

# Correlation Between Corneal Keratometry, Central Corneal Thickness and Anterior Chamber Depth as Measured by Wavelight OB 820 Biometer and Wavelight Oculyzer II in Preoperative Cataract Surgery Patients

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## ABSTRACT

**Objective:** To compare and correlate corneal keratometry (K), central corneal thickness (CCT), and anterior chamber depth (ACD) using a partial coherence interferometry device and a Scheimpflug camera system device in patients planned for cataract surgery.

**Study Design:** Comparative cross-sectional study.

**Place and Duration of the Study:** Armed Forces Institute of Ophthalmology, from December 2021 to June 2022.

**Methodology:** Patients planned for cataract surgery underwent measurement of central corneal thickness (CCT), anterior chamber depth (ACD), and keratometric values (K) by Wavelight OB 820 biometer and Allergo Oculyzer II, preoperatively. Correlation and inter-device agreement were assessed between two devices.

**Results:** There were 115 patients with a mean age of  $64.23 \pm 9.26$  years. All anterior segment parameters showed excellent agreement and high degree of correlation between the two optical devices. Correlation coefficient (r) for central corneal thickness was  $r = 0.958$  ( $p < 0.001$ ) while correlation coefficient for anterior chamber depth was  $r = 0.965$  ( $p < 0.001$ ),  $r = 0.966$  ( $p < 0.001$ ) for flat K, and  $r = .0969$  ( $p < 0.001$ ) for steep keratometry, respectively.

**Conclusion:** Ophthalmic parameters assessed by both devices were comparable and are recommended to be used in the clinical practice of keratorefractive and cataract surgeries interchangeably.

**Key Words:** ACD, CCT, Keratometry, Cataract, OB 820 biometer, Oculyzer II.

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## INTRODUCTION

Ocular biometry is an essential and critical step performed prior to cataract surgery to determine the refractive power of intraocular lens (IOL)<sup>1</sup> and its effective lens position in order to achieve targeted postoperative refractive outcome.<sup>2</sup> Central corneal thickness (CCT), keratometry (K) and anterior chamber depth (ACD) are important parameters for achieving accurate postoperative refraction in lens replacement and keratorefractive surgeries.<sup>3</sup>

Biometry devices measure these parameters along with ocular axial length (AXL) to calculate the IOL power. Premium IOLs (trifocal, multifocal, accommodating, toric IOLs) require high precision in biometry calculation.<sup>4</sup> Validated measurement of CCT is an essential parameter for proper intraocular pressure (IOP) calculation, diagnosing patients at risk of glaucoma, and planning keratorefractive surgeries.<sup>5</sup> Reliable and precise measurement of corneal refractive power by steep and flat meridian keratometry (K) is crucial for IOL power calculation, keratorefractive surgeries, diagnosing, managing and monitoring of corneal ectatic disorders and in contact lens fitting. In addition keratometry values play a key role for planning corneal incision sites in cataract surgery and for managing surgically induced astigmatism.<sup>6</sup> Preoperative ACD is required to calculate effective lens position which can change postoperative refraction and is also important due to its correlation with narrow angles and AXL, especially in hyperopic patients.<sup>5</sup>

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IOL master that used partial coherence interferometry (PCI) for measuring axial length, ACD, and keratometry values has now replaced the conventional ultrasonic biometry and has minimised the postoperative refractive surprise. The wavelight OB 820 biometer is one of the most current, noncontact fully automated multifunctional optical biometer used to measure anterior segment parameters and axial length of the eye. It employs the principle of partial coherence interferometry (PCI) and optical low coherence reflectometry (OLCR). For accurate data interpretation of a specific imaging technology, understanding the underlying principles of the that modality is very important, especially when CCT and non-contact AXL measurement technologies are preferable in current clinical practice.<sup>3,5</sup>

To increase the precision of biometric measurements PCI, OLCR, and SS-OCT are the advanced optical modalities.<sup>7</sup> Multimode laser diode (MMLD) emits a discrete light spectrum (infrared) at 780 nm which is used in PCI optical biometry while a continuous light spectrum emitted by a superluminescent diode (SLD) at 820nm is used in OLCR optical biometry.<sup>6</sup> PCI measures only the AXL, while A-scan of entire eye from cornea to retina is taken by OLCR.<sup>8</sup> A dual beam is used in PCI biometry which assesses reflection from the cornea and the retina in parallel fashion, while a Michelson interferometer setup is fitted with a measurement path (i.e. patient's eye) and an internal reference path in OLCR biometry. Modern biometers use swept source OCT technology (SS-OCT).

Optically based anterior segment imaging modalities have faster image acquisition (few seconds), superior image resolution, and naturally aided alignment due to a fixation target. The three major anterior-segment imaging technologies are scanning slit combined with topography (e.g. Orbscan), rotating Scheimpflug camera systems (e.g. Pentacam), and anterior segment OCT. The Wavelight Allegro Oculyzer II is a commercially available device which has revolutionised the automatic analysis of anterior segment imaging.<sup>9</sup>

The objective of this study was to assess the level of agreement, correlation, and repeatability of CCT, ACD, and Keratometry values between Wavelight Oculyzer II and Wavelight OB 820 biometer to decrease the chances of inter-examiner and inter-diagnostic error on all patients reporting for cataract and refractive surgery.

## METHODOLOGY

This comparative cross-sectional study was conducted at the Armed Forces Institute of Ophthalmology, between December 2021 to June 2022 in patients undergoing routine cataract surgery. Informed consent and the Institutional Ethical Committee's approval was taken. The study comprised of 115 preoperative cataract surgery patients. Inclusion criteria were; patients 35 years or older having refractive error due to cataract. Exclusion criteria were; patients having history of cataract surgery, or any other intraocular surgery, ocular surface disease e.g. dry eyes, compromised cornea, corneal degenerations and dystrophies, contact lens user or any intraocular disease other than cataract e.g. glaucoma, pseudo-exfoliation, ectopia lentis or

retinal pathologies. Past medical and ocular history were also documented. All patients underwent a thorough and comprehensive preoperative ophthalmic examination including uncorrected visual acuity (UCVA) and corrected distance visual acuity (CDVA), assessment of intraocular pressure (IOP) by Goldmann applanation tonometer, slit lamp examination of anterior and posterior segment, and cataract grading.

Each patient underwent consecutive Wavelight OB 820 biometry and Wavelight Oculyzer II scanning before pharmacological mydriasis by the same experienced trained operator. Evaluated parameters with both modalities were anterior chamber depth (ACD), central corneal thickness (CCT), and keratometry (steep K, flat K and mean K). All tomographic scans with Oculyzer II were taken in the dark room. Both machines were calibrated by the same operator before performing scans according to manufacturer recommendations. Patients for whom bilateral scanning was done, only one eye was randomly selected by flipping a coin between the left and the right eye.

The size of the sample was derived from the formula  $(N = [(Z_{\alpha} + Z_{\beta})/C]^2 + 3)$  where  $C = 0.5 * \ln[(1+r)/(1-r)]$ ,  $\alpha = 0.05$ ,  $\beta = 0.2$ , and  $r = 0.4$ <sup>10</sup> the expected correlation coefficient. Anticipating a 15% attrition rate, the final sample size was calculated to be 110.

Descriptive statistics and comparative analysis of both modalities were performed by using IBM SPSS version 23. Mean and standard deviations were used to evaluate quantitative data, while for qualitative and categorical data, frequencies and percentages were used. The mean anterior segment parameters were compared by paired sample t-test for two instruments. While Pearson's correlation test was employed to evaluate the correlation of ACD, CCT and K-readings between two ophthalmic devices. Correlation coefficients along with p-values were also reported. A p-value  $\leq 0.05$  was taken as statistically significant.

## RESULTS

One hundred and fifteen eyes of 115 patients having cataract were included in the study who were electively planned to undergo cataract surgery. There were 70 (60.9%) males and 45 (39.1%) females. The mean age of the patients was  $64.23 \pm 9.26$  years.

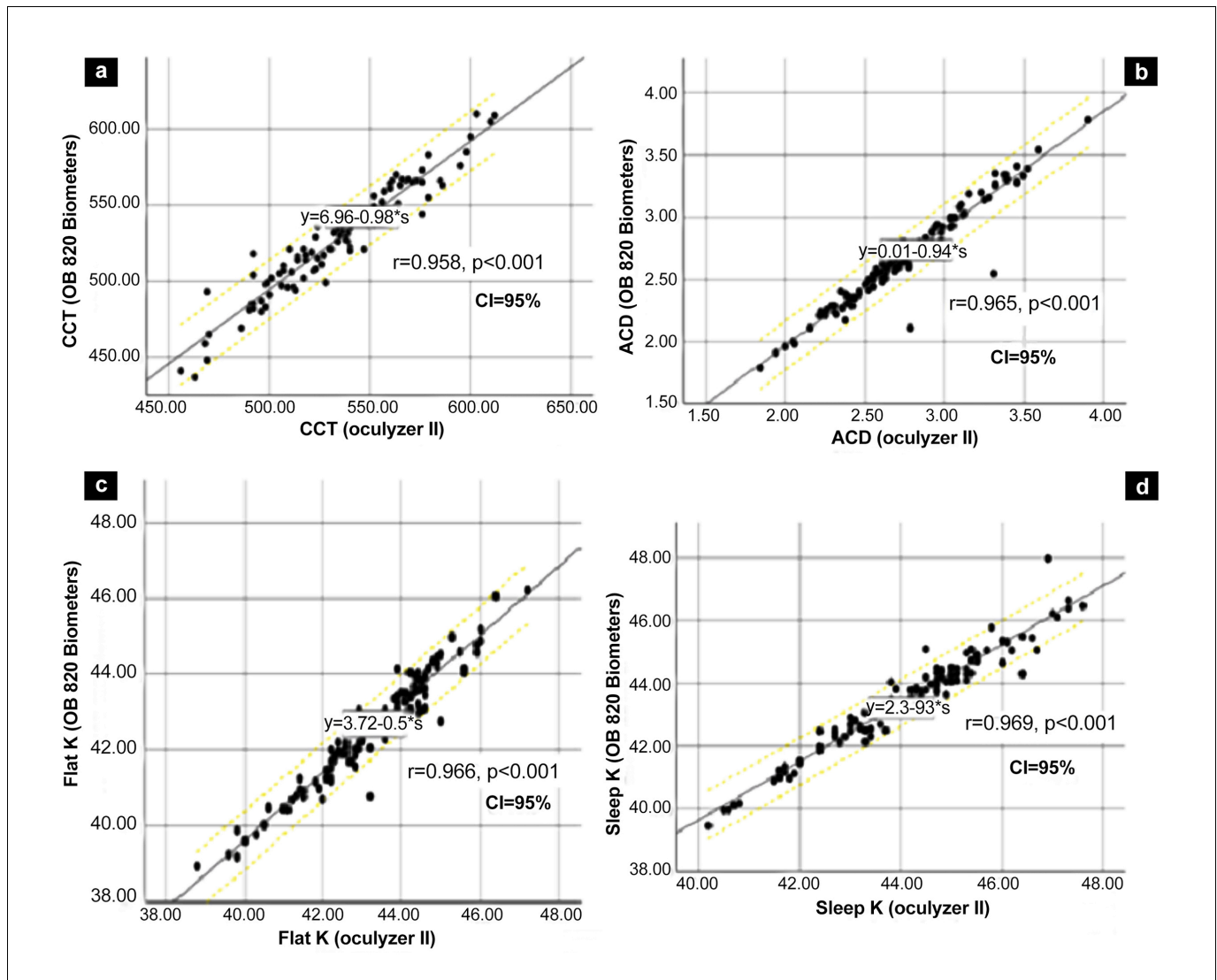
The biometrics including central corneal thickness, anterior chamber depth, and keratometry values including flat K, steep K and mean K were measured for each participant included in the study, using two study devices. Paired sample t-test was used to compare mean values and are given in Table I. Significant difference was found between mean CCT ( $p < 0.001$ ), ACD ( $p < 0.001$ ), flat K ( $p < 0.001$ ), steep K ( $p < 0.001$ ), and mean K ( $p < 0.001$ ). All the mean values measured by the Wavelight Oculyzer II instrument were found to be slightly higher in reading as compared to OB 820 biometer equipment.

Significant strong positive correlation was found between CCT ( $r = 0.958$ ,  $p < 0.001$ ), ACD ( $r = 0.965$ ,  $p < 0.001$ ), flat K ( $r = 0.966$ ,  $p < 0.001$ ), steep K ( $r = 0.969$ ,  $p < 0.001$ ), and mean K ( $r = 0.975$ ,  $p < 0.001$ ) as shown in Table II. The correlation graphs for each biometric parameter are given as Figure 1.

**Table I: Comparison of mean values measured by Wavelight Oculyzer II and Wavelight OB 820 Biometer (n=115).**

Parameters	Oculyzer II	OB 820 Biometer	P*
CCT ( $\mu\text{m}$ )	535.17 $\pm$ 33.16	528.85 $\pm$ 33.75	<0.001
ACD (mm) internal	2.74 $\pm$ 0.38	2.66 $\pm$ 0.37	<0.001
Flat K (D)	43.31 $\pm$ 1.58	42.62 $\pm$ 1.46	<0.001
Steep K (D)	44.14 $\pm$ 1.58	43.51 $\pm$ 1.52	<0.001
Mean K (D)	43.73 $\pm$ 1.54	43.06 $\pm$ 1.45	<0.001

\*Paired sample t-test. CCT= central corneal thickness, ACD = anterior chamber depth, flat K= flat meridian keratometry, steep K= steep meridian keratometry, mean K= mean keratometry, D=dioptr,  $\mu\text{m}$ =micrometer, mm=millimeter.

**Figure 1: Correlation plots for (a) Central corneal thickness; (b) Anterior chamber depth; (c) flat K; (d) steep K between two optical devices.****Table II: Correlation between Wavelight Oculyzer II and Wavelight OB 820 biometer for various biometric parameters (n=115).**

Parameters	Correlation Coefficient (r)	p
CCT ( $\mu\text{m}$ )	0.958	<0.001
ACD (mm)	0.965	<0.001
Flat K (D)	0.966	<0.001
Steep K (D)	0.969	<0.001
Mean K (D)	0.975	<0.001

CCT = central corneal thickness, ACD= anterior chamber depth, flat K=flat meridian keratometry, steep K=steep meridian keratometry, mean K=mean keratometry.

## DISCUSSION

Wavelight OB 820 biometer and the Allegro Oculyzer II are used frequently for meticulous and accurate assessment before keratorefractive and lens exchange surgeries. These devices attracted the attention of researchers in clinical practice to minimise the risk of postsurgical refractive surprise. These two optical tools are compared in terms of level of agreement for ACD, CCT, and keratometric values in this comparative cross-sectional study. All anterior segment parameters showed excellent and satisfactory levels of agreement between two optical modalities.

A study conducted by Kanellopoulos *et al.* on the Caucasian population reported similar results and concluded significant comparability of two devices to measure ACD, CCT, and keratometry.<sup>11</sup> The present study also showed excellent degree of correlation between these anterior chamber parameters. Previously studies had reported comparisons of the ultrasonic and other optical devices for biometric measurements.<sup>12,13</sup> Another study conducted by Khan *et al.* compared OB 820 biometer with the IOL master 500 to determine the axial length (AL) and other biometric parameters.<sup>14</sup> It was reported that both the instruments had significant correlation for keratometry and anterior chamber depth measurement, but agreement between two devices for axial length was not significant. Labiris *et al.* also compared the IOL-master and OB 820 and concluded that these devices should not be used interchangeably due to disagreement in the AL parameter but both biometers may provide consistent results regarding corneal astigmatism (Cyl), ACD and corneal radii R1 parameters.<sup>3</sup> ACD measured with IOL master and OB 820 biometer were 3.17 mm and 3.23 mm, respectively.

In addition to that, central corneal thickness is also an important biometric parameter often measured during routine ophthalmic examination, along with intraocular pressure measurement. Literature reported that mean CCT among Pakistani population is  $536.48 \pm 35.77\mu\text{m}$  and  $526 \pm 37\mu\text{m}$  with Dual Scheimpflug analyzer and Ultrasonic pachymeter, respectively which is in agreement with the present data that showed  $535.17 \pm 33.16\mu\text{m}$  with Oculyzer II and  $528.85 \pm 33.75\mu\text{m}$  with OB 820 biometer.<sup>15</sup>

Preoperative ACD measurement is a critical step for calculating effective lens position before performing Phakic ICL implantation, AC-IOL implantation, glaucoma surgical intervention, and phacoemulsification surgery.<sup>16</sup> Junejo *et al.* reported that the mean external ACD among the Pakistani population was 3.02 mm who were undergoing phacoemulsification surgery.<sup>17</sup> In this study the mean internal ACD was reported to be  $2.74 \pm 0.38$  mm (Oculyzer II) and  $2.66 \pm 0.37$  mm (OB 820 biometer) in the Pakistani population. The slight difference in findings can be due to the way the anterior chamber depth was measured, as this study methods measured internal ACD from posterior surface of cornea to anterior capsule of the lens.

Average flat K in the study population was found to be 43.3 D (Oculyzer II) and 42.6 D (OB 820 Biometer) while average steep K was reported to be 44.1 D (Oculyzer II) and 43.5 D (OB 820 Biometer). Keratometric mean values measured by Oculyzer II instrument were found to be slightly higher in reading as compared to OB 820 biometer but were also highly correlated.

El-Sayed *et al.* did a comparative study between Pentacam and optical biometer in normal and myopic eyes. ACD, K1, and K2 with Pentacam were reported to be 2.85 mm, 42.6 D and 43.63 D while with optical biometer these were 2.68

mm, 42.70 D and 43.75D respectively in normal eyes. His results using the two devices were well correlated and comparable, suggesting that these two devices could be used interchangeably in most clinical settings.<sup>18</sup> The present study also showed correlation in anterior segment parameters when measured with OB 820 biometer and scheimpflug system and the results were comparable to this study as well.

Therefore, this study showed that both Oculyzer II and OB 820 biometers are excellent noncontact devices for accurate measurements of anterior segments parameters with the high degree of correlation and linearity found for optic biometers including ACD, CCT, and keratometry.

## CONCLUSION

All anterior segment parameters showed excellent and satisfactory levels of agreement between two optical modalities. It is concluded that both devices can be used in the clinical practice of keratorefractive and cataract surgeries interchangeably.

## ETHICAL APPROVAL:

This study was carried out after obtaining approval from the Institutional Review Board and Ethical Committee of Armed Forces Institute of Ophthalmology.

## PATIENTS' CONSENT:

Informed consent were taken from all patients participated in the study.

## COMPETING INTEREST:

The authors declared no competing interest.

## AUTHORS' CONTRIBUTION:

SH: Conception and design of the work.

MN: Drafting and data acquisition.

SAHN: Data interpretation.

MS: Data analysis.

MI: Final approval of the manuscript.

HY: Acquisition.

All the authors have approved the final version of the manuscript to be published.

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