The Professional Medical Journal
www.theprofesional.com

DOI: 10.29309/TPMJ/18.4805

ORIGINAL PROF-4805

INTRA OCULAR PRESSURE;

CORRELATION BETWEEN CENTRAL CORNEAL THICKNESS AND INTRA OCULAR PRESSURE

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Article received on:
19/03/2018
Accepted for publication:
20/09/2018
Received after proof reading:
03/12/2018

ABSTRACT… Introduction: The ideal optical properties of the eye requires support of state of the eye-ball which is normally regulated by the intraocular pressure (IOP). There is variation in the measurements of IOP with Goldmann applanation tonometry if the thickness of the central cornea is not uniform, the IOP is high when cornea is thicker and vice versa. Therefore, the central corneal thickness (CCT) is thought to affect the IOP readings, however, as shown, the evidence available remains controversial. The aim of the study was to determine correlation between CCT and IOP. **Objectives:** To determine the correlation between the Central Corneal Thickness (CCT) and Intra Ocular Pressure (IOP). **Study Design:** A cross-sectional study. **Place and Duration:** Department of Ophthalmology, Aga Khan University Hospital, Karachi from July to December, 2014. **Methodology:** During the study period of six months total 431 participants were purposively sampled according to the set criteria. Variables included were age, gender, CCT, and IOP. Correlation between IOP and CCT was assessed by using Pearson correlation test, P value of ≤ 0.05 was considered significant. **Results:** Out of 431 participants, 239 (55.5%) males and 192 (44.5%) females. The mean age was 34.9 ranging from 20 to 50 years. The mean central corneal thickness of right eye was 529 µm with SD ± 39.5 and range of 473-591 µm. The mean intraocular pressure of right eye was 14.7 µm, SD ± 3.1 with a range of 9-21 mmHg. The left eye mean central corneal thickness was 533, SD ± 29.6 with range of 481-589 µm. The mean intraocular pressure of left eye was 15.6, SD ± 3.1 with a range of 10-21 mmHg. Strong positive correlation was found (P-value < 0.001) between central corneal thickness and intra ocular pressure for both eyes. **Conclusion:** There is positive correlation between CCT and IOP. Therefore, along with the routine ophthalmic examination for intraocular pressure measurements pachymetry should also be considered for accurate interpretation of the results.

Key words: Central Corneal Thickness, Intraocular Pressure, Pachymetry.

Article Citation: Rajput AA, Mirza AA, Maree GK, Shaikh AA. Intra ocular pressure; correlation between central corneal thickness and intra ocular pressure. Professional Med J 2018; 25(12):1833-1839. **DOI:** 10.29309/TPMJ/18.4805

INTRODUCTION

The ideal optical properties of the eye requires support of state of the eye-ball which is normally regulated by the intraocular pressure (IOP).[1,2] According to Medinet, IOP is defined as "The pressure exerted by fluids within the eye." Intraocular pressure is directed by the protection from the outward stream of the aqueous humor inside a limited range by perplexing and dynamic balance between the creation and escape of the fluid diversion through depleting channels. The distribution of the Intraocular pressure among the general population has a range of 11 to 21 mmHG.[3] Exact estimation of intraocular pressure is the key parameter in every single ophthalmic examination.[4]

The most commonly used method for the measurement of IOP is Goldmann applanation tonometry which is also universally acknowledged as the gold standard.[5] IOP measurement varies with the thickness of the central cornea by Goldmann tonometry, as it gives more reliable results on "normal corneae" (i.e., corneal thickness not too different from 520µm).[6,7,8] The intraocular pressure estimation by applanation tonometry depends on the Imbert-Fick standard, which affirms that the power required to level or applanate the surface of the circle is equivalent to the result of the weight inside a fluid filled circle and the applanated territory.[9] The standard Goldmann applanation tonometer tip prompts an applanated territory of 3.06 mm in measurement, with the goal that a power of 0.1 gram connected

to the tonometer head region compares to an intraocular pressure of 1 mmHg. At this distance across, the contradicting powers of surface pressure and corneal inflexibility counteract each other.[6]

The cornea is a clear avascular tissue with smooth curved foremost surface and inward internal surface. It must be transparent, have the capacity to refract light, contain intraocular pressure and furnish a defensive interphase with the external conditions.[10,11] It is somewhat spherical and is mainly responsible for refraction of light.[12] Despite the fact that measurements of cornea change extensively starting with one portion then onto the next, the estimated estimations are around 10.6 mm vertically and 11.7 mm horizontally. Posteriorly, cornea is concave with measurements of around 0.5-0.6 mm in the central part and thickest at the peripheral which is approximately 1.0 mm. The radius of curvature is 7.8 mm of anterior surface and 6.5 mm of posterior surface. The central third of cornea is nearly spherical and measures nearly 4 mm in diameter. Typical focal corneal thickness (CCT) is estimated with a gadget called Pachymeter, which utilizes ultrasound waves to quantify corneal thickness in any given area, and the method is called pachymetry,[13] while there are likewise other approach as well to check CCT that incorporates optical pachymetry, ultrasound scheimpflug imaging, optical coherence tomography (OCT), and even Magnetic resonance imaging.[14]

Corneal thickness estimation has as of late been acknowledged as an essential component in the management of patients determined to have glaucoma, and also those at high hazard for creating glaucoma. Especially, focal corneal thickness (CCT) has been found to impact the estimation of IOP. It is the main factor known to be amendable for the treatment of glaucoma and glaucoma suspected patients. When the central corneal thickness is more than 520 μm, there is systematic error in IOP measurement which is related to rigidity of cornea due to increased central corneal thickness. This expansion in toughness brings about more power being exerted to applanate the cornea. This extra power is interpreted by instrument as an increased IOP, which in reality is not the actual IOP.[7]

The conceptualization that CCT is an independent risk factor for glaucoma was first introduced by the Ocular Hypertension Treatment Study (OHTS), it reported that subjects with a corneal thickness of 588 μm or more were less likely to develop glaucoma than subjects with a corneal thickness of 555 μm or less.[14] Although by Dueker et al, found mixed evidence as far as association of CCT with the presence of glaucoma is concerned and hence the utility of CCT estimation as a screening tool for glaucoma seems to be negligible.[8]

Globally number of studies have been carried out in order to come up with correlation between central corneal thickness and IOP. A study carried out in study carried out in the Indian population with CCT at 544.73±30.46μm could not find any correlation between CCT and IOP.[15] In contrary to the above stated calculations, there are studies, which suggest that CCT and IOP may be correlated.[15,16,17] For example, a study in Karachi, Pakistan revealed a positive correlation between CCT and IOP (Pearson correlation coefficient r=0.136, p=0.022) in local population; they found mean CCT 529.5 ± 33.6 (range 438-619µm) while Mean IOP was12.75 ± 2.85 (range 8-20 mmHg).[18] Moreover, study by Galgauskas S et al revealed that there is no any correlation of IOP and CCT, but there is correlation in individuals over the age of 50 years.[19]

The study aimed to assess the effect of this central corneal thickness on IOP measurements. Central corneal thickness is thought to affect the IOP readings, however, as shown, the evidence available remains controversial and lack of sufficient work especially in this part of the world. Therefore, the objective of the study was to evaluate the correlation between CCT and IOP measurements not only to determine its importance in ophthalmic examination but also to improve the management of the patients by avoiding unnecessary treatment of those individuals with IOP wrongly elevated or decreased due to such postulated effect of central corneal thickness on IOP.

METHODOLOGY

The study used cross-sectional study design. It was conducted from July to December 2014. All the patients visiting ophthalmology department of Aga Khan University with the complaint of decreased vision between ages of 20 to 50 years were included in the study. However, out of those who were having corneal ulcers, abscess or opacity, corneal degenerations, corneal ectasia, astigmatism of more than 3 diopters, history of refractive surgery, glaucoma, patients taking any steroids or IOP lowering drugs or with some systematic illness (diabetes etc) were not included in the study. The non-probability purposive sampling technique was adopted in order to maximize the sample size. Patients visiting eye clinic at Aga Khan University Hospital fulfilling inclusion criteria were enrolled for this study. A written and informed consent was obtained from each patient after explaining the purpose and procedure of the study. A printed proforma prepared by the research team after going through a thorough literature search was used to enter the data for the variables including age, gender, address, IOP readings, and measurements. After anaesthetizing the eye with topical proparacaine 0.5% the cornea was stained with flourescene strip 2% and intraocular pressure was checked by Goldmann Applanation Tonometer. Mean of three consecutive IOP readings from each eye with spacing of 3 minutes between the readings was taken as the final reading. The central corneal thickness measurements were taken by using an ultrasonic pachymeter (SP 3000). After anaesthetizing the eye with topical proparacaine 0.5% and patients looking in primary position of the gaze, the pachymeter probe was placed on the center of the cornea and five measurements with 3 minutes of spacing in between were taken and the mean of the five readings was considered as the final reading and used for the analysis. Data was entered into SPSS (Statistical Package for Social Sciences; version 16.0) and manually verified for the data entry errors and finally was also used to analyze the data. Mean + SD was calculated for age, CCT and IOP and frequency was calculated for gender. Correlation between IOP and CCT was assessed by using Pearson correlation test. P value of < 0.05 with confidence interval of 95% was considered significant.

RESULTS

A total of 431 patients were enrolled for the study. Out of 431 patients 239 (55.5%) were males and 192 (44.5%) were females. The mean value of age was 34.9 years with ± 6.1 standard deviation (SD) and age range from 20 to 50 years.

The right eye mean central corneal thickness was 529, SD ± 39.5 with range of 473-591 μm. The left eye mean central corneal thickness was 533, SD ± 29.6 with range of 481-589 μm. These results are summarized in Table-I.

Eye	Minimum	Maximum	Mean	Standard Deviation (SD)
Right	473	591	529	± 39.5
Left	481	589	533	± 29.6

Table-I. Central corneal thickness (CCT) of study participants (μm)

The mean intraocular pressure of right eye was 14.7, SD ± 3.1 with a range of 9-21 mmHg. The mean intraocular pressure of left eye was 15.6, SD ± 3.1 with a range of 10-21 mmHg. These results are summarized in Table-II.

Eye	Minimum	Maximum	Mean	Standard Deviation (SD)
Right	9	21	14.7	± 3.1
Left	10	21	15.6	± 3.1

Table-II. Intra ocular pressure (IOP) of study participants (mmHg)

Pearson correlation test was applied using SPSS version 16 and significant association was found between central corneal thickness and intraocular pressure for normal subjects with positive correlation ($r = 0.136$) at significance level (P value of < 0.001) for both eyes.

DISCUSSION

The purpose of the study was to know the correlation between central corneal thickness and intraocular pressure among the normal subjects visiting the ophthalmology department Aga Khan University Karachi. In spite of numerous studies

and publications ophthalmologists frequently do not make correlations between IOP and corneal thickness particularly in normal individuals. Intraocular pressure is an essential hazard factor that has a huge impact in the determination and follow-up of visual hypertension and glaucoma patients. The results of the study are in line with most of the studies conducted, however few studies also give a totally opposite scenario.[20,21,22]

The majority of the studies analyzed did not exhibit that CCT is useful in foreseeing the advancement of glaucomatous damage. It was noticed that despite the fact that the proof supporting the requirement for the measurement of CCT as a hazard factor for glaucoma development is not as solid, IOP is the fundamental threat factor in the correction of glaucoma, and CCT can possibly altogether affect IOP estimation by applanation tonometry in all patients.[20,23,24]

The initial study to establish central corneal thickness as a risk factor for glaucoma were the Ocular Hypertension studies (OHTS).[17] The study identified the patients who were more prone to develop open angle glaucoma and also tried to find out that any conventional medical treatment for reduction of IOP would avert or defer the development of vision loss due to glaucoma. Patients with raised IOP seemed to be at modest risk of developing Primary Open Angle Glaucoma (POAG) and were randomly assigned for a stepped medical regimen or either close observation only. Topical anti-glaucoma agents were used for the medical treatment. According to analysis of OHTS by Kass, that mediocre IOP depletion could be attained and can also be maintained during a median 72 months follow up period.[25] Furthermore, according to Brandt et al, cross-sectional study arm of OHTS, tried to find out whether there is any association of CCT with race. By using similar ultrasonic pachymeters at study settings, CCT was measured in 1301 patients with ocular hypertension. The study highlighted that African-Americans have more attenuated corneas than their white mates as the mean CCT recorded was 573 µm and 555.7 µm, for Caucasians and African-Americans respectively. The study further demonstrated that the CCT of Caucasians was slightly higher than their African-American counterparts and the diagnosis, screening and management of patients with raised IOP by the applanation tonometry may be influenced by the thickness of the central cornea.[16] In this way ocular hypertension treatment studies became the pioneer studies to establish the fact that the major risk factor for the development of raised IOP leading glaucoma and ultimately visual loss is central corneal thickness. Moreover, one of the major limitations of OHTS was that it only involved the patients with raised IOP that was greater than 24mmHg, without establishing the value of using corneal pachymetry for screening in persons with normal IOP. In addition, there is lack of research evidence for the use of corneal pachymetry in choosing patients for treatment and enhancing the clinical outcomes. Keeping in view the results of study, the American academy of ophthalmology, recommended that all the glaucoma suspects/patients with raised IOP must be examined for corneal thickness with electronic pachymetry.[26]

In a comparative study, La Rosa reported CCT of African-Americans and Caucasians in patients with glaucoma and control population without glaucoma. He reported that the difference between the central corneal thickness of subjects who had suspected or confirmed glaucoma from control population was statistically significant. The study suggested that there may be misinterpretation of IOP due to thinner corneas of one of the population (African-Americans) of study subjects. The study further concluded that to accurately diagnose the patients of glaucoma or raised IOP, the measurement of CCT is mandatory.[27] Although, the aim of this study was not same as current study but somehow the conclusion of both the studies are similar to each other.
Another comparative study carried out by Sallet et al, CCT was measured by two different devices that is optical pachymetry was compared with ultrasound pachymetry. The analyst inferred that optical and ultrasound pachymetry are practically identical.[28]

Available evidence on keratoconus indicates that it is associated with corneal thinning, however the

studies suggest that in diagnosing keratoconus video keratography is more accurate than ultrasonic corneal pachymetry. Rabinowitz et al compared the measurements derived from video keratography and ultrasonic pachymetry to differentiate study subjects with keratoconus and normal eyes. The corneal thickness was measured by ultrasonic pachymetry of 99 keratoconus patients 142 normal subjects. For the corneal surface topography video keratography was used in patients with keratoconus. The investigators reported that video keratography indices provided a 97.5% correct classification rate and pachymetry data ($p < 0.01$). They researchers concluded that keratoconus ultrasonic pachymetry measurements are less likely to give accurate results tan the video keratography in diagnosis of patients with keratoconus. They further postulated that the results of the study might be due to high dissimilarity in corneal thickness of normal population or due to lack of ability of ultrasonic pachymetry in precisely detecting the site of corneal thinning The investigators finally came to the conclusion that the diagnosis of the keratoconus should not be relied only on pachymetry as it have a high false positive and false negative rates as compared to video keratography.[29,30,31]

The results of the current study are also in line with these studies as there is strong positive correlation between CCT and IOP, which suggests that all the patients suspected of glaucoma may also be assessed for CCT in order to have more accurate diagnosis and proper follow-up treatment.

CONCLUSION

There is strong positive correlation between central corneal thickness and intra ocular pressure. Therefore, along with the routine ophthalmic examination for intraocular pressure measurements pachymetry should also be considered for accurate interpretation of the results. Furthermore, research is also needed to enhance the results of the previous studies and to make pachymetry a routine examination in all patients visiting the eye clinics.

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Every man is guilty of all the good he did not do.

– Unknown –

AUTHORSHIP AND CONTRIBUTION DECLARATION

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1	Arsalan Ahmed Rajput	Data collection	
2	Azfar Ahmed Mirza	Data collection & Data analysis	
3	Ghazi Khan Maree	Resutls Formulation	
4	Adil Ali Shaikh	Results & Paper Formulation	