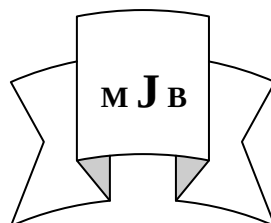


Corneal Thickness Measurement with Optical and Ultrasonic Pachymetry

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Abstract

Background: Evaluation of central and peripheral corneal thickness is of great clinical importance in the ophthalmology. The main aim of this study is to evaluate the optical and ultrasound pachymetric measurements by comparing the central corneal thickness measurements obtained by the (SP 3000 pachymeter from TOMEY) and Allegro Oculyzer (pentacam) pachymeter.

Patients and methods: 28 patients attending the photorefractive surgery unit at IBSAR LASIK center in Alnajaf were collected. The patients were grouped into three major groups according to the refractive errors they got and the central corneal thickness for each patient was measured by two methods:1. using the Allegro Oculyzer (pentacam) as a non contact optical pachymeter.2. using the ultrasonic pachymeter SP 3000 pachymeter from TOMEY, all measurements were done by the same surgeon.

Results: the findings of this study reported that the ultrasound pachymeter significantly overestimates the corneal thickness by about 2.85 micron and the eyes with refractive errors ranging from 0 to -6D in our study have higher optical central corneal thickness values than ultrasonic values but the differences were statistically non significant.

Conclusion: Ultrasound pachymetry overestimates the corneal thickness measurements compared to optical pachymetry and they should not be used interchangeably during sequential checking of this ocular parameter

الخلاصة

قياس سمك القرنية الوسطي والطرفي له اهمية سريرية, تهدف هذه الدراسة الى مقارنة قياس سمك القرنية الوسطي بطريقتين مختلفتين هما الطريقة البصرية والامواج فوق الصوتية. اجريت الدراسة على 28 شخصا في مركز ابصار للعيون في محافظة النجف. اظهرت الدراسة اني طريقة الامواج فوق الصوتية تعطي قرائنه اعلى من الطريقة الصوتية بصورة ملحوظة بحوالي 2,85 مايكروميتر.

Introduction

Examination of the cornea and anterior segment of the eye, especially evaluation of central and peripheral corneal thickness, is important in various fields of ophthalmology.[1] The corneal thickness is an important indicator of the corneal function and is routinely determined in several clinical settings. Its evaluation reflects the endothelial function, offers an insight to the cornea's adaptation in contact lens wear, is of postoperative prognostic

value for penetrating keratoplasty, can reveal local or systemic metabolic disorders, and is important when diagnosing and treating patients with glaucoma [2]. Pachymetry, measurements of the corneal thickness, has gained increasing importance in ophthalmic practice because of the growing interest in keratorefractive surgery and extended-wear contact lens. The design and outcome of refractive surgical procedures rely on the accuracy of pachymetry measurements.[1,3]

Corneal thickness measured by pachymetry is a sensitive indicator of corneal health. One of the most common approaches to corneal pachymetry is ultrasound technology. Slit lamp mounted optical pachymetry is the other method for obtaining measurements of corneal thickness. Specular microscopic pachymetry ,especially the newly introduced automated non contact specular pachymetry, is also a widely used and accepted method to measure this important parameter that reflects corneal health and is considered essential for diagnosing multiple corneal diseases or planning treatment for some problems.[3,4] The principle behind obtaining this measurement ,whether in optical or ultrasound pachymetry, depends on the reflection of “ light or ultrasound ” from the anterior and posterior surface of the cornea.[3]

Corneal thickness has been evaluated by various methods, and a wide array of literature on the topic is available.[5] Ultrasound pachymetry has been the gold standard for estimating the corneal thickness for the past few decades. Now modern pachymetric techniques are commercially available, ultrasound pachymetry is the reference against which the rest are currently tested[.3,6] Different studies report different results while comparing the two methods for assessing the corneal thickness and most of the results showed that optical pachymetry tends to underestimate corneal thickness compared to ultrasonic pachymetry because the former only measures between Descemet's membrane and Bowman's layer.[7] In other studies a slight tendency for ultrasound methods to underestimate corneal thickness was noted especially if it was carried out prior to optical pachymetry, because of

the changes in tissue hydration secondary to the ultrasound speed through the cornea.[4]

The aim of this study is to evaluate the optical and ultrasound pachymetric measurements by comparing the central corneal thickness measurements obtained by the (SP 3000 pachymeter from TOMEY) and Allegro Oculyzer (pentacam) pachymeter.

Patients and Methods

The study was conducted on 56 undiseased eyes of 28 patients attending the photorefractive surgery unit at IBSAR LASIK center in ALnajaf.

All patients were subjected to thorough ocular examination as a part of their preparation for photorefractive surgery. The spherical equivalents for their refractive errors range from (+6)D to (-15.25D).

The patients were grouped into three groups according to the refractive errors they got;

1. The hypermetropes, those having spherical equivalent of refractive error (>0).
2. The myopes with spherical equivalent range between (0 to -6D)
3. The myopes with spherical equivalent of refractive error more than (-6D)

The central corneal thickness for each patient was measured by two methods:

1. Using the Allegro Oculyzer (pentacam) as a non contact optical pachymeter
2. Using the ultrasonic pachymeter(SP 3000 pachymeter from TOMEY)

All measurements were done by the same surgeon.

The readings of both methods and the differences in the two readings for each eye were tabulated .Mean and standard deviation for the readings in each group were calculated and the

statistical significance was calculated using the T test with a P value <0.5 considered as significant.

Results

The patients' age range was 17-54 year with a mean of 32.78 ± 8.77 year.

Male to female ratio was 3:4.

Ultrasound and optical pachymetric measurements means and standard deviations for whole studied patients are shown in table 1.

Student T test applied on the paired observations of the studied groups revealed the P values shown in table 1.

Table 1 Mean and SD of the Pachymetric readings for the studied patients

	all patients	Hypermetrops	Myopes <6D	Myopes >6D
No. of eyes	56	8	31	17
Mean CCT (US readings) in micron	520.98 ± 31.72	561 ± 32	505.35 ± 24.32	530.64 ± 29.62
Mean CCT(optical readings)In micron	518.39 ± 30	552.37 ± 31.12	505.54 ± 23.95	525.82 ± 31.22
Difference of the means(US-O) in microns	2.85 ± 8.29	8.62 ± 10.71	-0.19 ± 8.44	4.82 ± 5.67
P value	$<0.01^*$	$<0.01^*$	>0.5	$<0.001^*$

(*) statistically significant

Discussion

Accurate assessment of corneal thickness is important in many clinical situations such as the diagnosis of corneal ectatic conditions and corneal physiology, contact lens research, or refractive surgery procedures.[4] Ophthalmic biometry should provide rapid, objective, and accurate measurements of ocular dimensions. Optical coherence tomography is a high resolution technique that can create precise cross-sectional images of the anterior and posterior eye segments.[3] The physical basis of imaging depends on differences in optical infrared reflectivity between different tissue microstructures within the eye. Thus it is the optical analog of ultrasound B scan, although it provides images with higher resolution in both axial and lateral dimensions and does

not require direct contact with the eye for qualitative and quantitative assessments. Optical pachymeters depend on this basis.[3] At present, ultrasound is the most frequently used pachymetry technique and is considered the gold standard because of its high degree of interobserver, intraobserver, and interinstrument reproducibility.[1,8] However, the required probe-cornea contact is associated with patient discomfort, the need for topical anesthesia, the risk for epithelial lesions and transmission of infections leading to the preference of the non contact methods such as the optical coherence tomography, partial coherence tomography, low coherence reflectometry, specular microscopy, scanning slit pachymetry and corneal confocal microscopy.[1]

Most of the published studies report differences between the readings of the central corneal thickness obtained by the optical and the ultrasound pachymeters. Ultrasound based systems of pachymeters tends to overestimate the readings with variable significance. This could be attributed to large probe-tip size, probable probe tilting, the averaging US mode, epithelial edema from local anesthesia, and most importantly the calibration or sound velocity factors because the sound velocity is likely to vary between different layers of the cornea. On the other hand compression of the tear film during contact US pachymetry is expected to give lower values than non contact other methods, thus complicate the relationship.

The current study demonstrates, after comparing the paired data, that ultrasound pachymeter significantly overestimates the corneal thickness by about 2.85 micron. But upon reviewing the data of the different groups of refractive errors, the moderately myopic eyes didn't show the same result. The US measurements in eyes with refractive error ranging between 0 and -6D were below the optical ones, however the difference was statistically non significant. Table 1

Prospero et al reported, in a series of one hundred sixty-three eyes, that ultrasound pachymetry measurements were consistently higher OCT measurements (mean difference 7.5 +/- 1.4 micron) ($P < .0005$) in normal eyes and post-LASIK eyes ($P < .0005$). [9]

Amano et al showed that the mean corneal thicknesses were comparable between ultrasonic pachymetry optical pachymetry. The measurements had significant linear correlations with one another and both methods had highly satisfactory measurement repeatability. [10]

The mean difference of readings measured by US pachymetry with those measured by optical pachymetry was 2.3 μm in Karimian's study. [11]

Christopher K. demonstrated thinner corneas when measured optically (visnate OCT) than ultrasonically but he found comparable results when he used another model of optical pachymeter (the SLOCT-OCT). Suggesting that different devices with different algorithm for image analysis display different results. [12]

There is an evident agreement of our statistically significant levels of differences between the paired data with most of the published studies that emphasized on the US readings to be higher than the optical readings, however none of the reviewed published articles mentioned that the level of refractive errors or corneal curvature may play a role as a factor affecting the dynamics of corneal thickness measurements. Eyes with refractive errors ranging from 0 to -6D in our study have higher optical central corneal thickness values than ultrasonic values but the differences were statistically non significant. This finding needs to be further evaluated thoroughly in a larger population study. Furthermore, other factors, most importantly the age of the patients, should also be studies as a probable factor affecting the interchangeability of central corneal thickness measurements by different devices.

In conclusion, ultrasound pachymetry overestimates the corneal thickness measurements compared to optical pachymetry and they should not be used interchangeably during sequential checking of this ocular parameter. Careful attention is needed when interpreting data obtained from different imaging systems, different models and even different versions of analysis software. Better

standardization is needed for new devices and instruments.

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