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Comparative study of measurements of central corneal thickness (CCT) by ultra-sonic pachymetry (USP) VS non-contact pachymetry (NCP)

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ABSTRACT

Aims: This study aims to compare and measure the reliability, repeatability of USP and NCP (NIDEK NT530P) clinically.
Settings and Design: It was a hospital-based comparative study conducted in the outpatient department of Ophthalmology, CCT measurements were taken by NCP (NIDEK NT530P) and USP.
Materials and Methods: This study done on 50 subjects, age group between 18-25 Years and it's approved by IRB committee, subjects with emmetropia and low myopia only were included. Participants were subjected to comprehensive ophthalmic examination, Corneal thickness measurement taken with NCP(NIDEK NT530P) and USP. To eliminate the effect of diurnal variations on thickness all measurements were taken between 2 PM -6 PM.CCT measurements was first taken by NCP (Nidek NT530P) five readings were taken followed by USP. Eyes was anesthetized, and the probe placed perpendicularly on the cornea and the readings were observed in the display. The test was repeated five times and the mean values was calculated.
Results: The results were well inside the normal range and there are no significant measurements obtained by these devices.

1. Introduction

This study aims to compare the CCT measurement and determine its reliability between NCP (Nidek NT530P) and standard USP clinically.[1]

Ultrasonic Pachymetry is commonly used and regarded as gold standard.[2] It's based on reflection of ultrasonic waves from anterior and posterior corneal surfaces.[3] It's the time difference (transit time) between ultrasonic signal from probe's transducer and reflected signal from front and back surfaces of cornea to transducer.[4]

NCP (Nidek NT530P) been developed in recent years, using Scheimpflug camera system.[5] Tono-pachymetry is patient-friendly and time-saving, but it is unclear whether the CCT values are comparable to those from USP.[6]

2. Materials and Methods

It was a hospital-based comparative study conducted in the outpatient Department of Ophthalmology. CCT measurements were taken by USP and Non-Contact pachymetry (NIDEK NT530P) for 50 young emmetropic and low myopic subjects. Participants were provided with informed consent and the entire steps and purpose of the study were explained thoroughly before conducting the survey. The comparative study sample consisted of 50 patients (100 eyes) aged 18 years of age and above. The study had a total sample of 50 participants (n=50), out of which 23 participants were male and 27 participants were female.

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Subjects with ocular disease other than (high refractive error), contact lens users, pregnancy, and with a history of previous eye surgery were excluded. All participants were subjected to comprehensive ophthalmic examination including Vision, Refraction, IOP measurements, Slit-lamp examination, corneal thickness measurement with these two methods followed by dilated fundus examination.

To eliminate the effect of diurnal variations on thickness all measurements were taken between 2 PM – 6 PM. Corneal thickness measurement was first taken by non-contact pachymetry (Nidek NT530P) five readings were taken for each eye, a gap of one minute was given for each reading and the alignment was freshly done each time. Following this, the cornea was anesthetized with topical 0.5% proparacaine and five readings were taken with ultrasonic pachymetry. All the readings from non-contact pachymetry and ultrasonic pachymetry were taken by a single trained internship student. The highest and the lowest were excluded and the mean, standard deviation (SD) of the remaining three were used for the analysis.

3. Results

A sample of 50 subjects (men and women) was included in the study. Central Corneal Thickness was measured by two instruments: Standard Ultrasonic Pachymetry and Non-Contact Pachymetry. This section presents the comparison of Central Corneal Thickness (OD) (OS) (OU) measurement between Standard Ultrasonic Pachymetry and Non-Contact Pachymetry. Paired samples t-test is applied to test whether the instruments are reliable. The results are shown in Table 3.

From Table III the t-value of OD-21.866 (p=.000), OS-21.029 (p=.000), OU-30.0467 (p=.000) reveals there is significant difference exists between Standard Ultrasonic Pachymetry and Non-Contact Pachymetry in measuring the Central Corneal Thickness (OD)(OS)(OU). Further, the mean Central Corneal Thickness measured through Standard Ultrasonic Pachymetry OD(549.9μm) OS(549.72μm) OU(549.83μm) is significantly greater than the mean Central Corneal Thickness measured through Non-Contact Pachymetry OD(541.68μm) OS(541.60μm) OU(541.64μm). However, the Central Corneal Thickness measured by both instruments: Standard Ultrasonic Pachymetry and Non-Contact Pachymetry is very well inside the normal limits (530-560μm). So it is concluded that both instruments are reliable. The comparison is shown graphically.

4. Discussion

Numerous technologies are available to measure CCT, although ultrasonic pachymetry considered to be the gold standard method in recent years, a wide variety of instruments, especially non-contact pachymetry, been use to measure corneal thickness and studies have been done comparing these methods.

Ultrasonic pachymetry has long been the gold standard for such measurements, but as technology advances, new imaging techniques based on alternative physical principles have entered the field of anterior segment assessment.

Central corneal thickness plays an vital role in the diagnosis and treatment of corneal pathology. CCT can be measured with ultrasound biomicroscopy, slit-lamp pachymetry, non-contact specular microscopy, scanning-slit corneal topography (Orbscan), confocal microscopy, OCT, and UP.

The commonly used CCT measurement method at present is ultrasonic pachymetry and it is accepted as the gold standard. However, the requirement for topical anesthesia, large variability in repeat measurements, and the cross-contamination risk are disadvantages of this contact method. The reliability of the procedure is further limited by the experience of the person making the measurement, the location of the probe, and the patient's fixation deficits.

The key finding in this study is to compare the CCT measurements by Ultrasonic pachymetry & Non-Contact Pachymetry (NIDEK NT530-P). In a group of young emmetropic adults.

There is a significant difference exists between Ultrasonic pachymetry & Non-Contact Pachymetry (NIDEK NT530-P). In measuring the CCT, yet there is no significant difference between these devices regarding the reliability in measuring CCT.

Beutelspacher et al Orb scan 2 (Bausch and Lomb, Germany), a scanning-slit Scheimpflug-based corneal analysis system; IOPac (Reichert/Heidelberg Engineering, Germany), an ultrasound-based pachymeter; SL-OCT (Heidelberg Engineering, Germany), a slit-lamp-mounted, anterior segment OCT-based analysis system; and optical low coherence reflectometry (OLCR) pachymeter Despite the fact that each device's repeatability was excellent and the mean CCT values were generally similar, the authors advised caution when using the Orbscan device, which could overstate the readings.

Bayhan et al compared USP with three different optical devices: SD-OCT, Sirius Scheimpflug-Placido topographer, and Lenstar OLCR. The CCT values from SD-OCT and the Scheimpflug-Placido topographer were very similar (pl 0.05), but all other pairwise comparisons showed significant differences.[7,8] These authors also suggested that UP could not be used interchangeable and reliable with optical systems.

In a recent study by Scott et al., the mean CCT values by anterior segment OCT, noncontact SM, and UP were 535.8 ± 35.5, 547.7 ± 38.2, and 537.4 ± 37.5 I'm, respectively. The authors suggested that OCT & UP can be reliable and interchangeable, whereas noncontact SM could give quite different results clinically.[9]

Table 1: Descriptive statistics for age

	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	19	24	20.88	1.437

Source: Primary data

Table 2: Distribution of gender

Gender	Number of Respondents	Percentage
Female	27	54
Male	23	46
Total	**50**	**100.0**

Source: Primary data

Table 3: Central Corneal Thickness (OD), (OS), (OU) measurement between standard ultrasonic pachymetry and non-contact pachymetry.

	Mean	S.D	t value
Non-contact pachymetry	549.9 μm	25.337	**21.866** (p = .000)**
Ultrasonic pachymetry	541.68 μm	24.657	
Non-contact pachymetry	549.72 μm	25.248	**21.029** (p = .000)**
Ultrasonic pachymetry	541.60 μm	24.465	
Non-contact pachymetry	549.83 μm	25.164	**30.467** (p = .000)**
Ultrasonic pachymetry	541.64 μm	24.437	

Source: Computed from Primary data

Similarly, Fishman et al. compared central heal thickness measurements with ultrasonic pachymetry and AS-OCT and found no significant difference between measurements in their study. [10]

Ke-skin et al. measured mean CCT as 528.55±35.11 μm with OCT and 530.47±33.39 μm with UP, and the difference was not statistically significant. [11]

However, Acar et al., measured the mean CCT value as 536±37 μm with OCT and 559±36 μm with UP, with the mean CCT about 22 μm lower with OCT and a statistically significant difference between the two methods was obtained. [12]

5. Conclusions

Central Corneal Thickness (CCT) measured by Standard Ultrasonic Pachymetry (USP) and Non-Contact Pachymetry (NCP) is well inside the normal limits (530 - 560μm). It's concluded both instruments are clinically significant and reliable.

6. Conflict of Interest

The authors declare that they have no conflict of interest.

7. Source of Funding

None.

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