

Correlation between Keratometric Measurements Obtained by the VERION Image Guided System, Optical Biometry (IOL Master) and Corneal Topography in Egyptian Cataractous Patients

AYA S.M. MUBARAK, M.Sc.; MOHAMED O. YOUSIF, M.D.; MAGED M. SALIB ROSHDY, M.D. and ISMAIL I. HAMZA, M.D.

The Department of Ophthalmology, Faculty of Medicine, Ain Shams University

Abstract

Background: Recent applications and developments have increased the accuracy of preoperative corneal shape and refractive power evaluations prior to phacoemulsification with intraocular lens (IOL) implantation. The toric IOL has been shown to have substantial efficacy in correcting astigmatism. Accurate keratometry values (K-values) can be used as part of surgical planning for corneal incision design, astigmatic keratotomy (AK), the management of surgery-induced astigmatism (SIA), and correcting postoperative residual astigmatism. Several previous studies have compared corneal astigmatism measurements obtained using a range of keratometers.

Aim of Study: To measure the correlation coefficient for the keratometric measurements of VERION Image Guided System, an optical biometry (IOLMaster) and corneal topography (Oculus Keratograph) in Egyptian cataractous patients.

Patients and Methods: A forty-five eyes of cataractous patients were included in this cross-sectional observational study which was approved by the Ethics Committees of the Ain Shams University Hospitals.

Results: This study demonstrated excellent correlations between the Keratograph and each of VERION and IOLMaster for the Km values, good correlation for the axis and astigmatism between Keratograph and VERION, and moderate correlation between Keratograph and IOLMaster for axis and astigmatism. The agreement of keratometry measurements (Km and astigmatism) obtained from VERION versus Keratograph ranged between -1.3845 to 2.0783 and -1.0616 to 1.2913) respectively and for IOLMaster versus Keratograph are 0.7528 to 1.2510 and -0.9396 to 1.2463) respectively.

Conclusion: No differences in km, astigmatism and axis were observed between the VERION, IOLMaster and Keratograph. The keratometry values obtained with the VERION system were slightly steeper than those obtained with other devices except for astigmatism.

Key Words: IOLMaster – Keratometric – VERION – Keratograph.

Introduction

THE prevalence of astigmatism increases with age. Most of studies reporting that approximately 30% of patients undergoing cataract surgery present more than 1.5 D of preexisting corneal astigmatism [1].

This astigmatism must be corrected to achieve a real spectacle independence after cataract surgery, with the presence of a minimal postoperative refractive error. It should be considered that currently patients undergoing cataract surgery are more demanding [2].

For this reason, toric IOL designs were developed to provide a correction of not only spherical but also astigmatic refractive errors. The selection of the cylindrical power of toric IOLs is based on the measurement of corneal astigmatism which should be very accurate to avoid inadequate IOL power calculations. Currently, there are many devices providing measurements of corneal curvature and astigmatism that can be used for toric IOL power calculation [3].

Recently, the cataract surgery has evolved to a refractive surgery in a way that surgeons can customize the refractive outcome in every case, but surgical planning has also become a great challenge to meet patients' visual expectations [4].

Increased patient expectations can only be met with an excellent refractive outcome. The final refractive outcome mostly depends on accurate clinical measurements of corneal power, anterior chamber depth, axial length, and IOL power calculations. Correct measurement of corneal astigmatism and axis location is a key to astigmatism

Correspondence to: Dr. Aya S.M. Mubarak,
[E-Mail: ayamubarak95@gmail.com](mailto:ayamubarak95@gmail.com)

correction during cataract surgery by either toric IOLs or astigmatic keratotomies [5].

Nowadays, these values can be measured using different devices. The IOLMaster (Carl Zeiss Meditec, Germany) has become the gold standard by setting non-contact thorough biometry avoiding indentation and infection risk [6].

A newer system arrived on the market and intended to provide a complete preoperative and postoperative assessment called the "VERION Image Guided System" (Alcon Laboratories Inc., Fort Worth, TX). With this new system, a question is raised concerning the reproducibility of its keratometric measurements and the differences in the data obtained by this new system and the standard ones [7].

VERION Image Guided system captures and utilizes a high-resolution reference image of a patient's eye to determine the radii and corneal curvature of steep and flat axes, corneal diameter, pupil position and diameter, and corneal reflex position.

Besides, it provides intraoperative surgical planning functions that use the reference image and intraoperative measurements to assist planning cataract surgical procedures, including the number and location of incisions and the appropriate IOL using existing formulas. It links to compatible surgical microscopes to display concurrently the reference and microscope images, allowing the surgeon to account for lateral and rotational eye movements.

In addition, the planned capsulorhexis position and radius, IOL positioning, and implantation axis can be overlaid on a computer screen or the physician's microscope view at the time of surgery. This suite may be especially useful in cases where the implantation of a toric IOL is being planned [8].

In a prospective clinical trial, the right eyes of 52 patients with cataract were examined. Flat K readings of VERION were higher than IOLMaster. Steep K readings were different for all two. There were excellent correlations between the VERION and IOLMaster for K1, K2, and Km values [9].

Aim of the work:

To measure the correlation coefficient for the keratometric measurements of VERION Image Guided System, an optical biometry (IOLMaster) and corneal topography in Egyptian cataractous patients.

Patients and Methods

A forty-five eyes of cataractous patients were included in this cross-sectional observational study from June 2020 to March 2021 which was approved by the Ethics Committees of the Ain Shams University Hospitals.

Inclusion criteria: Patients coming for cataract surgery.

Exclusion criteria: Uncooperative patients, history of prior intraocular or corneal surgery, history of ocular trauma, corneal or anterior segment disease that could affect the keratometric outcome, and contact lens wear.

Examination technique: Complete history including demographic data (age, sex, full medical history (systemic diseases, medications and surgical history) and ophthalmic history (previous ocular surgical intervention, eye drops usage, past ocular pathology and history of trauma) was taken. Full ophthalmological examination including: Best corrected visual acuity measurement using Snellen's chart with the conversion of the values to LogMAR notation for statistical analysis. External examination of the eyelid and conjunctiva. Anterior segment examination using slit lamp biomicroscopy. All eyes were examined by optical biometry IOLMaster 500 (Carl Zeiss Meditec, Germany). All eyes were examined by Keratograph Topography (OCULUS, Germany).

All eyes were examined by IOLMaster: Each patient was comfortably positioned at the instrument with proper placement on the chin rest and forehead strap. We told the patient to blink his/her eye shortly before the measurement to produce a continuous tear film and asked to fixate on the fixation target then we aligned the IOLMaster as the six peripheral measuring points should be symmetrical to the circular crosshair and appear optimally focused before taking the measurement.

Then each patient was comfortably positioned at Keratograph Topography on the chin rest and forehead strap. The patient was asked to blink a few times and to open both eyes and stare at the fixation target. After proper alignment was obtained, the keratometry measurement was taken.

Then Patients were seated at VERION Image Guided System in an upright position with their chin and forehead properly resting against the chinrest on the measurement module of the image-guided system. They were instructed to stare com-

accepted was set to 5%. So, the p-value was considered significant as the following: p -value >0.05 : Non significant (NS). p -value <0.05 : Significant (S). p -value <0.01 : Highly significant (HS).

Results

The 45 patients included 22 females (48.9%) and 23 males (51.1%) with age ranged from 24 to 92 years (mean \pm SD = 67.5 ± 10.9 years), the corrected distance visual acuity (CDVA) mean \pm SD was 0.29 ± 0.09 .

Table (1): Demographic and clinical data of the studied patients.

	No. = 45
Age:	
Mean \pm SD	67.53 ± 10.92
Range	24-92
Gender:	
Females	22 (48.9%)
Males	23 (51.1%)
Laterality:	
Right eyes	28 (62.2%)
Left eyes	17 (37.8%)
CDVA:	
Mean \pm SD	0.29 ± 0.09
Range	0.1-0.5

CDVA: Corrected distance visual acuity.

Table (4): The interdevice differences in Axis, Km, and the magnitude of astigmatism measurements for "VERION and Keratograph", "IOL Master and Keratograph" devices.

	VERION and Keratograph			IOLMaster and Keratograph		
	M \pm SD interdevice difference	95% CI	Spans of limits of agreement	M \pm SD interdevice difference	95% CI	Spans of limits of agreement
Axis	12.4867 ± 61.744	-6.063 to 31.037	-108.5315 to 133.5048	-8.18 ± 30.181	-17.247 to 0.887	-67.3347 to 50.9747
Km	0.3469 ± 0.8834	0.08149 to 0.6123	-1.3845 to 2.0783	0.2491 ± 0.5112	0.09554 to 0.4027	-0.7528 to 1.2510
Astigmatism	0.1149 ± 0.6002	-0.06544 to 0.2952	-1.0616 to 1.2913	0.1533 ± 0.5576	-0.01420 to 0.3209	-0.9396 to 1.2463

Discussion

Cataract surgery has changed dramatically in recent years, both in terms of the technologies used in preoperative planning and during surgery. Only an excellent refractive outcome can meet increased patient expectations. Accurate clinical measurements of corneal power, anterior chamber depth, axial length, and intraocular lens (IOL) power calculations are critical to the final refractive outcome. The correct measurement of corneal astigmatism and axis location is critical for astigmatism correction during cataract surgery using toric intraocular lenses or astigmatic keratotomies El Hofi [10].

Table (2): Comparison between the three studied devices regarding the studied parameters.

	Keratograph No. = 45	IOLMaster No. = 45	VERION No. = 45	Test value*	p value
K1:					
Mean \pm SD	43.06 ± 2.03	43.27 ± 2.07	43.45 ± 2.01	0.405	0.668
Range	38.6-49.3	38.66-49.56	39.12-49.33		
K2:					
Mean \pm SD	44.48 ± 2.02	44.84 ± 2.16	44.99 ± 2.12	0.676	0.511
Range	39.5-50.5	39.71-52.41	40.47-52.12		
AST:					
Mean \pm SD	1.42 ± 0.75	1.57 ± 0.74	1.53 ± 0.75	0.513	0.600
Range	0.3-3.2	0.35-3.39	0.22-3.15		
Km:					
Mean \pm SD	43.81 ± 1.99	44.05 ± 2.08	44.15 ± 2.06	0.345	0.709
Range	39.05-49.9	39.19-51	39.8-50.73		
Flat axis:					
Mean \pm SD	71.05 ± 52.96	62.87 ± 48.99	83.53 ± 53.16	1.821	0.166
Range	2-172	2-164	4-196		

K1: Corneal power at the flat axis. Km: Mean corneal power
K2: Corneal power at the steep axis. *: One Way ANOVA.

Table (3): Intraclass correlation coefficients for each of IOL Master and VERION image guided system regarding Km, astigmatism and axis taking Keratograph as a gold standard.

	Intraclass correlation coefficient of Keratography with	
	VERION	IOL Master
Km	0.9752	0.9292
Astigmatism	0.8806	0.7108
Axis	0.7554	0.5073

The aim of this study was to measure the correlation coefficient for the keratometric measurements of VERION Image Guided System, an optical biometry (IOLMaster) and corneal topography Keratograph in Egyptian cataractous patients.

This study enrolled 45 cataractous patients, (51.1%) were males with age mean \pm SD was 67.53 ± 10.92 years.

In this study, the mean corneal astigmatism was (1.42 ± 0.75 , 1.57 ± 0.74 and 1.53 ± 0.75) for Keratograph, IOLMaster and VERION, respectively, with ranging (0.22-3.39) D.

In line with Lin et al., [11] study, as the mean corneal astigmatism was 0.96 ± 0.58 D, ranging from 0.07 D to 3.54 D. Hoffmann and Hütz [12] and Ferrer-Blasco et al., [13] found that 64.4% and 22.2% of cataract patients had (0.25-1.25) D and 1.25 D corneal astigmatism, respectively.

In the current study, K1, K2, and Km obtained with the VERION system were slightly steeper than those obtained with other devices. However, there was no statistically significant difference found between the three studied devices regarding flat K1, K2, Astigmatism, Km and the Flat axis.

The study by Mueller et al., [7] reported similar results in the comparison of VERION and LenStar LS900 (OLCR device), and Schultz et al., [14] also found that the Ks values of VERION were slightly steeper than those of AL-Scan and OPD III.

Wu et al., [15] who compared the keratometric measurements of the VERION with the IOLMaster 700 and the Oculus Scheimpflug corneal topography (Pentacam), found no significant difference between the three devices regarding K1, K2, Km and corneal astigmatism magnitude among the three instruments.

In same hand El Hofi [10] study compared between LENSTAR (LS900,,,) and VERION in toric intraocular lens power calculation, as they demonstrated no statistical differences between the two groups regarding the K1 values ($p=0.072$), K2 values ($p=0.394$), and astigmatism values ($p=0.218$); however, there was a statistical difference between the two groups regarding the average K values ($p=0.010$).

Also Lin et al., [11] study compared corneal power obtained from VERION system, Placido-based corneal topography (OPD-Scan III), monochromatic light-emitting diodes (LenStar LS900 and AL-Scan), and rotary prism technology (auto kerato-refractometer KR-8800). They found no differences between the VERION Reference Unit, AL-Scan, and LenStar devices, which are all automated keratometers that rely on the projection of light onto the corneal surface in order to obtain K-values measurements.

In other side, we differ with Asena et al., [16] study aimed to make a comparison of keratometric measurements obtained by the VERION with optical biometry and auto-keratorefractometer (AKR), as they found K1 readings of VERION were steeper than IOLMaster and AKR ($p=0.01$ and $p=0.02$, respectively). Steep K readings were different for all three devices ($p<0.05$). Mean K readings of

VERION were also higher than IOLMaster and AKR ($p=0.01$ and $p<0.01$, respectively). The magnitude of astigmatism by VERION and IOLMaster were 0.98 ± 0.65 D and 0.98 ± 0.59 D ($p=0.88$). The mean astigmatism measured by AKR was 0.82 ± 0.62 D, less than other two instruments ($p<0.001$)

In Labiris et al., [17] study, to evaluate the level of agreement of IOLMaster and VERION in terms of keratometric values and IOL power as the keratometric values (K1, K2, and Km) obtained by the VERION were significantly steeper than the ones obtained by the IOLMaster.

The difference in the average K values between the different devices can be attributed to the different technologies implemented in different devices for K reading acquisition.

In the current study there were excellent correlations between the Keratograph and each of VERION and IOLMaster for the Km values, good correlation was found for the axis and astigmatism between Keratograph and VERION, and moderate correlation was present for axis and Astigmatism between Keratograph and IOLMaster.

Nemeth et al., stated that the 'VERION reference unit' exhibits high measurement repeatability for all obtained keratometric measurements and shows high correlations with the data of the IOLMaster, making it suitable as an alternative tool in clinical practice [8].

Asena et al., found that there were excellent correlations between the VERION and IOLMaster for the K1, K2, and Km values. Although there was excellent correlation between the K1 and Km values obtained with VERION and AKR, there was only moderate correlation for the K2 value. All devices showed moderate correlation among each other for the magnitude of astigmatism and the strongest correlation was between VERION and IOLMaster for this value Asena et al., [16].

Lin et al., [11] study demonstrated moderate to high correlations for all parameters measured using VERION compared to those measured using other devices.

Asena et al., [16] also study the mean interdevice differences in K1, K2, Km, and the magnitude of astigmatism, and the 95% limits of agreement for the VERION and the IOLMaster, the VERION and the AKR, the IOLMaster and the AKR are for Km (-0.79 to 1.13 , -0.83 to 1.34 and -0.62 to 0.79) respectively and magnitude of astigmatism (-0.006 to 0.02 , -0.54 to 0.87 and -0.47 to 0.79).

The agreement of keratometry measurements (Km and astigmatism) obtained from VERION versus Keratograph was ranged between (-1.3845-2.0783 and 1.0616-1.2913) respectively and for IOLMaster versus Keratograph are (0.7528-1.2510 and -0.9396-1.2463) respectively.

The width of the 95% limits of agreement for K1, K2, and Km values range between 1.91 D and 2.10 D for the difference between VERION and IOLMaster and between 2.04 D and 2.50 D for the difference between VERION and AKR. The width of the 95% LoA for magnitude of astigmatism difference was narrowest between VERION and IOLMaster (0.026 D) in Asena et al., [16].

The differences in Km, which affects the IOL power selection, are quite small and are not expected to affect the final astigmatic correction. Differences in measurement zone diameter and data points of these three instruments probably caused the difference. On the other hand, astigmatic axis measurement differences between instruments can be more detrimental on final astigmatic corrections.

Patient head tilt during the measurements can be the underlying reason and the caution of the technician can contribute to decrease these differences.

Conclusion:

This study demonstrated excellent correlations between the Keratograph and each of VERION and IOLMaster for the Km values, good correlation was found for the axis and Astigmatism between Keratograph and VERION, and moderate correlation was present for axis and Astigmatism between Keratograph and IOLMaster. No differences were observed between the VERION Reference Unit, IOLMaster and Keratograph which are all automated keratometers that rely on the projection of light onto the corneal surface in order to obtain K-values measurements. The keratometry values obtained with the VERION system were slightly greater than those obtained with other devices except for astigmatism.

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العلاقة بين القياسات الكيراتومترية التي تم الحصول عليها بواسطة نظام للصور الموجهة وجهاز المقياس البصري البيولوجي وجهاز تضاريس القرنية في مرضى المياه البيضاء المصريين

لقد أدت التطورات والتطبيقات الحديثة إلى زيادة الدقة في تقييم شكل القرنية والقوة الانكسارية لها قبل إجراء عملية المياه البيضاء بالموجات الصوتية وزراعة العدسات. قارنت العديد من الدراسات السابقة الاستجماتزم الذي تم الحصول عليه باستخدام مجموعة من أجهزة مقياس القرنية المختلفة. وقد أجريت هذه الدراسة المقطعية المستعرضة على ٤٥ مريض والتي تمت بقسم الرمد بجامعة عين شمس.

تهدف هذه الدراسة: إلى قياس معامل الارتباط بين القياسات الكيراتومترية التي تم الحصول عليها عن طريق جهاز VERION للصور الموجهة وجهاز المقياس الحيوي البيولوجي IOLMaster وجهاز قياس تضاريس القرنية في مرضى المياه البيضاء المصريين. وقد نتج عنها أنه لا توجد فروق ذات دلالة إحصائية بين الأجهزة الثلاثة من حيث القياسات الكيراتومترية الاستجماتزم ومحوره. وقد ظهر أيضاً ارتباطات ممتازة بين جهاز تضاريس القرنية وجهاز الـ VERION لقيم Km وعلاقة جيدة بين جهاز تضاريس القرنية وجهاز الـ VERION من حيث الاستجماتزم ومحوره. وهناك ارتباط متوسط بين جهاز المقياس وجهاز تضاريس القرنية لقيم الاستجماتزم ومحور الاستجماتزم. وقد أوضح تحليل الانحدار الخطى متعدد المتغيرات أن وجد أن نظام VERION للصور الموجهة أكثر توافقاً مع جهاز تضاريس القرنية من جهاز المقياس الحيوي البيولوجي فيما يتعلق بالمحور أما بالنسبة لـ Km فإنه لا يظهر توافقاً كبيراً بين الـ VERION أو المقياس الحيوي البيولوجي وجهاز تضاريس القرنية. وتم العثور على أن نظام الـ VERION للصور الموجهة أكثر توافقاً مع جهاز تضاريس القرنية متبوعاً بجهاز المقياس الحيوي البيولوجي فيما يتعلق بالاستجماتزم.