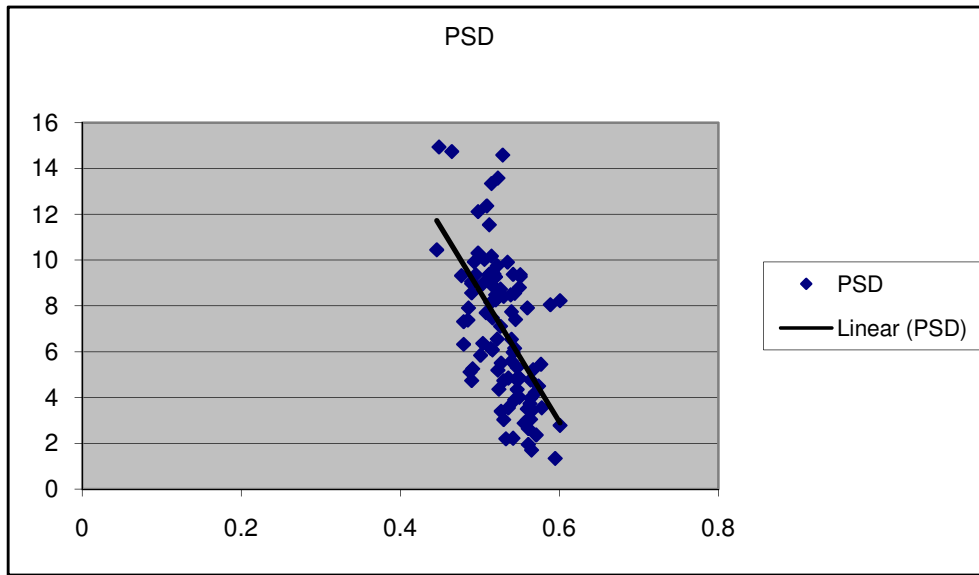|	Avg PSD	SD	N
CCT<540 micron	8.3	2.89	59
CCT>540 micron	5.07	2.33	41

There is statistically significant differences between mean PSD in these two groups (p<0.05)

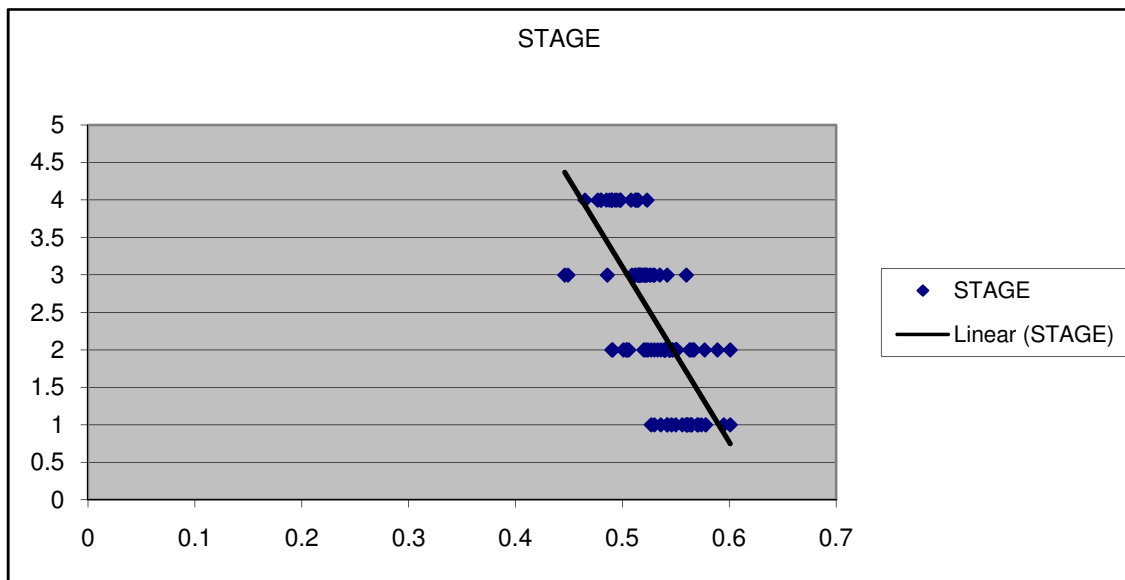Fig 4: Linear regression analysis of correlation between CCT & MD:
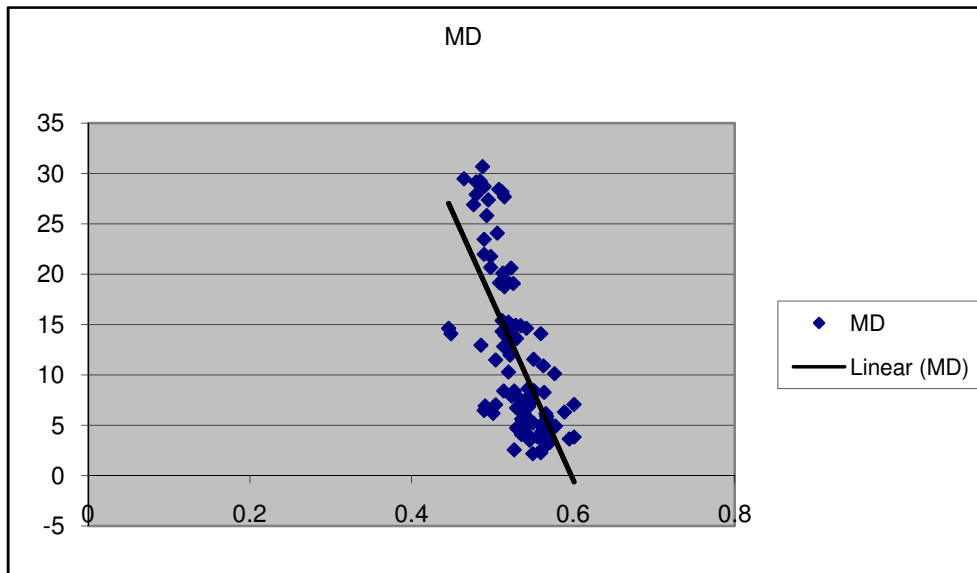
Pearson coefficient = - 0.697

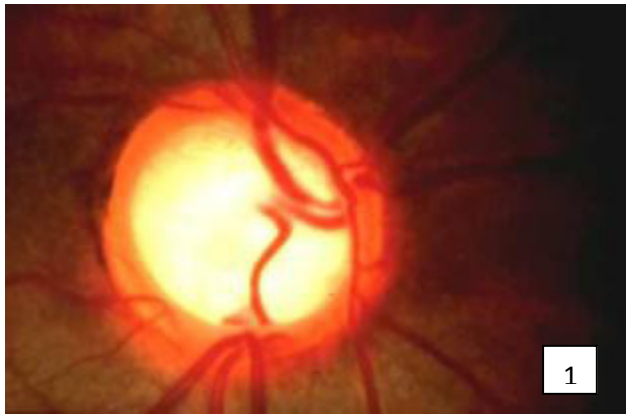Fig 4: Linear regression a Linear regression analysis of correlation between CCT & PSD:

Pearson coefficient = - 0.576

Fig 5: Linear regression analysis of correlation between CCT and GSS stage:

Correlation between	Pearson coefficient	Strength of correlation
MD & CCT	- 0.697	Strong
PSD & CCT	- 0.576	Strong
GSS & CCT	- 0.714	Strong

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Discussion

From the results of this study several factors regarding POAG patients, their visual field loss and CCT have come into light. Those points need some discussion.In the study population number of male patients is more than female patients. This does not mean POAG is more prevalent in male population. On the contrary these pictures signify the socio-economic condition of our country because of which male patients seek medical attention more than females.The age distribution of the study population shows most patients belong to 50-70 years of age group. This signifies POAG is a disease of elderly population. This finding is supported by Ocular Hypertension Treatment Study which indicated increasing age as a risk factor of glaucoma.

In the study conducted by Papadia M,et al[6] among the POAG patients mean CCT was 554micron +/- 45.03 .Based on CCT value, the sample was split at the mode in two groups (group 1<535 micron, n=49; group 2>or=535 micron, n=50). A significant difference was found between the two groups for both MD and PSD. Linear regression analysis showed a significant correlation between CCT and PSD (P<0.001). These results are similar to our study results where we also found a statistically significant difference in MD and PSD among groups with CCT>540 micron and CCT<540 micron and correlation was found between PSD & CCT as well as MD & CCT.

A study was conducted by Hong S, et al.[7] which was on chronic primary angle closure glaucoma. Here readings were taken initially and at 3 years follow-up. On the basis of the CCT value, the sample was split

in two groups (group 1 <540 micron; group 2 > or =540 micron). There was no significant difference for initial MD (P = .979). But in our study we found significant difference of MD in these two groups. In the above mentioned study ,however,significant difference of MD was noted after 3 years follow-up.

Shah H, et al[8] conducted a study on role of CCT as a baseline parameter and in progression of visual field loss in POAG. Charts of consecutive patients with POAG were reviewed to obtain visual field data. Visual field was measured by standard threshold static perimetry. Variables analyzed included mean deviation (MD) and pattern standard deviation (PSD). A significant negative relationship between CCT and PSD (correlation coefficient: -0.02, p<0.05) was found. Analyses comparing CCT to change in PSD and MD (visual field progression) were statistically not significant. This study showed negative correlation between CCT and PSD which resembles our study but failed to find out any relationship of field progression and CCT.

A study by Kim JW, et al.[9] showed that the mean CCT in patients with visual field progression was significantly lower than the mean CCT in patients who did not progress (529+/-36 mum vs. 547+/-35 mum; P = 0.02). Those with thinner CCT were more likely to progress than those with thicker CCT as identified by Cox proportional hazards regression analysis (P = 0.01; hazard ratio, 1.44 for a 40-mum thinner CCT; 95% confidence interval, 1.12-1.80), and CCT was the only risk factor identified to be significantly associated with visual field progression. Since our study was cross-sectional, we did not note the progression of visual field.

Two similar studies [10,11] conducted among Nepalese and South Indian poplulations have been compared and all the results have been presented in the form of the following table:

	Author	Study population	Result
1.	Papadia M,et al,2007	Italians	Significant correlation between CCT and PSD (P<0.001).
2.	Hong S,et al,2007	Seoul,Korea	There was no significant difference for initial MD (P = .979). But in our study Significant difference of MD was noted after 3 years follow-up.
3.	Shah H, et al,2007	United States	A significant negative relationship between CCT and PSD (correlation coefficient: -0.02, p<0.05) . **Analyses comparing CCT to change in PSD and MD (visual field progression) were statistically not significant**.
4.	Kim JW, et al,2004	Seattle, Washington, USA	Those with thinner CCT were more likely to progress than those with thicker CCT as identified by Cox proportional hazards regression analysis (P = 0.01; hazard ratio, 1.44 for a 40-mum thinner CCT; 95% confidence interval, 1.12-1.80
5.	Natarajan M,et al 2013	South Indians	There is no significant difference in CCT between POAG patients and normal controls.
6.	Adhikari P, eta al ,2014	Nepalese	CCT in glaucoma suspects is similar to normal subjects and POAG, but thicker than NTG
7	Bhattacharya A, et al 2016 Present study	Eastern Indians	Patients with thinner CCT showed worse visual field damage than those with thicker CCT; & Strong negative correlation between visual field damage and CCT was noted

Conclusion

Measurement of CCT is recommended in all patients in work up for POAG, since visual field loss is the most important handicap these patients suffer from and this study clearly points out the relationship of CCT and visual field loss. Importance of CCT measurement is far more than its effect on IOP measurement as it is related to severity of visual field loss.

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