Original Article

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A Clinico Imaging Correlation between Central Corneal Thickness with Cup Disc Ratio, Retinal Nerve Fibre Layer Thickness in Glaucoma

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Abstract

Aim: To assess the CCT and its relationship with cup disc ratio and RNFL thickness in POAG and PACG patients. *Design:* Prospective observational study. *Material and Method:* This study was carried out at the Regional Institute of M.L.N. Medical College and Hospital Prayagraj from December 2018 to November 2019. A total of 43 eyes, 17(29 eyes) patients of POAG , 8 (14 eyes) patients of PACG included. Measurement of CCT done by Specular Microscope and (RNFL) thickness evaluated by OCT. *Results:* In thinner cornea group (450–500 μm) CCT is more positively correlated with RNFL thickness in both PACG (r = 0.420) and PAOG (r = 0.451) patients. CCT and CD ratio was more negatively correlated in PACG patient (r = –0.652) for vertical and (r = –0.907) for horizontal CD ratio than in PAOG patients (vertical CD ratio r = –0.018 and horizontal r = –0.022). In thicker cornea group i.e. 501–550 μm average RNFL thickness was more positively correlated with the CCT variation in POAG (r = 0.448) than in PACG (r = 0.219). CCT was more negative correlated with cup disc ratio in PAOG group (r = –0.447) than in PACG group (r = –0.104) of patients. *Conclusion:* In thinner cornea group (450–500 μm) there is a definite positive correlation between CCT and RNFL thickness. Both average and quadrantric RNFL thickness was more pronounced in PACG Group as compared to POAG group. However in thicker Cornea (501–550μm) group CCT is more positively correlated with RNFL loss in POAG as compared to PACG group. Also POAG group exhibited more rapid increase in cup disc ratio with thinning of cornea.

Keywords: (CCT) Central corneal thickness; (RNFL) Retinal nerve fiber layer; (POAG) Primary open angle glaucoma; (PACG) Primary angle closer glaucoma.

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Introduction

Glaucoma is a chronic, progressive optic neuropathy caused by group of ocular conditions, which lead to damage of the optic nerve with loss of visual function.[3] Glaucoma is the leading cause of irreversible blindness globally and accounts for about 10% of all blindness worldwide and Asia alone accounts for 60% of this number. Reports indicate that the glaucoma population will increase from 60.5 million in 2010 to 80 million people up to 2020 and to approximately 111.8 million by the year 2040.[1,2] Though primary open angle glaucoma (POAG) is more common worldwide, but the incidence of blindness is higher with primary angle closure (PACG) glaucoma.

In India, at least 12 million people affected and nearly 1.2 million people blind from the disease. Screening of glaucoma is challenging, as there is no single parameter or test with high sensitivity and specificity and disease is usually asymptomatic until the advanced stages and so actual burden of disease prevalence is hidden , so early detection and treatment of glaucoma are essential to prevent the vision loss.[3]

The role of central corneal thickness (CCT) measurement in the clinical evaluation of glaucoma is well established by many previous studies. Also the effect of CCT is directly related to the

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measurement of intraocular pressure (IOP), the only modifiable risk factor in the treatment of glaucoma which play a important role in deciding the management of glaucoma patients.[4] Thus, evaluation CCT is an important component of a complete ocular examination in glaucoma, particularly for patients being evaluated for the risk of developing POAG.

Glaucoma causes progressive thinning of retinal nerve fiber layer (RNFL) thus evaluation of the it has a potential clinical value, thinning can occur before irreversible functional visual field loss. OCT is an effective means of quantifying the retinal nerve fiber layer.

The current study is undertaken to explore the variation of central corneal thickness (CCT) and its correlation with RNFL thickness and optic disc parameters i.e. cup to disc ratio in PACG and PAOG patients.

Material and Methods

Study was carried out at the Regional Institute of Ophthalmology (M.D. eye Hospital, Dr. Katju Road, Nakhas Kona, Prayagraj) after taking permission from ethical committee of M.L.N. Medical College Prayagraj from December 2018 to November 2019.

Study Design

This was a prospective observational study. We included total of 17 (29 eyes) patients of POAG , 8 (14 eyes) patients of primary PACG . There were 15 (40%) male and 10 (60%) female subjects with mean age of 36.62 years (SD=7.31) in PACG and 51.58 years (SD=16.70) POAG group.

Selection of Cases

Inclusion Criteria: Diagnosed case of POAG and PACG were included in this study.

Exclusion Criteria: We excluded the glaucoma types other than the POAG and PACG ,Patients having corneal pathology or surgery that might influence CCT measurement, cataract surgery,Contact lens user subjects which might influence central corneal thickness measurement .

All subjects underwent baseline evaluation as complete systemic examination, detailed medical history and history of visual disturbance with duration, progression and associated complaints. History of anti-glaucoma drugs were also taken. Following examinations had been done to evaluate the patients.

1. General examination.
2. Ocular Examination
   a. Best corrected Visual Acuity
   b. Slit Lamp Biomicroscopy including gonioscopy.
   c. IOP measurement have been done by Schiotz tonometer
   d. All the patients undergone dilated fundus examination.
   e. Visual field examinations was performed in all patients in which vision permitted and being performed by Oculus Twinfield Version 3.18r 925 using 24–2 Swedish Interactive Threshold Algorithm (SITA).
   f. Measurement of CCT was done by Specular Microscope Topcon SP-1P Version 1–41. RNFL thickness was evaluated by Cirrus HD-OCT (Software version 6.5.0.772; Zeiss Meditec).

Patients were followed within 3 month of presentation and further evaluation of CCT and disc parameters with RNFL have been done.

Observation and Result

We included a total of 25 patients with 43 eyes for the study. Out of which 29 eyes of PAOG and 14 eyes with PACG were taken. There were 15 (40%) male and 10 (60%) female subjects with mean age of 36.62 years (SD=7.31) in PACG and 51.58 years (SD=16.70) POAG group.

All the patients were divided into two groups for the comparison ,one between CCT 450–500 µm and second between CCT 501–550 µm. In both group we have done OCT-ONH and evaluated average and quadrantic RNFL thickness.

To assess the correlation between CCT and RNFL thickness we calculated Pearson correlation coefficient for each quadrant and also for average RNFL thickness.

Table 1: Showing RNFL thickness in patients with CCT 450–500 µm.

RNFL Thickness	PACG	PAOG	R value	
			PACG	PAOG
Average	25.56±7.93	48.31±33.27	0.357	0.240
Inferior	21.33±28.01	63.77±47.73	0.420	0.226
Superior	26.44±28.59	50.18±44.35	0.386	0.218
Nasal	34.78±20.02	38.81±28.65	0.170	0.457
Temporal	24.67±29.78	41.18±29.67	0.288	0.277

r= pearson correlation coefficient

We found positive correlation between CCT and RNFL thickness in all quadrant and also for average RNFL thickness. The average RNFL thickness was found more positively correlated with CCT in PACG patients than POAG patients.

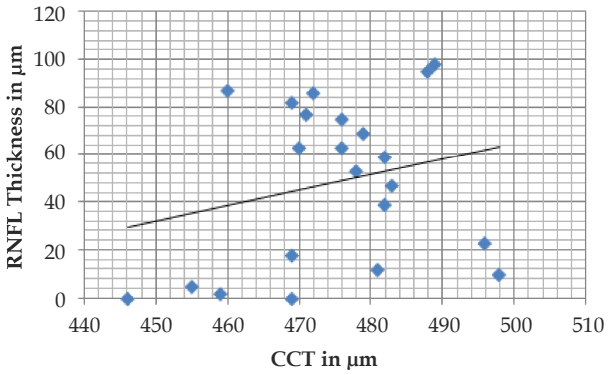

Fig. 1: Showing correlation of CCT variation with average RNFL thickness in PAOG patients with CCT 450–500 µm and pearson correlation coefficient r=0.240 i.e. positive linear relationship.

In thicker cornea group (501–550 µm) we found that average and quadrantic RNFL thickness was more positively correlated with the CCT in POAG than in PACG group of patients.

Table 2: RNFL Thickness in patients with CCT 501–550 µm.

RNFL Thickness	PACG	PAOG	Pearson correlation=r	
			PACG	PAOG
Average	56.40±17.53	51.57±24.56	–0.291	–0.448
Inferior	65.00±56.34	46.71±35.49	–0.167	–0.816
Superior	57.20±13.22	69.28±33.96	–0.027	–0.246
Nasal	45.60±05.81	48.85±21.91	–0.189	–0.166
Temporal	57.60±20.24	41.71±18.06	–0.222	–0.215

We also evaluated cup disc ratio in both groups of patients and calculated mean and standard deviation for both vertical and horizontal meridian.

Table 3: Showing cup disc ratio and Pearson correlation coefficient for vertical/horizontal both.

CCT group 450–500 µm	PACG	PAOG
Cup disc ratio vertical/horizontal	0.77±0.26/0.83±0.06	0.65±0.15/0.67±0.13
Pearson correlation coefficient vertical/horizontal	–0.652/–0.652	–0.181/–0.022
CCT group 501–550 µm		
Cup disc ratio vertical/horizontal	0.56±0.19/0.60±0.15	0.68±0.18/0.71±0.18
Pearson correlation coefficient vertical/horizontal	–0.097/–0.123	–0.104/–0.447

We found that cup to disc ratio was negatively correlate with CCT for both in vertical and horizontal meridian in both group of patients.

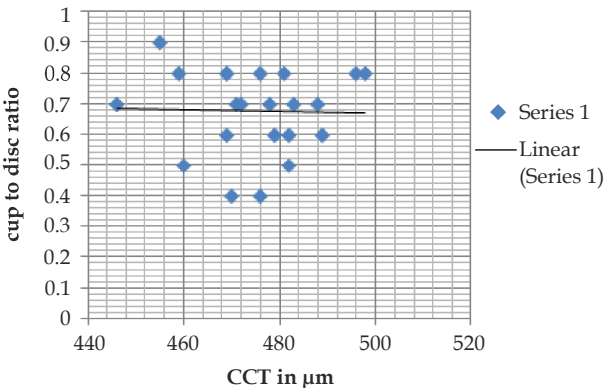

Fig. 2: Showing correlation between CCT and horizontal cup to disc ratio in (CCT)450 –500 µm. with Pearson correlation coefficient r= –0.022 i.e. negative correlation in PAOG patient.

From the above mentioned scatter graphical presentation and Pearson correlation coefficients we can see that in CCT group 450–500 there is more negative correlation between CCT and cup disc ratio in PACG group of patients than in PAOG group of patients.

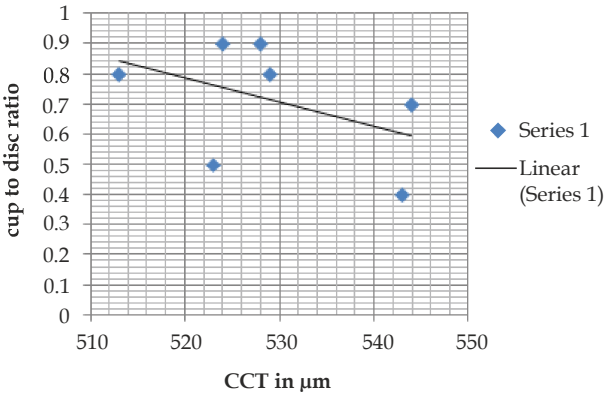

Fig. 3: Showing correlation between CCT and horizontal cup to disc ratio in (CCT)501 –550 µm. with Pearson correlation coefficient r= –0.447 i.e. negative correlation in PAOG patient.

On the other hand from the above mentioned scatter graphical presentation and Pearson correlation coefficients we can see that in CCT group 501–550 there is more negative correlation between between CCT and cup disc ratio in PAOG group of patients than in PACG group of patients.

Discussion

Patients presented were all diagnosed cases of POAG and PACG on treatment. In our study most of the patients of PACG were of younger age group and with advanced glaucomatous changes at the time of inclusion in our study.

It has previously been demonstrated by many authors that optic nerve head changes and nerve

RNFL thickness may occur earlier than visual field changes. In glaucoma patients, study of RNFL thickness exhibited that mean RNFL thickness differed significantly with the progression of disease.

We found that CCT is correlated significantly with all the RNFL thickness parameters in both subtypes of glaucoma i.e. POAG and PACG. Results of correlation between CCT the RNFL thickness showed that Pearson correlation coefficient is positive in all quadrants and also for average RNFL thickness in both groups of glaucoma and positively correlated i.e. with the decrease of CCT and RNFL thickness also decreases.

We observed that in also noticed that in thinner cornea group (450–500 μm) there is significant thinning of both average and quadrantic RNFL and it is more pronounced in PACG group showed (r=0.357) than in POAG group of patients (r = 0.240). These findings are in accordance with the previous studies reported by Boonchai Wang Supadilok et al 2014[11] that there is moderate positive correlation between CCT and RNFL thickness in POAG patients. Though they only included POAG patients. Sushmit Kaushik et al 2005[5] compared three RNFL parameters as average, superior, inferior quadrants in ocular hypertensive and normal control group subjects and found that CCT correlated significantly with all RNFL thickness parameters in ocular hypertensives and correlated positively. Hyuk Jin choi et al 2006[7] also found that there is relationship between CCT and localized RNFL thickness defect in N TG patients. Sana Muhsen et al 2013[10] also reported advanced glaucomatous optic neuropathy was associated with thinner CCT in POAG & PACG patients.

However in thicker CCT group (501–550 μm) CCT is more positively correlated to RNFL loss in POAG group (r = 0.448) than in PACG group (r = 0.291) patients. It signifies that POAG patient are more vulnerable to RNFL loss than in PACG patients. Boonchai wang Supadilok 2014[11] also reported that in POAG patients RNFL thickness is moderately correlated with CCT.

The association between central corneal thickness and cup to disc ratio was previously documented by many authors. We also found a negative correlation in CCT and cup to disc ratio in both types of glaucoma patients.

In CCT group (450–500 μm) PACG patients shows more rapid increase in cup disc ratio (r = –0.652 vertical and r = 0.907 horizontal) cup to disc ratio than in PAOG patients (vertical CD ratio r = –0.018 and horizontal r = –0.022). This clearly suggest that there is more rapid glaucomatous damage in thin cornea group patients of PACG than POAG.

Our study results supports the observations by Alex W Hweitt et al 2005[6] that CCT is negatively correlated with cup to disc ratio in glaucoma patient as progressive thinning in CCT tend to increase in glaucomatous damage and increased cup to disc ratio. Boonchai Wang supandilok et al 2014[11] also suggested that CCT is negatively correlated with the cup to disc ratio in primary open angle glaucoma patients. We also found negative correlation between the CCT and cup to disc ratio in CCT group 501 – 550 μm. Tharwat H.mokbel et al 2010[8] also reported the negative correlation between CCT and optic disc area in PAOG patients which is consistent with our study results. However, Naim Teri et al 2011[9] reported in a clinically relevant correlation between optic disc size and CCT in POAG patients. This was not in accordance with our study that a thin cornea might be marker for cup disc.

While in CCT group 501 – 550 μm there is much more negative correlation between CCT and cup to disc ratio in POAG patients (r = – 0.104, r = – 0.44) than PACG patients (r = –0.097 vertical, r = –0.123 horizontal). This signifies that POAG patients exhibited more rapid increase in cup disc ratio with thinning of cornea.

Thus it suggests that there is more glaucomatous damage in the initial stages of POAG patients with the thin CCT as it is more positively correlated with RNFL thickness and also more negatively correlated with cup to disc changes.

Conclusion

It is now very clear in our study that CCT imposes a big impact upon diagnostic and prognostic parameters as RNFL and cup disc ratio. Thus any individual found to be having increased intraocular pressure, CCT should be mandatorily investigated by appropriate tool which is definitely having prognostic significance.

However, the present study also had certain limitations because sample size was small, and most of the patients of PACG presented late in our study with advanced glaucomatous damage. Also in our study the influence of other ocular factor as level of IOP, refractive error, size of eye ball upon RNFL and cup disc ratio which should also be considered.

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