

RELATIONSHIP BETWEEN CENTRAL CORNEAL THICKNESS (CCT) AND INTRA OCULAR PRESSURE

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Objective: To determine relationship between central corneal thickness (CCT) and intra ocular pressure (IOP).

Design: Cross-sectional analytical study.

Methodology: The study subject were recruited from Ophthalmology Outpatient Department, Dow University of Health Sciences and Civil Hospital Karachi, from January to July 2006. Patients above 40 years of age of either gender having no history of ocular trauma, disease or surgery, neither suffering from systemic disorder nor taking medicine for any disease were studied for CCT and IOP.

Goldmann applanation tonometry and pachymetry were performed in a single session. IOP was measured by Goldmann Applanation Tonometer (GAT). Pachymetry was performed with ultrasonic pachymeter. Regression analysis was conducted to determine relationship.

Result: Six hundred eyes of 300 patients (male 53%, female 47%), were analyzed. Average IOP was 14.83 mmHg. Average CCT was 548 microns. A significant association was found between CCT and IOP ($r=0.63$, $p<0.001$). CCT was found to be correlated linearly with increased IOP values ($p<0.000$).

Conclusions: A positive relationship exists between CCT and IOP.

Key words: Corneal thickness, Intraocular pressure, Pachymetry.

INTRODUCTION

Intraocular pressure (IOP) is an important parameter for screening, diagnosis and progression monitoring, response to treatment and control of glaucoma. The diagnosis of glaucoma is straightforward when classical triad of increased IOP, visual field defects and glaucomatous optic nerve damage is present. Glaucoma may still develop with normal IOP termed normal-tension glaucoma (NTG). If glaucoma does not develop despite the IOP range being above normal, The condition is termed ocular hypertension (OHT).¹ Normal IOP is one that does not result in optic nerve damage.²

Measurement of IOP with Goldmann applanation tonometer (GAT) is considered to be most accurate because

of its reliability and reproducibility.^{3,4} Central corneal thickness (CCT) has been identified as an important variable for accurate assessment of IOP.⁵ Accurate measurements of IOP by GAT are most likely in eyes with CCT of 0.52mm and values above or below may produce error in measurements.⁶ IOP is found to be positively related to CCT.^{5,7} The IOP measured by GAT is underestimated if cornea is thin and overestimated with thick corneas.⁸ Laser refractive surgery changes the thickness of the cornea and affects the accuracy of measurement of IOP by GAT. The cornea becomes thin after refractive correction by excimer laser. The work by Faucher et al. demonstrated change in accuracy of GAT causing underestimation of IOP after photorefractive keratectomy.⁹ A significant decrease in IOP was found in eyes after refractive correction of myopia, hypermetropia and astigmatism by laser in-situ keratomileusis.¹⁰ Since CCT and IOP measurements correlate positively, monitoring of the CCT has served as a basis for adjustments of reading of IOP.⁸ Misdiagnosis may occur when CCT

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is not considered.

In view of the importance of relationship between these two parameters, this study was conducted to determine a relationship between CCT and IOP in an out patient population.

METHODOLOGY

This cross sectional study was conducted at Ophthalmology Outpatients Department, Dow University of Health Sciences and Civil Hospital, Karachi from January to July 2006. Six hundred eyes of 300 patients were analyzed with non-probability purposive sampling from attending outpatients, of 40 years or above irrespective of gender. Patients having history of ocular trauma/disease/surgery, suffering from or taking medicine for any systemic disorder, having corneal/ocular pathology/disease and having vision below 6/6 after full correction were excluded. Informed consent was taken. A detailed history and examination was carried out. Refraction was performed to attain a corrected vision of 6/6 where it was found below this level. The IOP and CCT were measured in a single session.

IOP was measured according to standard protocol, with a calibrated GAT from the central area of the cornea with eyes in primary position of gaze. A drop of proparacaine hydrochloride 0.5% was instilled into the lower conjunctival cul-de-sac for topical anaesthesia and fluorescein impregnated paper strip was touched to the tear film. The patient's head and the microscope were positioned so that the bar was against the patient's forehead, well above the eyebrows, allowing maximal separation of the patient's eyelids. The outer canthus of eye was aligned with the mark on the side rod of the slit lamp by rotating the chin rest. The GAT was mounted on the end of the lever hinged on the slit-lamp. The patient was asked to keep gaze in the primary position. With the cornea and tonometer biprism maximally illuminated by the cobalt blue light from slit-lamp, the biprism was brought into gentle contact with the apex of the cornea. The semicircular patterns were observed through the left ocular of the slit-lamp. The tension dial was adjusted so that the inner edges of the upper and lower semicircles became aligned. The reading on the dial was multiplied by 10 to obtain IOP in mmHg.

DGH400/JEDMED ultrasonic pachymeter was used to measure CCT with frequency set at 1640m/s. A drop of proparacaine hydrochloride 0.5% was instilled into the lower conjunctival cul-de-sac of the eye for topical

anaesthesia. Before taking measurement, the patient was asked to blink to avoid corneal drying. The patient was then asked to look straight ahead and the probe was placed perpendicular to the center of the cornea. Five measurements were taken rapidly. The pachymeter is programmed to take measurements only when the probe is positioned perpendicular to corneal surface. The lowest CCT reading was used for analysis as this represented the most accurate measurement from the centre of the cornea.

The IOP and CCT measurements were taken between 9 am to 12 noon to avoid any effect of diurnal variation of CCT and IOP.⁴ The data was entered on a proforma including the name, age, gender, registration number of the patient including IOP and CCT measurements. Both eyes of the patients were analyzed and used for the study.

The collected data was analyzed by SPSS version 10.0. Relevant descriptive statistics, frequency and percentages were computed for presentation of qualitative variables like gender and ocular findings. Quantitative variables like IOP, CCT and age were presented by mean and standard deviation. Scattergram for IOP as the independent variable and CCT as dependant variable was drawn. Test of linear correlation (Pearson's correlation) was applied to test the hypothesis at p value below 0.05 level of significance.

RESULTS

The sample included 600 eyes of 300 patients. There were 53% males and 47% females. Average IOP was 14.83 mmHg with ranging from 11-19 mmHg. Individuals were also divided into 14 subgroups according to measured CCT with 10 microns increment steps. Mean CCT was 548 microns ranging from 445-655 microns. Mean IOP of each subgroup was also calculated as well as the difference of mean according to increment in CCT presented in Table I. Mean of difference of IOP according to 10 micron of CCT increase was 0.27 mmHg. Average age was 48.04 years ranging from 41-68 years presented in Figure I and 49.3 % individuals were between the ages of 41-45 years. The age showed no association with CCT ($p=0.929$). A significant association was found between CCT and IOP (Pearson correlation coefficient $r=0.63$, $p<0.001$ (Figure II). In linear regression analysis, the CCT was found to be correlated linearly with increased IOP values ($p<0.001$).

Table 1: IOP Relationship to CCT

CCT in microns	Mean IOP	Difference of IOP
Group: I (441-450)	12.04	0
Group: II (451-460)	12.33	0.29
Group: III (461-470)	12.60	0.27
Group: IV (471-480)	12.95	0.35
Group: V (481-490)	13.12	0.17
Group: VI (491-500)	13.43	0.31
Group: VII (501-510)	13.72	0.29
Group: VIII (511-520)	14.00	0.28
Group: IX (521-530)	14.32	0.32
Group: X (531-540)	14.68	0.36
Group: XI (541-550)	14.89	0.21
Group: XII (551-560)	15.17	0.28
Group: XIII (561-570)	15.50	0.34
Group: XIV (571-580)	15.88	0.38
Group: XV (581-590)	16.05	0.17
Group: XVI (591-600)	16.44	0.39
Group: XVII (601-610)	16.64	0.20
Group: XVIII (611-620)	16.93	0.29

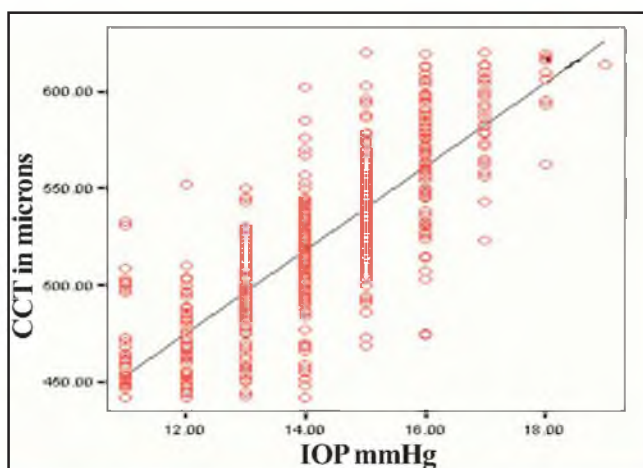


Figure 2: Correlation of CCT and IOP

DISCUSSION

Glaucoma is one of the leading causes of blindness worldwide.¹¹ Glaucoma is defined as an optic neuropathy with characteristic appearance of optic disc and specific pattern of field defects that is associated frequently but not invariably with raised IOP.¹²

GAT is the gold standard of measuring IOP. Goldmann and Schmidt presented their applanation tonometer in 1957 and also cautioned about the possible sources of error in measurements by the instrument with CCT as one of them.¹³ The IOP measurements with GAT assume a corneal thickness of 520 microns. When it is greater, IOP is recorded as high and when it is lower, the IOP is recorded low due to the effect of corneal rigidity and corneal thickness.³ The present study have shown a positive relationship between CCT and IOP as has been described in other studies.^{4,5,14-20} IOP measurements by pneumotonometer, non-contact tonometer, Tono-Pen, ocular blood flow and GAT have all shown positive relationship with CCT.¹⁷⁻¹⁹ Variations in CCT and its relationship to IOP have been worked out and it is estimated that for every 10 microns change in CCT produce an error in the measurement of IOP.²⁻²⁹ Patients having OHT have demonstrated thicker CCT as compared to normal subjects and patients with Primary open angle glaucoma (POAG) while patients having NTG have shown to have thin cornea compared to normal subjects and patients with POAG.²³⁻²⁵ Based on positive correlation between CCT and IOP, true IOP was calculated with the result that many patients diagnosed as OHT were reclassified as normal and many patients diagnosed as having NTG were

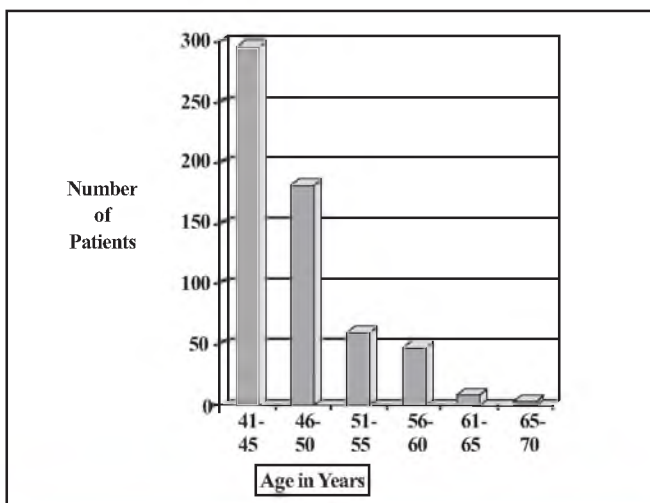


Figure 1: Age distribution

reclassified as having POAG.²³⁻²⁵

The cornea becomes thin after refractive correction by Excimer laser resulting in lower IOP values postoperatively.⁹⁻¹⁰ This may lead to subsequent mismanagement of glaucoma due to underestimation of IOP if CCT is not considered especially in patients who underwent refractive surgery while having glaucoma and in myopic individuals who are at increased risk of developing glaucoma.

Variation in CCT and its relationship to IOP have been worked out. It is estimated that every 10 microns of change in CCT produce error in the measurement of IOP.¹⁷⁻¹⁹ Underestimation and overestimation of IOP based on CCT range to about 16 mmHg.¹⁷ Results of the present study have demonstrated mean IOP change of 0.27 mmHg for every 10 microns change in CCT.

Population based studies have demonstrated the pattern of CCT and its implication on IOP has been determined for proper diagnosis and management of glaucoma.^{8,15,16,26-27} Uncorrected underestimation of IOP due to thin CCT may lead to delay in diagnosis, inadequate treatment target setting and high morbidity.

In the present study, 49.3 % individuals were between the ages of 41-45 years and only 0.7 % were between 66-70 years presented in Figure I. Although the study has demonstrated a positive relationship between CCT and IOP, further large population-based studies are required to determine this relationship including all age groups because it is difficult to find large number of healthy individuals of different age groups in hospital patient population.

The authors would like to recommend that CCT measurement should be included as a baseline evaluation for glaucoma assessment for proper classification and management of patients.

CCT and IOP measurements should be performed and documented both preoperatively and postoperatively in all patients undergoing corneal refractive surgery to be used as reference for future glaucoma assessment especially in myopic individuals and patients having glaucoma.

CONCLUSIONS

A positive relationship was found between CCT and

measured IOP in the studied subjects.

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