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Central corneal thickness of Pakistani adults
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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).
µm corneal thickness above or below the mean. 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.

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.

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). A study from South Korea gave the
average CCT as 553µm, while one from Israel gave a value of
555 ± 32. 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.

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-morbid 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.

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).
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 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 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. 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