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Original Article

Comparison of Central Corneal Thickness Measurements Using Specular Microscope, Optical Biometer and Corneal Topographer

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ABSTRACT

Purpose: To compare the Central Corneal Thickness (CCT) measurements by three different devices in normal eyes.

Study Design: Cross sectional observational study.

Place and Duration of Study: Dow University of Health Sciences and Dr. Ruth K.M. Pfau Civil Hospital, Karachi, from October 2020 to January 2021.

Methods: 80 eyes of healthy subjects aged between 20 to 50 years were included in the study. Patients with corneal pathologies, systemic disease, history of ocular surgery or trauma, high intraocular pressure and high refractive error were excluded. Subjects underwent full ophthalmic examination. Central Corneal Thickness was measured by specular microscope (Shin-Nippon SPM-700; Rexxam Co. Ltd, Takamatsu, Japan), optical biometer (AL-Scan; Nidek, Gamagori, Japan) and corneal topographer (TMS-5; Tomey corporation, Nagoya, Japan). All data entry and analysis was done on SPSS version 23. For correlation among devices, Pearson correlation coefficient was used. Scatter plot was drawn for graphical presentation.

Results: 80 eyes of 80 healthy subjects (50 males, 30 females) were recruited in the study by convenient sampling. The mean age was 37.76 ± 8.35 years. Mean Central Corneal Thickness values were 515.57 ± 31.54 µm, 510.21 ± 30.11 µm, 522.03 ± 29.78 µm with specular microscope, optical biometer and corneal topographer respectively. Measurements by these devices strongly correlate with each other using Pearson correlation coefficient ($r = 0.927$ to 0.966, $p \leq 0.001$).

Conclusion: The results of Central Corneal Thickness measurements obtained from these three devices positively correlate with each other so any of these devices can be used for its measurement.

Key Words: Central Corneal Thickness (CCT), Specular microscope, Optical biometer, Corneal topographer.

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INTRODUCTION

Corneal deturgescence by endothelial pump is indicated by corneal thickness.[1] Normal central corneal thickness is 540 µm.[2] Central Corneal Thickness evaluates corneal pathologies like keratoconus and corneal dystrophies.[3] It is a key determinant of intraocular pressure and prevents misdiagnosis of glaucoma.[4] Error of 3.4mm of Hg in IOP measurement occurs with 10% difference in

central corneal thickness.[5] It evaluates cornea for refractive procedures.[6] It is important in various disorders such as contact lens complications and diabetes mellitus.[7] Various modalities are used for the measurement of corneal thickness. Contact methods include confocal microscopy and ultrasound Pachymetry.[8] Noncontact methods such as topography, optical coherence tomography and specular microscopy are also used.[9] Corneal topography by Scheimpflug camera and scanning slit system provides corneal thickness map.[10] Scheimpflug imaging devices include Tomey, Galilei, Pentacam, and Sirius.[11] Optical biometer like AL-Scan uses diode laser of 830nm and works on scheimpflug principle for central corneal thickness measurement.[12] Specular microscope analyzes corneal endothelial cell count. It is also used for the measurement of corneal thickness.[13] It uses light reflections to differentiate layers of cornea for the measurement of corneal thickness.[14]

The current study was undertaken to compare the central corneal thickness measurement by specular microscope, optical biometer and corneal topographer.

METHODS

This comparative study was done in the Department of Ophthalmology, Dow University of Health Sciences and Dr. Ruth K.M. Pfau Civil Hospital, Karachi from 15th October 2020 to 30th January 2021. It included 80 right eyes of 80 healthy individuals aged 20 to 50 years, of both sexes, with refractive error of ≤ ± 1.5 diopters, healthy cornea and normal intraocular pressure of ≤ 21 mmHg and normal fundus. This study adhered to the Declaration of Helsinki. Written and informed consent was obtained. All subjects underwent full ophthalmic examination including refraction, slit lamp biomicroscopy, measurement of intraocular pressure and fundoscopy. Exclusion criteria comprised of patients with corneal pathologies, systemic diseases such as diabetes mellitus, contact lens wearers, history of ocular surgery or trauma, intraocular pressure > 21 mm Hg and refractive error > ± 1.5 diopters.

Central Corneal Thickness (CCT) was assessed using specular microscope (Shin-Nippon SPM-700; Rexxam Co. Ltd, Takamatsu, Japan), optical biometer (AL-Scan; Nidek, Gamagori, Japan) and corneal topographer (TMS-5; Tomey corporation, Nagoya, Japan). All the readings were taken from the right eye by a single investigator in the morning between 10:00 am and 1:00 pm to avoid diurnal variation. Specular microscope determines corneal thickness in the range of 400 – 750 µm by using light reflections from the anterior and posterior surface of the cornea. AL-Scan optical biometer uses scheimpflug imaging technique to measure central corneal thickness. Tomey corneal topographer TMS-5 combines scheimpflug and placido disc principle. It uses 25 – 31 rings capturing 256 point per ring and measurement time is around 1 second. The patients were asked to blink before each measurement and then fixate at the target after head positioning. Central zone of 3.0 mm of cornea was used. Three measurements were taken. The images were captured and analyzed with each device. An interval of 5 minutes was taken between measurements with the devices. Selection of devices was in random order as all of them were noncontact methods.

Data analysis was done on SPSS version 23. Qualitative data including gender was presented as frequency and percentage. Mean ± standard deviation (SD) was calculated for age of the patients and Central Corneal Thickness (CCT). Pearson's correlation coefficient (r) was used to show strength of relation among three devices for CCT measurement. R > 0.7 indicates strong positive correlation between devices. Scatter plot was used for graphical presentation of correlation among the three devices. P ≤ 0.001 was considered significant statistically.

RESULTS

The study included 80 eyes of healthy subjects. The age ranged from 20 to 50 years. The mean age was 37.76 ± 8.35 years. There were 50 (62.5%) males and 30 (37.5%) females. Table 1 shows Mean Central Corneal Thickness (CCT) using different devices. There was strong positive correlation among all devices with Pearson correlation coefficient (r) more between specular microscope and optical biometer (r = 0.966) than between specular microscope and corneal topographer (r = 0.946) and between optical biometer

Table 1: *Central Corneal Thickness (CCT) measurements (µm), n = 80.*

Method	Mean	Standard Deviation
Specular microscope	515.57	31.545
Optical biometer	510.21	30.114
Corneal topographer	522.03	29.789

and corneal topographer (r = 0.927) as shown in Table 2. However, all three methods had strong correlation ($p \leq 0.001$). The scatter plots showed highest linear correlation (R^2) of CCT readings between specular microscope and optical biometer ($R^2 = 0.934$) in Figure 1 followed by the correlation between specular microscope and corneal topographer ($R^2 = 0.895$) in Figure 2 and between optical biometer and corneal topographer ($R^2 = 0.860$) in Figure 3.

Table 2: *Correlation among Specular microscope, Optical biometer and Corneal topographer*.

Method		Specular Microscope	Optical Biometer	Corneal Topographer
Specular microscope	Pearson Correlation	1	.966**	.946**
	Sig. (2-tailed)		.000	.000
	N	80	80	80
Optical biometer	Pearson Correlation	.966**	1	.927**
	Sig. (2-tailed)	.000		.000
	N	80	80	80
Corneal topographer	Pearson Correlation	.946**	.927**	1
	Sig. (2-tailed)	.000	.000	
	N	80	80	80

**. Correlation is significant at the 0.01 level (2-tailed).

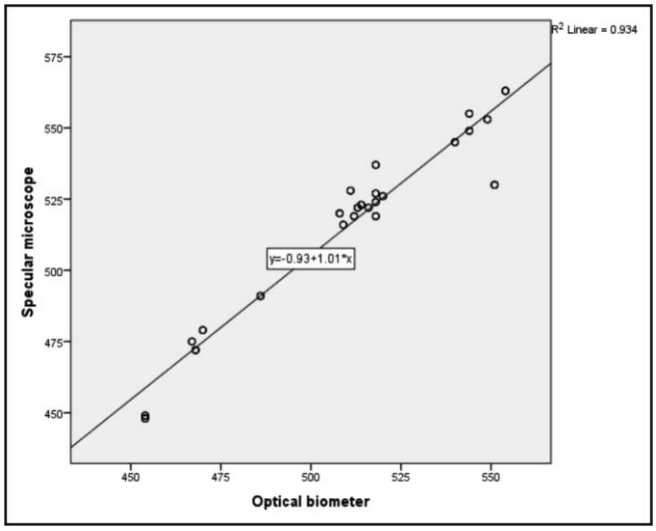

Figure 1: Scatter plot of central corneal thickness measurements by Specular microscope with Optical biometer.

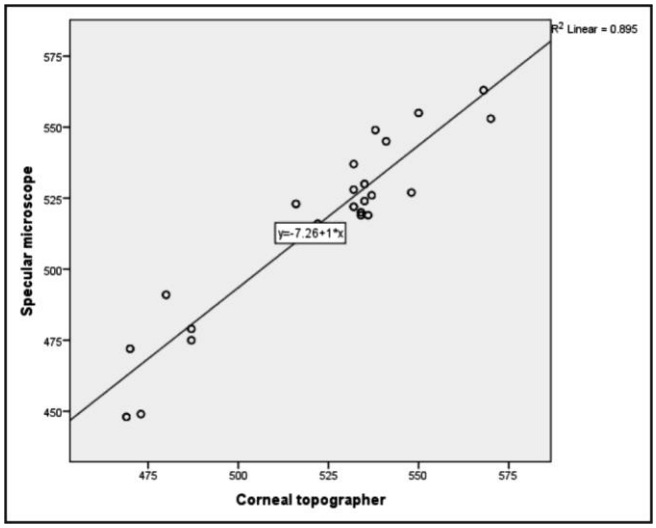

Figure 2: Scatter plot of central corneal thickness measurements by Specular microscope with Corneal topographer.

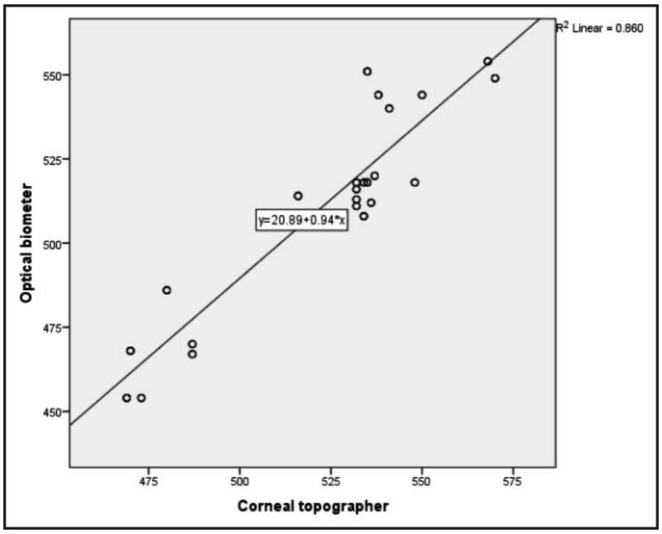

Figure 3: Scatter plot of central corneal thickness measurements by Optical biometer with Corneal topographer.

DISCUSSION

Measurement of CCT may be undertaken by ultrasonic pachymetry, confocal microscopy, corneal topography or optical coherence tomography.[15]Central Corneal Thickness is an important component in the diagnosis of glaucoma and assessment of corneal disease.[16] It is required for reliable preoperative assessment of candidates for keratorefractive surgery as corneal thickness of less than 500 µm is a relative contraindication for LASIK.[17] Increased corneal thickness may indicate early corneal decompensation.[18] Bourges et al observed that noncontact methods for CCT measurement can be used interchangeably with each other.[19]

In our study, mean CCT values were 515.57 ± 31.54 µm, 510.21 ± 30.11 µm, 522.03 ± 29.78 µm

when measured by specular microscope, optical biometer and corneal topographer respectively. Different methods are available for Central Corneal Thickness (CCT) estimation and several studies have compared the accuracy of various devices.[20] Mean CCT using scheimpflug analyzer was 536.4 ± 35.77 µm in a study conducted in Pakistani population which was comparable to our results and also reported positive correlation among different devices for CCT measurement (r = 0.804 to r = 0.949).[1] In a study by Chen et al, mean CCT with Scheimpflug imaging was 521.7 ± 27.62 µm which relates to our study.[21]According to Sadik and Rahmi study, the mean CCT was 542 ± 46 µm with specular microscope.[22] Other studies reported mean CCT of 518.53 ± 34.96 and 520 ± 29 with specular microscope which corresponds to our result.[23, 24] Jiang et al demonstrated that the mean CCT by specular microscope was 532.6 ± 40.0 µm. There was good correlation in scatter plot (r = 0.954) between specular microscope and optical biometer.[13] The mean CCT for the AL-Scan optical biometer and corneal topographer was 554.6 ± 30.9 µm and 570.7 ± 30 µm respectively.[15]

In the present study, there was strong linear correlation with Pearson correlation coefficient ranged from r = 0.927 to r = 0.966 when all three methods were compared. Many studies support our result. Ozyol et al in his study concluded that CCT measurements by optical biometer and Scheimpflug system are comparable with each other.[25] Our study results are in accordance with the study by Reem which had positive correlation of CCT measurements between specular microscope and scheimpflug topographer (r = 0.949).[26] Khaja W et al, study found linear correlation between specular microscope (r^2=0.98) and corneal topographer (r^2 = 0.96)[9]. Luisa observed high correlation coefficient (r = 0.852 to 0.995) among different instruments for central corneal thickness.[16]

With the current pandemic of COVID-19 Corona virus disease, these methods of measuring Central Corneal Thickness are probably safer to use as all of them are non-contact methods.

Limitations of this study is the small sample size. Comparison between different age groups and different ethnic groups were also not made. Further study to address these issues are needed.

CONCLUSION

In normal eyes, CCT measurements by all three devices show strong linear correlation and these modalities can be used correspondingly for the measurement of central corneal thickness.

Ethical Approval

The study was approved by the Institutional review board/ Ethical review board.
(Ref: IRB-1787-DUHS/Approval/2020)

Conflict of Interest

Authors declared no conflict of interest.

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Authors' Designation and Contribution

Madiha Waseem; Consultant Ophthalmologist: *Concepts, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing.*

Mehvash Hussain; Assistant Professor: *Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*

Muhammad Muneer Quraishy; Professor: *Design, Literature search, Manuscript preparation, Manuscript review.*

Zaheer Sultan; Consultant Ophthalmologist: *Search, Data acquisition, Data analysis, Manuscript review.*