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CORRELATION OF CENTRAL CORNEAL THICKNESS ON OCT AND PACHYMETRY IN GLAUCOMA PATIENTS

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ABSTRACT

BACKGROUND AND AIM: Central corneal thickness (CCT) measurement has become an important test in the diagnosis and management of glaucoma. Currently, ultrasound corneal thickness measurement (pachymetry) is the most frequently used clinical technique and the gold standard to assess CCT. Newer instruments are currently available including the optical coherence tomography (OCT) instrument. The aim of the present study was therefore to evaluate the accuracy of the CCT measurements, both with the OCT and ultrasound pachymetry (USP), in patients suffering from glaucoma. **METHODS:** Cross-sectional study, Ophthalmological examination was performed before including patients in the study. Visual acuity by snellens chart, IOP measurements by goldmann applation tonometer , optic nerve status by 90D lens slit lamp biomicroscopy, gonioscopy, Humphrey visual fields (HFA, 24–2), and presence or absence of exfoliation were noted after pupil dilatation under slit lamp examination. Glaucoma was defined as patients who had at least two repeatable Humphrey visual fields showing glaucoma damage using the software 24–2, and with the optic nerve showing typical glaucoma damage. **RESULTS:** 48 eyes of 25 patients were included. The average age was 64 ± standard deviation (SD) 10.88, the average pachymetry value with OCT was 536 ± 29 µm, and the average pachymetry with USP was 532 ± 32µm. The differences between OCT and USP were not significant (t-test, p = 0.32). The intraclass correlation coefficients were, for OCT, 0.99 [confidence interval (CI): 0.98–0.996], and for USP, 0.97 (CI: 0.95–0.98). **CONCLUSIONS:** OCT and USP both showed high accuracy in pachymetry measurements. OCT Might be used as a substitute for pachymetry, if USP is not available.

KEYWORDS: Optical coherence tomography, USP pachymetry, humphery perimetry, central corneal thickness, glaucoma.

INTRODUCTION

Cental corneal thickness(CCT) measurement has become an important test in the diagnosis and management of glaucoma . The relationship between CCT and the development of glaucoma is multifaceted. It is well known that CCT affects intraocular pressure (IOP) measurement i.e IOP is overestimated in thicker corneas and underestimated in thinner ones. The ocular hypertention treatment study found that CCT alone is a powerful predictor of the development of primary open angle glaucoma.[1]

Corneal thickness measurements can be performed using ultrasonic based or optic based techniques.[2] Various instruments are available for this purpose, of which ultrasound pachymetry (USP) is the gold standard method for measuring CCT. 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, sound transmission variability due to dryness and tropical anesthesia must be instilled before USP measurement and this could induce bais in the measurement.[3]

Newer instruments are currently available that have the advantage of being the non contact type. One type is the optical coherence tomography (OCT) instrument. OCT is now widely used at ophthalmology departments, mostly for measuring thickness in the retina; but the OCT instrument can be used for measuring thicknesses in the cornea and the nerve fiber layer. However, it is not known how repeatable and stable the measurements are.

Previous studies were performed in normal eyes [4][5][6] or eyes suffering from keratoconus.[7][8][9] The only confirming study regarding CCT measurements with OCT in glaucomatous eyes was that of Garcia Median et

al.[10] The aim of the present study was therefore to evaluate the accuracy of the CCT measurements performed by three different observers using both OCT and USP in patients diagnosed with glaucoma.

MATERIAL AND METHODS

SUBJECTS: This cross-sectional study was composed of 25 patients (48 eyes) who had been previously diagnosed with glaucoma. The subject with informed consent were recruited at the ophthalmology department of Index medical college hospital and research centre, Indore.

STUDY PROTOCOL

A comprehensive medical and ocular history was obtained. Ophthalmological examination was performed before including patients in the study. Visual acuity by snellens chart, IOP measurements by goldmann applation tonometer, optic nerve status by 90D lens slit lamp biomicroscopy, gonioscopy, Humphrey visual fields (HFA, 24–2), and presence or absence of exfoliation were noted after pupil dilatation under slit lamp examination. Glaucoma was defined following the European Guidelines for Glaucoma, as patients who had at least two repeatable Humphrey visual fields showing glaucoma damage using the software 24–2, and with the optic nerve showing typical glaucoma damage.[11]

Then after diagnosis, the patient were included in the study and were measured for CCT with USP (NIDEK pachymetry, US-4000 echoscan) and OCT (3D OCT-1 Maestro) by the same examiner.

CCT measurements using the USP instrument were taken after instillation of topical local anesthetic (0.5% proparacaine hydrochloride). The probe was directed perpendicular to the central cornea surface. And the measurement was displayed on USP.

Each participant was positioned on the OCT headrest and requested to direct his or her gaze at the internal fixation point. The subject's pupil was used to center the scan. Images were taken using the anterior segment option that provided a radial scan with 12 spaced lines around the central cornea.

STATISTICS

Descriptive statistics were calculated for OCT and USP CCT measurements using SPSS version 20 (SPSS, Chicago, IL, USA). To measure differences in the CCT values between OCT and USP, a paired *t* test was performed. Significance level was $p < 0.05$. To test agreement between the two different instruments, a Bland–Altman plot was performed. Mean differences and limits of agreement (LOA) were calculated.

RESULTS

DEMOGRAPHY

In total, 25 patients (48 eyes) were included in the study. The mean age of all patients was 64 ± 10.88 years, and the age range was 35– 85 years of age. Regarding gender distribution, there were 12 male and 13 female patients included in the study. The visual field damage was estimated using the visual field index (VFI), and was VFI = 79.93 % ± 21.23%.

Regarding diagnostic distribution, 41 eyes suffered from primary open angle glaucoma, and 7 eyes had pseudoexfoliative glaucoma. The included eyes were 17 eyes with pseudophakia and 32 eyes were phakic (no cataract surgery). None of the included patients underwent refractive surgery before inclusion.

ENDPOINTS

The CCT measured using OCT (536 ± 29 µm) was thicker than when measured using USP (532 ± 30 µm). However, the difference between measurements was not significant (*t* test, $p = 0.32$) (Fig. 1).

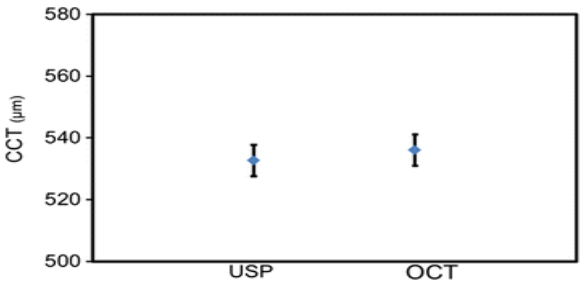

Fig. 1: Corneal thickness measurements. Left = USP, right = OCT measurements. No significant difference was found (*t*-test; $p = 0.32$). The bars represent 95 % confidence interval (CI) for the mean.

The Bland–Altman plot revealed mean differences of −3, or 39 µm between OCT and USP. The 95 % LOA were calculated based on a 1.96 SD difference between OCT and USP. LOA was −20 µm to +13.22 µm. Only two values were situated outside the LOA: −27.6 µm and 23.6 µm (Fig. 2).

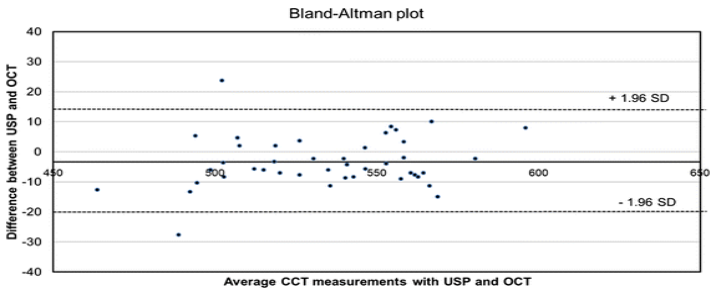

Fig. 2: Bland–Altman plot showing the comparison between the two different instruments. Only two measurements were outside the limits of agreement (LOA)

DISCUSSION

The main aim of our study was to determine if OCT could be a possible substitute for USP in the measurements of CCT in glaucoma patients, because OCT has the advantages of being aseptic and without the risk of contact corneal trauma. A further advantage of OCT is that it is possible to examine the results at a later time in the absence of the patient. The intra and inter repeatability of OCT pachymetry has also been shown to be good and perhaps even better than USP in the study by Lin et al.[12] The studies of Garcia Medina et al.[10] on glaucomatous eyes, in that there was no significant difference between OCT and USP when measuring CCT.

In our study, OCT measurements overestimated CCT, when compared with USP hoeever this difference is not significant($p< 0.05$)[13]. To our knowledge, this finding is not consistent with most other studies, including those of Garcia Medina et al.[10] Dutta et al.[7] and Doughty[14] all describing results with OCT underestimating CCT, when compared with USP. Differences in the studies could be due to several factors, including a difference in calibration and methods of measurements. Inter instrument variations have been demonstrated in other studies. For example, Wells et al.[15] reported a difference of up to 30 μm in CCT using different instruments. Another possible explanation for the disagreement related to previous studies could be that the present study included glaucoma patients, while other studies were based on healthy subjects. As explained by Garcia Medina et al.[10] glaucoma is a disease that might change the characteristics of the cornea. This could explain some of the differences in CCT as measured with OCT versus USP.

Topical anesthesia needed for USP may cause the cornea to swell and can affect the measurements. The physical pressure from the USP on the cornea is also a factor to consider. A study by Mukhopadhyay et al.[16] showed that USP together with topical anesthesia could give variations in CCT from −10 μm to +30 μm. By randomizing OCT/USP measurements and the order of the examiners, we tried to minimize any bias from patient examiner contact, and the effect of repeated measurements within a short time with OCT versus USP.

CONCLUSION

Both instruments displayed high repeatability, with strong agreement between devices.

OCT and USP both showed high accuracy in pachymetry measurements.

OCT Might be used as a substitute for pachymetry, if USP is not available.

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Conflict of interest

There are no conflicts of interest.

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