The Comparison of Central Cornea Thickness in Primary Open Angle Glaucoma with Optical Biometry and Ultrasonic Pachymetry

Primer Açık Açılı Glokomda Santral Kornea Kalınlığının Optik Biyometri ve Ultrasonik Pakimetri ile Karşılaştırılması

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ABSTRACT

Purpose: We aimed to compare central corneal thickness (CCT) measurements in eyes with primary open-angle glaucoma (POAG) with optical biometry (Haag-Streit Lenstar LS 900 Optical Biometer,Switzerland) and ultrasonic pachymetry (USP) devices.

Materials and Methods: We included 35 eyes of 35 patients with POAG in this prospective observational study. CCT was measured with the optic biometric pachymetry and an USP device (Pac-Scan 300p, Sonomed Escalon, NY, USA). While the first observer conducted the measurement with both the optic biometric pachymetry and USP devices, the second observer only used the optic biometric pachymetry device. Spearman correlation analysis was used in the correlation analysis.

Results: Central corneal thickness with the optic biometric pachymetry was 526.6±39.6 µm for the first observer and 527.7±40.6 µm for the second observer. The central corneal thickness was 541.9±43.6 µm with USP. Statistically significant lower measurements were found with the optic biometric pachymetry device than with USP ($p<0.001$). A statistically significant and strong correlation was present between the observers' measurements of the central cornea thickness with the optic biometric pachymetry ($r=0.995$, $p<0.001$). A statistically significant and strong correlation was also present between the central corneal thickness measurements of the first observer using the two devices ($r=0.943$, $p<0.001$).

Conclusion: Optic biometric pachymetry provides lower central corneal thickness measurements than USP in primary open-angle glaucoma. Although there is a strong correlation between the two devices, this difference may be important in intraocular pressure measurements.

Key Words: Optic biometric pachymetry, ultrasonic pachymetry, central corneal thickness, primary open angle glaucoma, intraocular pressure.

ÖZ

Amaç: Primer açık açılı glokomlu (PAAG) gözlerde santral kornea kalınlık (SKK) ölçümlerini optik biyometri (Haag-Streit Lenstar LS 900 Optical Biometer, Switzerland) ve ultrasonik pakimetri (USP) cihazlarıyla karşılaştırmayı amaçladık.

Gereç ve Yöntem: Bu prospektif, gözlemsel çalışmaya 35 PAAG'lı hastanın 35 gözü dahil edildi. SKK optik biyometrik pakimetri ve USP-(Pac-Scan 300p, Sonomed Escalon, NY,USA) cihazlarıyla ölçüldü. Birinci gözlemci hem optik biyometrik pakimetri hem de USP cihazı ile ölçüm yaparken ikinci gözlemci sadece optik biyometrik pakimetri cihazını kullandı. Korelasyon analizinde Spearman korelasyon analizi kullanıldı.

Bulgular: Optik biyometrik pakimetri ile santral kornea kalınlıkları birinci gözlemci için 526.6±39.6 µm, ikinci gözlemci için 527.7±40.6-µm olarak ölçüldü. USP ile santral kornea kalınlık ölçümü 541.9±43.6-µm idi. Optik biyometrik pakimetri cihazı ile USP karşılaştırıldığında istatistiksel olarak anlamlı düşük ölçümler bulundu ($p<0.001$). Optik biyometrik pakimetri ile santral kornea kalınlık ölçümü yapan gözlemciler arasında istatistiksel olarak anlamlı, güçlü bir korelasyon mevcuttu ($r=0.995$, $p<0.001$). Her iki cihazı kullanan birinci gözlemcinin santral kornea kalınlık ölçümleri arasında istatistiksel olarak anlamlı, güçlü bir korelasyon vardı ($r=0.943$, $p<0.001$).

Sonuç: Primer açık açılı glokomda optik biyometrik pakimetri, santral kornea kalınlığı USP'ye göre daha düşük ölçmektedir. Her iki cihaz arasında güçlü bir korelasyon olmasına rağmen göz içi basınç ölçümlerinde bu farklılık önemli olabilir.

Anahtar Kelimeler: Optik biyometrik pakimetri, ultrasonik pakimetri, santral kornea kalınlık, primer açık açılı glokom, göz içi basıncı.

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INTRODUCTION

Central corneal thickness (CCT) is quite important in the diagnosis and follow-up of glaucoma and also for refractive surgical interventions such as cross-linking.[1] Glaucoma studies have revealed that CCT must be measured as it plays an important role in identifying glaucoma patients at high risk for glaucoma progression.[2,3] CCT values are also known be a significant risk factor as regards the potential for POAG development.[4] Furthermore, each 40 µm decrease in CCT is associated with a relative risk of 1.71 for the development of POAG.[5]

Corneal thickness can be measured using ultrasound or optical techniques. Until recently, the most commonly used clinical method was USP.[6] Devices such as optical low-coherence reflectometry (OLRC), optical coherence tomography (OCT), non-contact specular microscopy, and corneal topography have now been developed to measure CCT with a non-contact optic method.[7] The optic biometric pachymetry has been used to measure CCT as well as other optical components such as anterior chamber depth, lens thickness, and axial length, in addition to keratometry and pupillometry values.[8-10] It uses a non-contact technology that does not require topical anesthesia and carries no risk of mechanical trauma or infection.

USP is still considered the gold standard for CCT measurement and continues to be widely utilized.[11-13] However, USP has several possible sources of error such as probe misplacement, lack of a fixation light for gaze control, oblique positioning of the probe in relation to the cornea, corneal compression during measurement, and sound transmission variability due to dryness.[14-17] Several studies have previously compared the optic biometric pachymetry device with USP. However, this study is the first aiming to compare central corneal thickness with the optic biometric pachymetry and USP in patients with primary open angle glaucoma (POAG) as far as we are aware.

MATERIALS AND METHODS

This prospective, comparative, observational study included 35 patients diagnosed with POAG from the Glaucoma Unit of the Ophthalmology Department of Ahi Evran University Faculty of Medicine. The study conformed to the principles of the Helsinki Declaration. Ethics Committee consent was obtained from the university's Clinical Studies Ethics Committee.

Patients with types of glaucoma other than POAG, a history of ocular surgery, using contact lenses, with a corneal or surface disorder, and patients with a refractive error over 5D spherical or 3D cylindrical were excluded from the study. The left eye was evaluated for POAG.

Measurements: CCT measurements of the POAG patients were first performed by the two observers with the optic biometric pachymetry device. The measurements were repeated three times by each observer with an interval of at least 30 seconds between the measurements to ensure tear film layer continuity and blinking. The first observer conducted the measurements with both the optic biometric pachymetry and Pac-Scan 300p devices while the second observer only used the optic biometric pachymetry. Fifteen minutes after the optic biometric pachymetry measurements, one drop of 0.5% proparacaine hydrochloride (Alcaine, Alcon labs, Fort Worth, TX) was instilled in the relevant eye and five consecutive measurements were conducted by the first observer with the Pac-Scan 300p device.

Statistical method**:** Mean, standard deviation, median, the lowest, the highest, and frequency and ratio values were used in the descriptive statistics of the data. Data distribution was determined with the Kolmogorov-Smirnov test. The Wilcoxon test was used in the analysis of dependent quantitative data. Spearman correlation analysis was used for correlation analysis. The SPSS 22.0 program (IBM Software Group SPSS 22, Chicago, IL; 60606 USA) was used for the analyses.

RESULTS

The mean age of the 35 patients consisting of 20 (57.1%) males and 15 (42.9%) females included in the study was 61.2±12.2 years. The mean intraocular pressure was 19.7±5.8 mmHg and the mean cup/disc ratios was 0.5±.0.2. Mean central corneal thickness with the optic biometric pachymetry was 526.6±39.6 µm for the first observer and 527.7±40.6 µm for the second observer. Mean central corneal thickness was 541.9±43.6 µm with USP. No statistically significant difference was present between the CCT measurements of the two observers using optic biometric pachymetry ($p=0.091$). However, statistically significantly lower measurements were obtained with optic biometric pachymetry compared with USP ($p<0.001$; Table 1). A statistically significant and strong correlation was present between the observers for central corneal thickness measurement with optic biometric pachymetry ($r=0.995$, $p<0.001$; figure 1). A statistically significant and strong correlation was also present between the CCT measurements of the first observer using the two devices ($r=0.943$, $p<0.001$; figure 2).

DISCUSSION

Accurately measuring CCT is increasingly important in

Table 1. *Central corneal thickness measurements of the observers with Lenstar 900 and USP.*

	Min – Max	Median	Mean±sd	p‡
Observer 1 LENSTAR CCT	446.3 – 608.7	532.7	526.6±39.6	
Observer 2 LENSTAR CCT	444.7 – 612.3	532.7	527.7±40.6	0.091[w]
Observer 1 USP CCT	453.0 – 637.4	540.8	541.9±43.6	***0.000***[w]

CCT; Central Corneal Thickness, Sd; Standard Deviation, [w] Wilcoxon test, p‡; Difference with Observer 1 Lenstar CCT

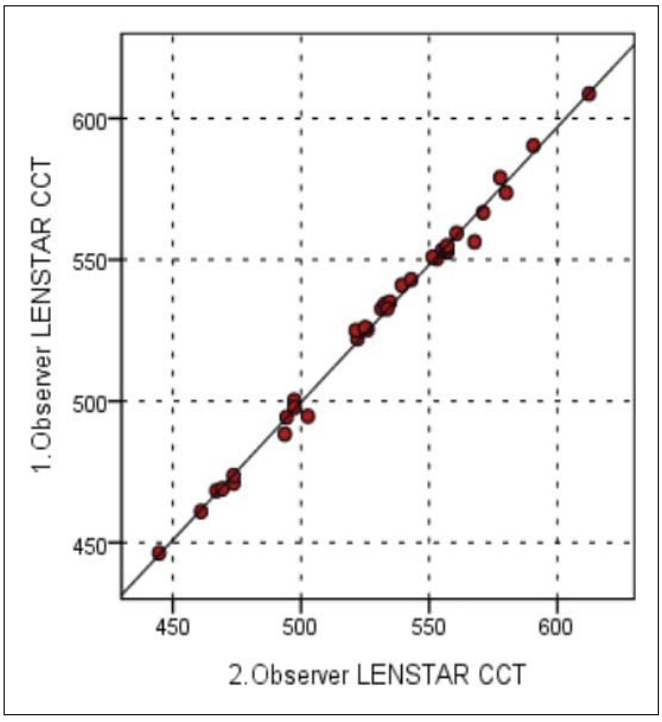

Figure 1. *Spearman correlation analysis between 1st and 2nd observers using optic biometric pachymetry.*

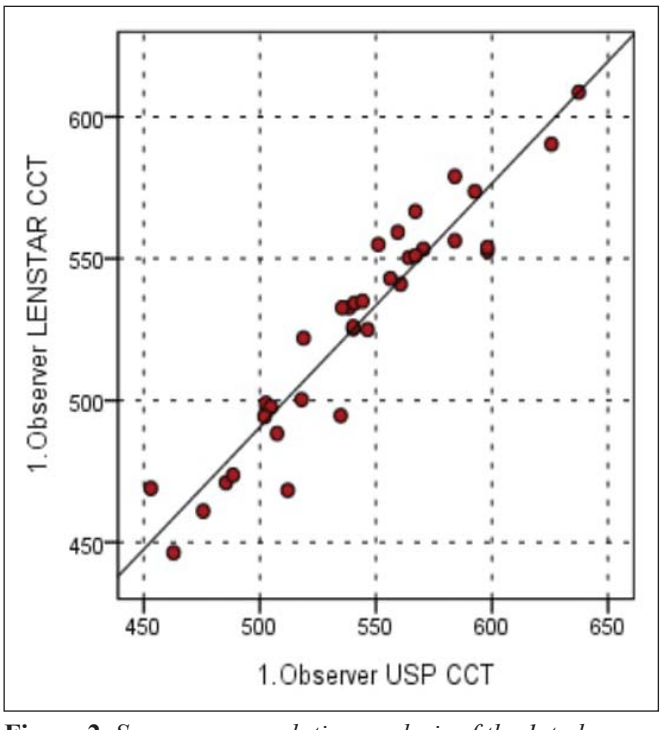

Figure 2. *Spearman correlation analysis of the 1st observer using optic biometric pachymetry and USP.*

clinical ophthalmology.[5,18] Kohlhaas et al.[19] have confirmed that the difference between measured and actual IOP was significantly dependent on CCT (p <.001). The association between IOP readings and CCT reveals an approximately 1 mm Hg correction for every 25 mm deviation from a CCT of 550 µm.

No statistical difference was observed between CCT measurements between observers using the optic biometric pachymetry in this study (p=0.091) but statistically significantly lower measurements were obtained with optic biometric pachymetry when compared with USP (p<0.001). A strong correlation was found between the two observers for CCT measurements with the optic biometric pachymetry (r=0.995 p<0.001). A strong correlation was also found between the CCT measurements of the first observer with the optic biometric pachymetry and USP (r=0.943, p<0.001).

Adıbelli et al. found CCT measurements to be approximately 14 µm larger with the Pac-Scan 300p compared to OCT in patients with POAG.[20] We similarly found an approximately 14 µm difference with the Pac-scan 300p in our study. Garcia-medina et al. similarly found statistically significantly higher CCT values with USP and a high correlation between the two devices when they compared CCT with USP (the Reichert IOPac pachymeter) and OCT in patients with POAG (r=0.969).[21] Şen et al. compared the optic biometric pachymetry and Pentacam devices in patients with newly diagnosed with glaucoma and found no statistically significant difference between the two devices.[22] We found lower CCT values with optic biometric pachymetry in patients with POAG in this study (p<0.001)

Borrego-Sanz et al. found a good correlation between optic biometric pachymetry and USP when they compared CCT with optic biometric pachymetry, USP, Pentacam and specular microscopy in healthy corneas.[23] Tai et al. similarly found close compliance between the optic biometric pachymetry and USP measurements in 184 healthy eyes.[24] Beutelspacher et al. reported a similar result with optic biometric pachymetry and USP in healthy corneas.[9] Similarly, Koktekir et al. found a significant correlation the CCT measurements with optic biometric pachymetry and USP in healthy corneas (r=0.996).[6] We also found a significant and strong correlation between optic biometric pachymetry and USP in our study (r=0.943). Koktekir et al.

found the CCT value to be approximately 4.6 µm lower with optic biometric pachymetry when compared with USP while we found it to be approximately 14 µm lower.[6] We believe the reason could be our study being conducted on a group of patients with POAG instead of healthy eyes.

There are several studies where optic biometric pachymetry and USP have been used to measure CCT in patients from various age groups and with various diagnoses. Huang et al measured CCT by using optic biometric pachymetry and UPS both in healthy eyes and eyes that had undergone surgery with femtosecond LASIK and found good compliance between the two devices.[25] Gürsoy et al. reported results similar to ours with CCT measurements obtained by optic biometric pachymetry in children 13.2 µm lower than those with USP.[26] Koç et al. found CCT values with the Topcon CT-1P to be 10 µm higher with the optic biometric pachymetry as with ultrasonic pachymetry, with a statistically significant difference, and that CCT measurements with the optic biometric pachymetry and ultrasonic pachymetry were very similar with no significant difference.[27]

Theoretically, the corneas of glaucomatous eyes could have different characteristics than the corneas of healthy eyes. Patients with glaucoma have lower corneal endothelial cell density.[28,29] Long-term use of anti-glaucomatous drops has been observed to cause endothelial cell loss.[30,31] The long-term use of preservatives such as benzalkonium is again reported to potentially disrupt the corneal epithelial barrier.[32]

In conclusion, despite a strong positive correlation between the two devices, optic biometric pachymetry provides CCT measurements that are approximately 14 µm lower measurements than those with USP in patients with POAG. These differences should be considered when measuring intraocular pressure in glaucoma cases.

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