DOI: https://doi.org/10.53350/pjmhs2023171814

ORIGINAL ARTICLE

Compare Mean Central Corneal Thickness with Ultrasound Pachymetry and Spectral-Domain Optical Coherence Tomography in Patients Presenting with Glaucoma

SOHAIB AFZAL[1], SHUJAH UR REHMAN[2], MUHAMMAD M. AFZAAL JAFAR[3], USAMA JAVAID[4], AQSA AKRAM[5]
[1] *Senior Registrar, Department of Ophthalmology, Shahida Islam medical and dental college*
[2] *Designation, PGR-4, Department of EYE UNIT 3, Mayo hospital Lahore*
[3] *Medical Officer, P&S Healthcare Department Punjab, RHC Rehanwala District Nankanasahib*
[4] *Consultant Ophthalmologist, Mughal Eye Trust and Medical Center.*
[5] *Senior Registrar, Shifa College of Medicine/shifa International Hospital*
Corresponding author: Sohaib Afzal, Email : Sohaib.afzal03@yahoo.com

ABSTRACT

Background: The optic nerve damage with the ultimate loss of vision resulting from a clutch of diseases named Glaucoma. In many conditions including, corneal dystrophies, corneal edema, and endothelial diseases of the cornea, the important biometric is Central corneal thickness (CCT).

Objective: To find the difference in mean CCT with spectral-domain optical coherence tomography and ultrasound pachymetry in patients presenting with Glaucoma.

Material & Methods: The study design opted was the observational cross-section. The study was done in tertiary care hospital. A total of 180 patients were registered for the present study. Both techniques noted the CCT value of all patients. Once the data was collected, it was stored electronically and analyzed by using SPSS version 20.0.

Results: 40.00±11.50 years was the average age of all the patients. There were 89(49.44%) males and 91(50.56%) females. The mean CCT was 531.01±28.54µm on OCT and 530.01±29.74µm on USP. The mean difference in CCT was 3.93±3.13µm between OCT & USP. The difference was statistically insignificant ($p<0.05$).

Conclusion: There is a statistically insignificant difference between the mean CCT with USP and spectral domain OCT patients presenting with Glaucoma.

Keywords: Glaucoma, Optical Coherence Tomography, Central Corneal Thickness.

INTRODUCTION

Glaucoma is diagnosed and managed by assessing many factors, out of which central corneal thickness (CCT) is an essential factor. Presently, measurement by ultrasound corneal thickness (USP) is considered the standard gold method for assessing CCT. However, new instruments have also been introduced to assess CCT, including optical coherence tomography (OCT)(1). The corneal thickness evaluation will provide clinically useful information related to the physiological status of the cornea(2)(3).

The significant changes in CCT may govern changes in the level of intraocular pressure. The glaucoma diagnosis and management would be delayed due to the IOP underestimation; hence, it is essential to evaluate the CCT in Glaucoma, dry eye disease, and corneal refractive surgery(4)(5).

The study rationale was to evaluate and observe the difference in mean CCT by USP and spectral-domain OCT patients presenting with Glaucoma. In routine, USP is mainly used to measure CCT. However, nowadays, in foreign countries, OCT is recommended in CCT measurement throughout the patient assessment with Glaucoma. USP is now a broadly accepted method of choice as it is easy, portable and used intra-op, and gives precise measurement. The gold standard for CCT measurement is taken as USP. So if OCT and USP give an almost equal measurement of CCT, then we can replace USP with OCT. However, ambiguous results have been reported as quoted above; one study has reported a significant difference between both methods for assessing CCT, but one study showed that the difference is significantly less. This study, therefore, claimed a method that is more appropriate for the assessment of CCT so that in the future, we may be able to implement the results of this study to resolve the controversy. This study will help us to improve the assessment of glaucoma patients.

Objective: Compare mean central corneal thickness with ultrasound pachymetry and spectral-domain optical coherence tomography in patients presenting with Glaucoma.

MATERIALS AND METHODS

This Observational cross-section study was conducted at the Department of Ophthalmology, Jinnah Hospital, Lahore. A sample size of 180 was calculated with a 95% confidence level, d=1, and taking the magnitude of difference in CCT, i.e., 17.59±6.76µm between OCT & USP in glaucoma cases. All the patients were recruited by applying the Non-probability Consecutive sampling technique. Patients of age 20-70 years, both genders presenting with Glaucoma are included i.e.

- Intraocular pressure >21mmHg on Goldman applanation tonometer.
- Visual Fields: A minimum of two reproducible Humphery visual fields demonstrating glaucoma damage were obtained using the program 24-2. (HFA, 24-2)
- Retinal Nerve Fiber Layer: Average RNFL thickness 66.07±15.5µm or less.

However, patients with Corneal surgery, Active infection of the cornea, Corneal scar, Posterior segment pathology, Diabetic macular edema or retinopathy, Previous eye surgery, or intraocular lens implantation were omitted. The research was carried out in conformity with the Helsinki Declaration's guidelines. Informed permission was acquired from all participants after they were informed about the nature of the research and the potential implications of taking part in it. One hundred eighty eyes fulfilling the selection criteria were included from OPD of the Department of Ophthalmology, Jinnah Hospital, Lahore. Demographic information (name, age, sex, anatomical side involved, and contact) was also obtained. A thorough refractive examination and anterior and posterior segment examinations were performed on all eyes involved in the research. Then all patients undergo measurement of central corneal thickness using both techniques. In order to eliminate the effects of diurnal fluctuation in corneal thickness, all measurements were performed at the same time of day and at least 2 hours following the subject's waking time. An experienced Ophthalmologist having expertise in operating both devices has performed all tests. The OCT was performed first on each patient. Corneal images were acquired utilizing the anterior segment 5-line raster mode of the SD-OCT and focus adjustment of the OCT beam. This scan technique employs five horizontal scan lines, each 3 mm long, separated by a 250-m distance. Each scan line is comprised of 4096 A-scans per second. This scan mode has a better resolution than the 512x128 cube scan mode (1024 A-scans/s); as a result, the upper and lower corneal borders are scanned more clearly, allowing for more precise placement of the

digital caliper. The image closest to the center of the CCT anterior segment 5-line raster was magnified compared to the other images.

A digital caliper was then used to manually measure the distance between the inner and outer margins of the cornea, which was then recorded. According to the manufacturer, the system operates at an 830 nm wavelength and can scan at a rate of 26,000 axial scans per second. The system has a depth resolution of 5 microns (full width, half maximum) at the highest resolution in tissue. CCT was taken into consideration. After the measurements with OCT, Topical proparacaine hydrochloride 0.50 percent was used to anesthetize the cornea, and 80 seconds passed before the USP (Pacline, Optikon) measurement. The patient was instructed to focus on a distant object, and the calibrated ultrasonic probe was manually positioned as precisely and perpendicularly as possible on the center of the cornea. Three measurements were collected consecutively. CCT value was noted.

To eliminate inter-examiner variability in ultrasonic pachymetry measurements, all ultrasonic pachymetry exams were performed by the same ophthalmic technician. Collected data was entered and analyzed through SPSS version 20.0. The quantitative variables like age and CCT (on OCT and USP) were presented as mean and standard deviation. Mean CCT was compared in both groups by using an independent sample t-test. A Bland–Altman plot was used to determine the degree of agreement between the two instruments. We computed mean differences and limits of agreement (LOA). The mean ±1.96 SD was used to determine the 95% limits of agreement (Loa). The study of three consecutive independent measurements was used to determine intra-examiner reproducibility. The intraclass correlation coefficient was used to assess reproducibility (ICC). A 1.0 score indicates complete agreement, whereas 0.81 to 0.99 values indicate almost perfect agreement. The 95 percent confidence interval and p0.05 threshold of statistical significance were used to assess the results. The difference was calculated by subtracting CCT measured on OCT from CCT measured on USP.

RESULTS

Table 1: Descriptive Statistics of CCT by OCT with study groups

CCT by OCT	n	180
	Minimum	480
	Maximum	580
	Mean	531
	SD	28.54

According to our study results, out of 180 patients enrolled, the mean CCT value on OCT was 531.01±28.54µm. In our sample size, CCT noted 480µm, while the maximum value of 580µm was recorded. The standard deviation from the mean is 28.54µm.

Ind. t test=-1.132 p-value =0.259

Table 2: Descriptive Statics of CCT on USP with study groups

CCT by USP	n	180
	Minimum	480
	Maximum	580
	Mean	530
	SD	29.74

According to our study results, out of 180 subjective eyes enrolled, the mean CCT value on USP was 530.01±29.74. In our sample size, CCT noted 480µm, while the maximum value of 580µm was recorded. The standard deviation from the mean is 29.74µm.

Ind. t test=-1.245 p-value=0.215

Table 3: Difference between CCT by OCT and USP with study groups

Difference	n	180
	Minimum	0
	Maximum	19
	Mean	3.93
	SD	3.13

In this study, out of 180 patients enrolled, the mean difference of CCT by OCT and CCT by USP was 3.93±3.13. Both technique's minimum difference of values is 0.00µm, while the maximum difference of 19.00µm was recorded. The standard deviation from mean is 3.13µm

Ind. t test=-0.953 p-value=0.342

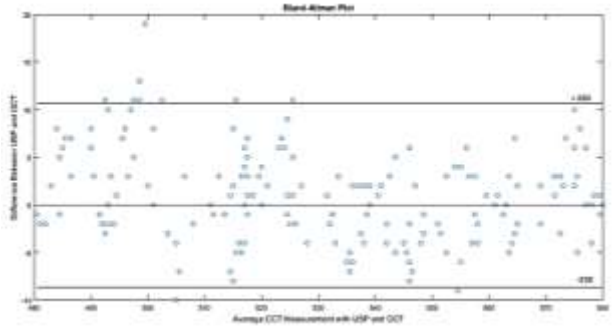

Figure 1: Bland-Altman plot

The Bland-Altman plot revealed that 95% LOA based on the 2 SD difference between OCT and USP is between - 9µm and 11µm. Only three values are outside the LOA; the values are at -10µm, 13µm, 19µm.

Table 4: Difference between CCT by OCT and USP with study groups after removal of outliers

Difference	n	180
	Minimum	0
	Maximum	7
	Mean	3.17
	SD	1.94

In this study, out of 180 subjective eyes enrolled, after removal of the outliers of the data, the mean difference of CCT by OCT and CCT by USP was 3.17±1.94. Both techniques' minimum difference of values is 0.00µm, while the maximum difference of 7.00µm was recorded. The standard deviation from the mean is 1.94µm.

The mean difference is reduced significantly after the removal of the outliers in the data. The same has been endorsed by the significant reduction in SD, which shows that the measurements of CCT by OCT and USP are almost equal.

DISCUSSION

In this research, a cross-sectional study of comparison of central corneal thickness by spectral-domain optical coherence tomography and ultrasonic pachymetry in glaucoma patients is presented, carried out at Unit 1, Department of Ophthalmology, Jinnah Hospital, Lahore.

CCT is a critical biometric assessment in various ocular disorders, including corneal edema, dystrophies, and endothelial diseases of the cornea. Ultrasound pachymetry (USP) is the most common method used for CCT measurement. USP is performed by direct apposition of an ultrasound probe to the anterior corneal surface, whereas the spectral domain OCT which combines imaging technology of OCT, can also be used to measure the corneal thickness(6).

The primary goal of our research was to establish if optical coherence tomography (OCT) could be used to replace ultrasonography (USP) in the evaluation of CCT in individuals with Glaucoma. OCT was chosen for this application because of the advantages of being aseptic and presenting no risk of corneal contact injury. Another benefit of OCT is that it allows the data to be reviewed later when the patient is not present, which is a significant advantage. Additionally, the reproducibility of OCT pachymetry is good both intra- and inter-observer, perhaps even

superior to that of USP, in research by Lin et al. (7). Our results are consistent with those of Garcia-Medina et al. (8). on glaucomatous eyes, there was no significant difference in CCT measurement between OCT and USP. Even though prior research comparing OCT and USP has been published(8).

The research had many limitations, one of them was the time of day when the data were collected. The diurnal changes with nighttime corneal edema should be addressed. Research by Fogagnolo et al. (9). on glaucoma patients found that the mean CCT was 534 (SD = 39) µm (range, 443–637 µm) with circadian variations of 16.5 (SD = 6.2) µm (range, 6–31 µm) and mean CCT was 534 (SD = 39) µm (range, 443–637 µm). According to du Toit(10), the mean corneal edema upon opening the eyes was 2.9 ±0.3 percent more than at baseline, but significant individual variation ranged from 1.3 to 7.2 percent higher than at baseline. Deswelling began 2 hours after the eyes were opened.

There is a chance that the use of topical anti-glaucoma medicines influenced the measurements. Active compounds in medications, as well as medications containing preservatives, may cause corneal thickness to change. Regarding OCT and USP, the most significant variables would be changes in corneal properties, such as the reflection and propagation velocity of the tissue, which would be the most significant factors, which is because both methods rely on the time-of-flight concept, which refers to the delay caused by a wave signal as it passes through ocular tissue and the reflected signal that results as a consequence.

Another drawback may be the changes in measurements that occur as a result of patient engagement. During the evaluation with OCT and USP, the patient should direct his or her attention to anything specific. Due to dementia or terrible hearing, only a small number of patients found this challenging since they could not comprehend the instructions given to them. It should be noted that both measuring techniques would be subject to the same problems.

In the procedure, the positioning of the USP probe and the OCT scans are different from one another. Unlike the USP, which uses a fixed probe to make measurements, the OCT uses 12 separate scans in the 12 o'clock position and then takes an automatically averaged measurement. The observer makes an effort to position the OCT scan in the center of the cornea; however, since an average measurement is computed, positioning may not be as critical as it would be with a standard USP scan.

There are numerous different instruments for measuring CCT, but they all work on the same two fundamental principles(11): ultrasonography and optics. As a result, in the present research and a comparison of two different devices, a comparison of two different measuring concepts was conducted.

Various variables have been found to impact the discrepancy in measurements between the two different approaches. The difference in the amount of thinning between the measurements taken with a pachymeter and those taken with an OCT may be related to the amount of pressure given to the cornea by the person taking the measurements. Regarding repeatability, Lin et al. found that OCT was superior to USP compared to other methods(12).

The Cirrus SD-OCT measuring bar has a sensitivity of 4 µm, which means that even the slightest movement will result in a measurement error of 4 µm. It is possible that decreasing the degree of sensitivity of the scale to 1 µm will result in precisely the same CCT readings as those obtained via ultrasonic pachymetry. Potential software improvements, such as those that enable automated CCT measurement, such as that used in the retinal examination, may avoid user dependant CCT variations.

CONCLUSION

It was concluded that there is a statistically insignificant difference between the mean central corneal thickness with ultrasound pachymetry and spectral-domain optical coherence tomography in patients presenting with Glaucoma.

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