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CENTRAL CORNEAL THICKNESS;
COMPARISON OF CENTRAL CORNEAL THICKNESS MEASUREMENTS BY PENTACAM AND ULTRASOUND PACHYMETRY, IN MYOPIC AND KERATOCONUS EYES.

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ABSTRACT…. Objectives: To compare central corneal thickness in myopic and keratoconus eyes by ultrasound pachymetry and pentacam HR. **Study Design:** Cross sectional study. **Setting:** Qassim University, Optometry Clinics, Kingdom of Saudi Arabia. **Period:** October 2016 to April 2017. **Methodology:** One hundred myopic and keratoconus participants. Central Corneal Thickness (CCT) were measured with two techniques by ultrasonic pachymetry and pentacam HR in two groups. Group one consisted of 80 myopic participants and group two of 20 Keratoconuspatients.Pentacamreadings were recorded first. CCT were compared and analyzed statistically using unpaired t-test and histogram. **Results:** One hundred participants (100) were included in which 80 participants were myopic and 20 with keratoconus. Both eyes (200) of all the participants were examined. Age of the myopics ranged from 18-30 years (Mean=23.03). The mean value with ultrasound pachymetery was $555\mu m$ (SD$\pm$32.021) and with pentacam $566\mu m$ (SD$\pm$37.367). We observed a tendency of overestimation of CCT measurements with pentacam. Statistically a significant difference of reading between two devices (P<0.001) was found. In keratoconus participants, the mean age was 23.7 years (21- 26). The mean CCT taken with Pentacam HR and US Pachymetry was $476\mu m$ (SD$\pm$ 16.980) and $465\mu m$ (SD$\pm$ 35.868) respectively. The t-test showed no statistical difference between thepentacam HR and ultrasound pachymetry (p>0.214). **Conclusion:** Measurements of central corneal thickness done with Ultrasound Pachymeter and Pentacam HR are closely related to each other and are interchangeable when used in normal refractive error cases. While in Keratonus patients ultrasound pachymetry is preferred because of its reliability.

Key words: Myopia, Keratoconus, Pentacam, Corneal Thickness, Ultrasound Pachymeter.

INTRODUCTION

Cornea is a transparent avascular tissue that measures 10-11 mm vertically and 11-12 mm horizontally. On average Central corneal thickness is 540.4 μm (SD 33.6) centrally and thicker towards the periphery.[1]

Clinically the measurement of Central cornea thickness (CCT) is most important for refractive surgery, glaucoma diagnosis and monitor the progression of various corneal problems.[2,3] Measurement of central corneal thickness is performed for both diagnostic and therapeutic purposes. CCT allows determination of the amount of stromal ablation to minimize the risk of iatrogenic keratectasia in Laser Assisted In situ Keratomileusis (LASIK) surgery.[4,5] In various ocular problems, corneal thickness measurement is of utmost importance.[6,7]

There are various ways of measuring corneal thickness. The most commonly used clinical method is ultrasound pachymetry (gold standard). It is a non-invasive contact ultrasonic technique for measuring corneal thickness, For the measurement of corneal thickness, it is considered to be a popular device because of its efficiency and accurate way of measuring corneal thickness and address the reliability and repeatability of these measurement techniques.[8,9] Its advantages include ease of use, portability, and low cost. However, the possibilities for patient discomfort produced even after topical anesthesia for numbness and the chance to

induce corneal epithelial damage, erosion and infection with this contact method and in addition to this, errors caused by indentation of the cornea have also been reported.[10,11] It is performed by placing an ultrasonic probe on the central cornea, after the cornea has been anesthetized with a topical anesthesia. There is also a newer generation ultrasound pachymeter that uses a composite probe.[12]

The Pentacam HR (Oculus) is a non contact device based on the Scheimpflug principle, which generates precise and sharp images of the anterior eye segment, it provides thickness of the entire cornea within less than 2 seconds, where 50 images with 500 true elevation points can be recorded along with a 3-dimensional scanning of the anterior segment of the eye.[3,13] Anterior chamber angle and volume can also be documented.[14,15]

Due to various corneal problems like keratoconus and increasing prevalence of myopia, measurement of corneal thickness has become very important to diagnosis and treatment.[16-18] The present study was conducted to compare the CCT readings of ultrasonic pachymeter and pentacam in myopic and keratoconus eyes.

OBJECTIVES
The purpose of this study was to compare the central corneal thickness (CCT) in myopic and keratoconus eyes by using two different modalities, ultrasonic Pachymeter and Pentacam HR.

MATERIALS AND METHODS
A prospective cross sectional study was conducted at Qassim University in optometry clinics in one hundred myopic and keratoconus participants. Central corneal thickness (CCT) was measured in two groups of participants. We divided the participants into two groups. Group one was consisted of eightymyopic (160 eyes) and Group two was twenty keratoconic participants (40 eyes).The study protocol and informed consent was obtained from all the participants. Routine ocular examination was conducted in all participants, like assessment

of visual acuity, refraction, anterior and posterior segment evaluation under slit lamp. Participants of any ocular pathology, corneal surgery or ocular trauma were not included in this study.

After that, all the participants underwent a Corneal thickness measurements by two different modalities that is Pentacam HR and Ultrasonic Pachymetry.

The non-contact device Pentacam (OculusPentacam HR 70900) was appliedon both eyes of all participants after briefing the procedure. The parameters of topographic corneal thickness, corneal curvature, anterior chamber depth and volume were calculated automatically through camera within two seconds. Then contact Ultrasound pachymeter (Sonomed Pac Scan 300 P) was used on both eyes of same participant after inducing surface anesthesia, by topical anesthetic (0.5% proparacaine hydrochloride) along with all antiseptic measurement.

All the data were analyzed in SPSS program 2009. The meansand standard deviation was determined. "P"value of less than 0.05 was considered statistically significant. The distributions of ultrasound Pachymetry and Pentacam HR measurements for CCT were compared using histograms and t-test was performed to see if any difference was present between the measurements.

RESULTS
Central corneal thickness (CCT) measurements were performed in a total of one hundred participants who were recruited for this study and both eyes (total=200) were examined in each participant.

Group one (1) was consisted of 160 normal myopic eyes of 80 participants with mean of age 23.03 years (range18–30 years). The measurements of central corneal thickness with both devices in myopic eyes are shown in Table-I, Figure-1 and 2.

The mean reading was 555μm (SD±32.021) in Ultrasound Pachymeter while with Pentacam HR was 566μm (SD±37.367).

	Mean	Std.Deviation	N
US Pachymetry (Myopia)	555	32.021	80
PentacamHR (Moypia)	566	37.367	

Table-I. Shows the means and standard deviations of central corneal thickness measurements obtained with 2 different modalities in myopic eyes
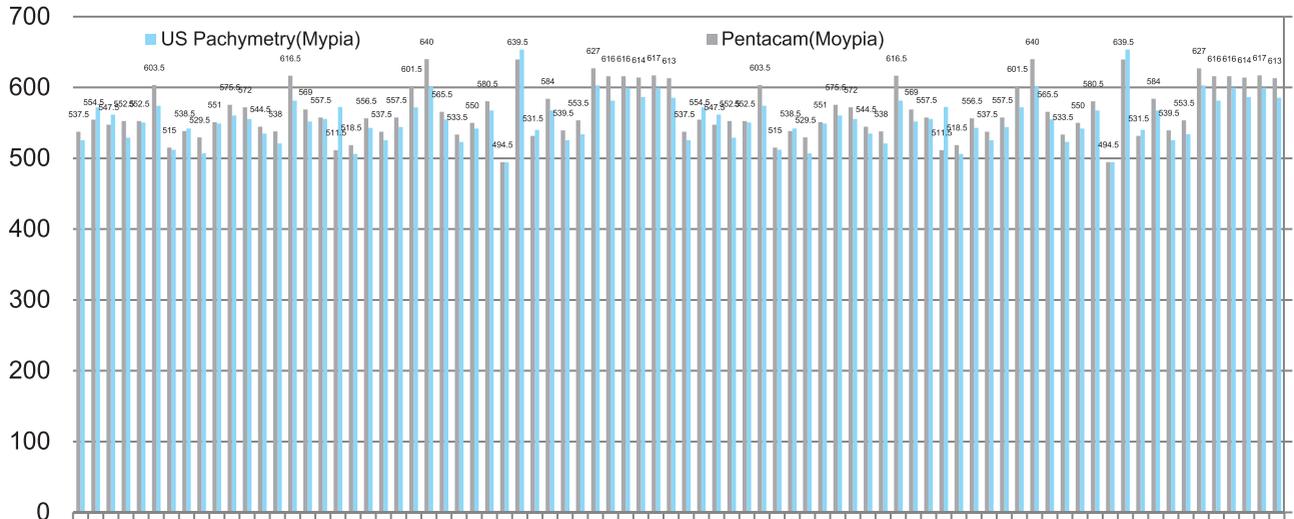

Figure-1. Describes the maximum CCT measured with US Pachymetry and Pentacam HR. (Histogram CCT distribution of US Pachymetry&Pentacam in myopic eyes)
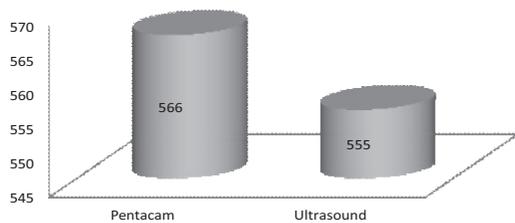
statistically significant ($P < 0.001$) as shown in Table-II.

Group two (II) included of 40 Keratoconus eyes of 20 participants with mean age of 23.7(range 21–26 years). In Table-III, are explained the means and standard deviations of CCT with Pentacam HR (476 ± 16.980µm) as compared with US Pachymetry (465 ± 35.868µm). Figure 3, showed that the maximum CCT with ultrasound pachymetry was (497.50µm) and with pentacam (487µm). The Ultrasound Pachymetry and the Pentacam HR measurements show close similarities in distribution.

Figure-2. Shows the average measurements of CCT with Ultrasound Pachymetry and Pentacam HR in myopic participants.

T-test showed that the mean values of central corneal thickness (CCT) differ significantly between Pentacam HR and Ultrasound Pachymetry (11.17500 ± 17.55229 µm) and was

Paired Samples Test								
		Paired Differences						
					95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	A - B	-11.17500-	17.55229	1.96241	-15.08107-	-7.26893-	-5.695-	79	.001

Table-II. T-Test shows differences between Ultrasound Pachymetry and Pentacam HR in myopic eyes
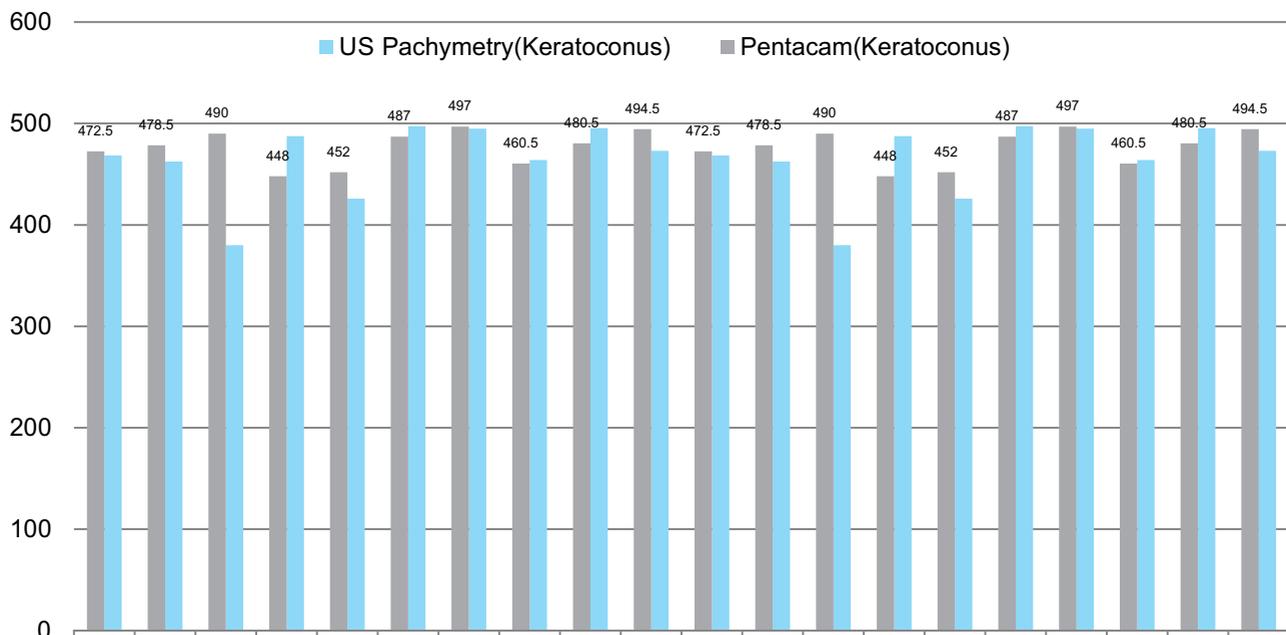
Figure-3. Showed that the maximum CCT with ultrasound pachymetry was (497.50μm) and with pentacam (487μm).

In Figure-4, describes that the mean value of CCT measurement in Pentacam HR was (476μm) and in US Pachymetry was (465μm).

	Mean	Std.Deviation	N
US Pachymetry	465	35.868	20
Pentacam HR	476	16.980	

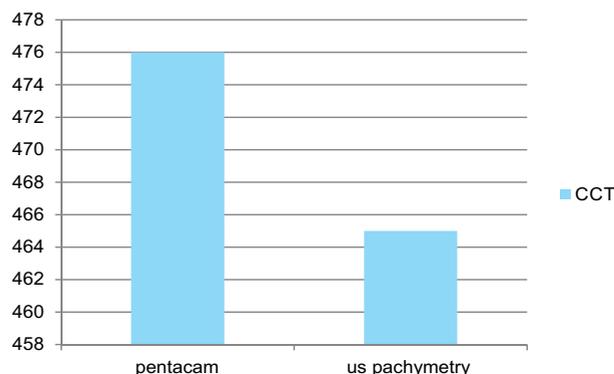**Table-III. Shows measurements of central corneal thickness measured with both instruments in keratoconic eyes**

T-test showed that the mean values of measurements of CCT with Pentacam HR and ultrasound pachymeter show no significant difference (11.10000 ± 38.64807 μm) and was

not statistically significant (P > 0.214) shown in Table-IV.

Figure-4. Describes the mean values of CCT with pentacam H and US Pachymetry in Keratoconus eyes

Paired Samples Test								
		Paired Differences						
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	C - D	-11.10000-	38.64807	8.64197	-29.18786-	6.98786	-1.284-	19	.214

Table-IV. T-Test shows the differences between US Pachymetry&Pentacam HR in keratoconus eyes

DISCUSSION
Different devices available for measuring the corneal thickness are based on a variety of techniques and each has its own merits and demerits.

In our study, central corneal thickness (CCT) measurements were compared between the Pentacam HR and Ultrasound Pachymetry in myopic and keratoconus eyes. Our study showed that statistically significant difference between the pentacam HR and ultrasound pachymetry was observed in measurement of the CCT in myopic eyes and no statistically significant difference between the Pentacam HR and US Pachymetry in measurement of the central corneal thickness (CCT) in keratoconus eyes. In this study the CCT measurements with two devices were highly correlated in keratoconus and myopic eyes.

In this study, the mean reading was 555μm (SD$\pm$32.021) in Ultrasound Pachymeter while with Pentacam HR was 566μm (SD$\pm$37.367). So a tendency of overestimation of CCT measurements with Pentacam HR has a statistically significant difference between both methods (P<0.001). Tai et al. had reported that the mean CCT measurements by Pentacam HR were 10 µm more than that obtained using US pachymetry.[19] Other different studies also found that in Pentacam HR, CCT measurement to be thicker than ultrasound by 2.7 µm, and 6.4 µm, 8.0 µm, and 8.2 µm respectively[15,17,20,21] and in our study it was almost 5.346 um. Similarly, Hani et al. concluded that Pentacam tends to overestimate CCT compared to US pachymetry in post Lasik patients.[22] According to another study, the average measurements of CCT were 526.8$\pm$35.3 and 529.1$\pm$37.9 for the Pentacam and US pachymetry values, respectively. Mean difference between both measurements was 2.3$\pm$2.6μm but no statistically significant difference was shown. However, the correlational analysis showed a significant positive correlation between central corneal thicknesses by US pechymetry.[23] Ciolino et al observed that CCT measurements by Pentacam HRhave good correlation and agreement with those performed using ultrasonic pachymeter.[24]

Ho et al. demonstrated that the Pentacam HR significantly underestimates CCT compared with US pachymetry.[25] Hashemi et al. showed that Pentacam underestimates CCT in comparison to US Pachymetry in a study of eyes that had Lasik.[26] Another study concluded that the CCT measurements obtained using the device were in high agreement with those obtained by US pachymetry, suggesting that the 2 devices are interchangeable.[27]

In this study measurements with both the devices are closely related to each other in keratoconus eyes but another study including big number of patients shows that pentacam shows overestimation in keratoconus eyes which may be due to loss of fixation and structural changes in these patients.[18] So it can be concluded that in keratoconus eyes the measurements with both the devices are not interchangeable and preferably ultrasound pachymetry should be used.

US pachymetry depends on the reflection of ultrasonic from the anterior and posterior corneal surfaces. In ultrasonic pachymetry, the exact posterior reflection point is not known; it may be located between Descemet's membrane and the anterior chamber. If the reflection point is located at the anterior chamber, this will cause overestimation of the corneal thickness. Comparing measurements between Pentacam and ultrasound, reports indicate that agreement is slightly worse after refractive surgery compared to before surgery.

CONCLUSION
Measurements of central corneal thickness done with Ultrasound Pachymeter and Pentacam HR are closely related to each other and are interchangeable when used in normal refractive error cases although pentacam offers comfort and convenient to the patients during corneal evaluation because of non-touch technique. While in Keratonus patient's ultrasound pachymetry is preferred because of its reliability.

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> *Don't think there are no crocodiles because the water is calm.*
>
> **– Malayan Proverb –**

AUTHORSHIP AND CONTRIBUTION DECLARATION

Sr. #	Author-s Full Name	Contribution to the paper	Author=s Signature
1	M. Ijaz Ahmad	Data collection, Methodology and Discussion.	
2	Manzoor Ahmad Qureshi	Literature review and results analysis.	
3	M. Shakeel Ahmad	Data analysis.	
4	Yousef Homood Aldebasi	Intellectual contribution and conveivement of idea.	