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Original Article

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Abstract

Objective: To determine the average central corneal thickness (CCT) of healthy adults in the ophthalmology clinic of a tertiary care hospital of Pakistan.

Methods: This was a cross-sectional study conducted in the ophthalmology clinics of Aga Khan University Hospital, Karachi Pakistan. One hundred normal subjects (200 eyes) were studied. An ultrasound pachymeter was used to measure CCT.

Results: The mean (±SD) age of the study population was 44.29 ± 15.18 years with a median of 47 years (range: 16-73). Twenty three percent of the subjects had diabetes mellitus, 29% hypertension and 6% had history of ischaemic heart disease. The mean (SD) CCT measurements were 531.08 ± 33.37) and 531.29 ± 33.33 micrometers in the right and left eyes respectively and were not significantly different from each other. There was no statistically significant correlation between CCT and IOP (r = 0.158, p = 0.12). We did not find a significant association between CCT and other independent variables like age, sex, presence of co-morbidity i.e. Diabetes Mellitus (DM), Hypertension (HTN), Ischaemic Heart Disease (IHD), myopia, hypermetropia, systemic and eye medication use.

Conclusions: The average CCT values obtained in the hospital-based study closely match those of the African Americans. A population-based study would be needed to provide unbiased CCT estimate in Pakistani population (JPMA 59:225; 2009).

Introduction

Globally, glaucoma is the second most common cause of blindness and the leading cause of irreversible blindness.[1] In, Pakistan it accounts for 7.1 % of the total causes of blindness.[2] Early diagnosis and initiation of treatment are important factors in minimizing the progression of disease and reducing its burden. Several studies have shown that intraocular pressure (IOP) alone is not an accurate test for detecting glaucoma. Central corneal thickness (CCT) has been identified as an important factor to consider when measuring IOP.[3-5] CCT has been shown to be associated with an over or underestimation of the IOP if the cornea is thick or thin, respectively.[6] It has been shown that Goldmann applanation tonometry over/underestimates IOP by as much as 5mmHg for every 70

μm corneal thickness above or below the mean.[3] A meta-analysis showed that the IOP-CCT interrelationship was different for glaucomatous and non-glaucomatous eyes. They concluded that for normal eyes, a 53 μm difference in CCT would be expected to produce a 1.1mmHg shift in the measured IOP. For, patients with long standing glaucoma a 53 μm difference in CCT would be expected to produce a 2.5 mmHg shift in the measured IOP value.[6]

Copt and colleagues had to reclassify 56% of patients previously followed up for ocular hypertension as being normotensive on the basis of higher than average CCTs. The IOP of an additional 31% of the individuals was found to be elevated after correcting for CCT.[7]

Several studies have recently reported that CCT varies from one population or race to another. In the United States, African Americans who are at a higher risk for developing glaucoma were found to have a significantly lower mean CCT compared with their Caucasian counterparts (531.0 ± 36.3 μm versus 558.0 ± 34.5 μm).[8] A study from South Korea gave the average CCT as 553um,[9] while one from Israel gave a value of 555 ± 32.[10] Despite its importance, CCT evaluation has received little attention in most South East Asian countries, including Pakistan, the sixth most populous country in the world (population of 160 million). In this report, we describe the mean CCT values and factors associated with them in a selected Pakistani adult population.

Subjects and Methods

Between February 1 2007 and March 31 2007, a sample of individuals undergoing executive check-up at the Aga Khan University Hospital (AKUH), Karachi was selected through convenience sampling for this study. AKUH is a well-equipped privately owned tertiary care university hospital. Its executive check-up programme includes a series of laboratory tests, a chest X-ray, dental check-up and an electrocardiogram (ECG), followed by physical examination, and counseling regarding risk factors and abnormal test results if any. Informed written consent was taken from all participants and they were examined at the ophthalmology clinics of the AKUH. Our exclusion criteria were: any history of ocular surgery, including laser surgery; any history of contact lens use reported by patient; history of intraocular trauma and presence of corneal pathology.

The questionnaire was pre-tested on 5 adults before using it for the study. All participants underwent a standard eye examination which included measurement of visual acuity, slit lamp examination, measurement of IOP and CCT, indirect and direct ophthalmoscopy.

CCT was measured using an ultrasonic Pachymeter (Topcon) in an upright position. All readings were taken in the morning to eliminate the effect of diurnal variation.[11]

Pachymetry readings were taken by two of the authors (RC and FM), who were trained by an ophthalmologist. Before the study, 20 normal eyes were examined by both doctors. Both of them took pachymetry readings on the same eyes and were found to have consistent results. IOP readings were measured twice in each eye by an ophthalmologist and the mean was recorded. IOP was measured using Goldmann Applanation tonometry. Refractive error was recorded by an ophthalmic technician using the auto refractor machine.

Information about the patient's age, sex, co-morbids i.e. diabetes, hypertension, eye diseases, and any eye medications and systemic medications being used currently was recorded. Interviewers first collected this information by asking the patients and later verified it from their medical record; in case of discrepancy, the hospital's most recent records regarding the patient were seen.

Five readings of CCT were obtained from each eye. All values were recorded, but the minimum value of corneal thickness for each eye was used for analysis. This value is believed to represent the most accurate measurement as it is most likely to be perpendicular to the central corneal surface.[8]

The data was entered and analyzed using SPSS version 15.0 (SPSS Inc., Chicago, IL). Means, standard deviations, median and ranges were calculated for CCT and other continuous variables such as IOP and age.

The total number of the study population was hundred with no missing data, and we calculated only frequencies. A histogram was plotted to show the distribution of CCT measurements. Means were compared using t-test and proportions were compared using chi square test.

Linear regression was performed to see if there was a relation between CCT measurements and independent variables. A correlation plot was computed, which shows the relationship between CCT and IOP.

Results

A total of 120 adults were requested to participate in the study of whom 20 (16.6%) declined. Of 100 individuals who were included in the study, 64 were men and 36 were women. The mean age of the study population was 44.29 ± 15.18 years with a median of 47 years (range: 16-73). Twenty three percent of them had diabetes mellitus, 29% had hypertension and 6% had history of ischaemic heart disease. Table 1 shows the demographic and clinical characteristics of the sample.

CCT and IOP measurements were analyzed for the right eye (n=100) and the left eye (97) separately. The mean (SD) CCT measurements were 531.08 ± 33.37 and 531.29 ± 33.33 micrometers in the right and left eye respectively (Table 1). The two means were not significantly different (Table 1, Figure 1).

Table 1: Demographic and clinical characteristics of the study population.

Variable	Frequency (n=100)
Age (mean ± SD)	44.29 ± 15.18
Sex (Male : Female)	64:36
Presence of at least one co-morbidity	39
Hypertension	29
Diabetes mellitus	23
Ischemic heart disease (IHD)	6
Existing eye disease*	3
Myopia	35
Hypermetropia	22
Eye medication (current)	2
Systemic medication use (current)	24
Central corneal thickness measurements (µm) right eye(n=100)	
mean ± SD	531.08±33.37
Median	524.50
Minimum, Maximum	470, 624
Central corneal thickness measurements (µm) left eye(n=100)	
mean ± SD	531.29± 33.33
Median	527
Minimum, maximum	467, 620

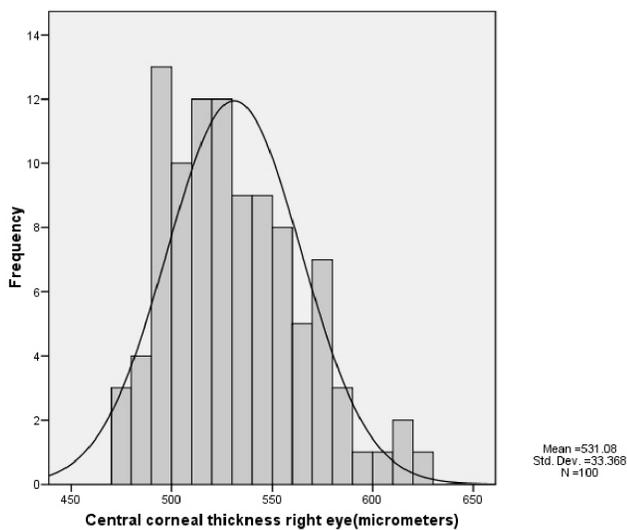*Other than refractive error, details in text

Figure 1: Distribution of ultrasound pachymetry central corneal thickness (right eye) in the study population (n=100).

The mean IOP in the right eye was 13.86 (± 2.79) and left eye 13.67 ± 2.68 mmHg.

The median IOP in the right eye was 14.00 mmHg (range 8-22) and in the left eye 14.00 mmHg (range 7-20).

For linear regression/correlation analysis, CCT measurements for the right (not left) eye were chosen. Figure 2 is a scatter plot which shows that there is no statistically significant correlation(r = 0.158, p = 0.12) between CCT and IOP in the study population. There was also no statistically significant linear association between CCT and other
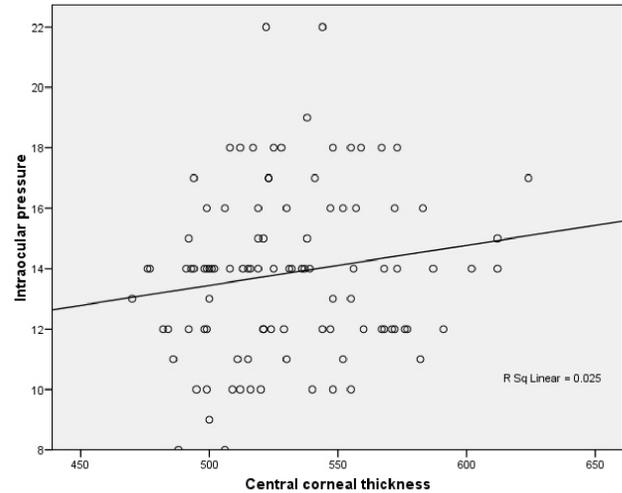

Figure 2: Scatterplot demonstrating the correlation between central corneal thickness (micrometers) and intraocular pressure in the study population. The correlation is not statistically significant (r = 0.158, p = 0.12).

independent variables like age, sex, presence of a co-morbidity i.e. DM, HTN, IHD, existing eye disease, myopia, hypermetropia, systemic and eye medication in use.

Discussion

To the best of our knowledge, this is the first report on the average CCT value in a selected Pakistani adult population. A study from another city in Pakistan,[12] looked at the association between IOP and CCT. It did not, however, give the mean CCT value of healthy population. The knowledge of the average CCT in a particular population is required in order to predict the risk of glaucoma in that population. The Ocular Hypertension Treatment Study recognized CCT as a strong predictor for the development of predict the onset of primary angle glaucoma (POAG).[13] In this study it was seen that individuals with CCTs of 555 µm or less had a 3 times greater risk of developing glaucoma compared with patients with CCTs of greater than 588 µm.[13] The average CCT in our population was 531 ± 33 µm. Extrapolating from that study, would lead us to believe that our population is also at a high risk for the development of POAG.

Racial variation influences CCT.[8] This implies that every population will have a unique CCT reading. The varied population bases used by different studies make comparison difficult. However, average CCT of our population (531+ 33 µm) closely matches that of the African Americans (531.0 ± 36.3 µm),[8] the Japanese (531.7 µm),[14] the Indians (537 ± 34 µm)[15] but is significantly different from that of the Caucasian population (558 + 34.5 µm). Population surveys done on Caucasians have been the basis for the definition of the "normal" range of IOP.[16] The

implications of this difference in average CCT are significant in terms of the correct determination of elevated IOP in our population. Glaucoma patients in our population will need to maintain a lower level of IOP.

Several factors including age, gender , diurnal changes, refractive error, genetic influence and diseases like diabetes have been shown to affect CCT.[11,17-19] In our study, we did not find any significant association between diabetes, hypertension, pre-existing ischaemic heart disease, age, sex and average CCT - although our study was not adequately powered to assess this question.

Patients with ocular hypertension and glaucoma have thicker central cornea than their controls. Our study did not have glaucoma patients or ocular hypertensives-- median IOP in the right and left eyes were 14.00 mmHg (range 8-22) and 14.00 mmHg (range 7-20), respectively. This probably means our CCTs values are slightly underestimated. However, changing few data values would not affect the median much because median is not sensitive to the extreme values (unlike mean).

A major limitation of our study was that it was done in a clinic setting. For our study population, we used adults visiting the clinic for executive check-up and not having any known ocular diseases other than refractive error. However, it is not a population based study and is prone to selection bias because the subjects we selected represents only those people who can afford to pay for an executive check up at this hospital, which costs about US\$ 200. The next step could be to do a population based study to estimate the mean CCT values, taking into account the socioeconomic factors, ethnic distribution and several other characteristics of the general population.

In conclusion, our hospital-based study reports the average CCT of our population as 531 ± 33 µm. We did not find any significant association between CCT and other variables. The average CCT values of this selected study population closely match those of the African Americans and may be suggestive of a higher risk of development of primary open-angle glaucoma in Pakistani population also. Our study calls for further research aimed to provide unbiased CCT estimate in Pakistani population.

References

1. Resnikoff S, Pascolini D, Etya ale D, Kocur I, Parajasegaram R, Pokharel GP, et al. Global data on visual impairment in the year 2002. Bull World Health Organ 2004; 82: 844-51.

2. Dineen B, Bourne RR, Jadoon Z, Shah SP, Khan MA, Foster A, et al. Causes of blindness and visual impairment in Pakistan. The Pakistan national blindness and visual impairment survey. Br J Ophthalmol 2007; 91: 1005-10.

3. Ehlers N, Bramsen T, Sperling S. Applanation tonometry and central corneal thickness. Acta Ophthalmol (Copenh) 1975; 53: 34-43.

4. Whitacre MM, Stein RA, Hassanein K. The effect of corneal thickness on applanation tonometry. Am J Ophthalmol 1993; 115: 592-6.

5. Hansen FK, Ehlers N. Elevated tonometer readings caused by a thick cornea. Acta Ophthalmol (Copenh) 1971; 49: 775-8.

6. Doughty MJ, Zaman ML. Human corneal thickness and its impact on intraocular pressure measures: a review and meta-analysis approach. Surv Ophthalmol 2000; 44: 367-408.

7. Copt RP, Thomas R, Mermoud A. Corneal thickness in ocular hypertension, primary open-angle glaucoma, and normal tension glaucoma. Arch Ophthalmol 1999; 117: 14-6.

8. La Rosa FA, Gross RL, Orengo-Nania S. Central corneal thickness of caucasians and African Americans in glaucomatous and nonglaucomatous populations. Arch Ophthalmol 2001; 119: 23-7.

9. Lee ES, Kim CY, Ha SJ, Seong GJ, Hong XJ. Central corneal thickness of Korean patients with glaucoma. Ophthalmology 2007; 114: 927-30.

10. Morad Y, Shavon E, Hefetz L, Nemet P. Corneal thickness and curvature in normal-tension glaucoma. Am J Ophthalmol 1998; 125: 164-8.

11. Kiely PM, Carney LG, Smith G. Diurnal variations of corneal topography and thickness. Am J Optom Physiol Opt 1982; 59: 976-82.

12. Mukhtar S. Central corneal thickness and its relation with measured Intra Ocular Pressure-A Retrospective study of 668 eyes of normal adults in a private practice. Pak J Ophthalmol 2004; 20: 23-5.

13. Gordon MO, Beiser JA, Brandt JD, Hever DK, Higginbotham EJ, et al. The ocular hypertension treatment study: Baseline factors that predict the onset of primary open-angle glaucoma 2002; 126: 714-20.

14. Aghaian E, Choe JE, Lin S, Stamper RL, et al. Central corneal thickness of Caucasians, Chinese, Hispanics, Filipinos, African Americans, and Japanese in a glaucoma clinic. Ophthalmology 2004; 111: 2211-9.

15. Thomas R, Korah S, Muliyil J. The role of central corneal thickness in the diagnosis of glaucoma. Indian J Ophthalmol 2000; 48: 107-11.

16. Colton T, Ederer F. The distribution of intraocular pressures in the general population. Surv Ophthalmol 1980; 25: 123-9.

17. Alsbirk PH. Corneal thickness. II. Environmental and genetic factors. Acta Ophthalmol (Copenh) 1978; 56: 105-13.

18. Harper CL, Boultan ME, Bennett D, Marcyniuk B, Jarris-Evans JH, Tullo AB, et al. Diurnal variations in human corneal thickness. Br J Ophthalmol 1996; 80: 1068-72.

19. Pedersen L, Hjortdal J, Ehlers N. Central corneal thickness in high myopia. Acta Ophthalmol Scand 2005; 83: 539-42.