Comparison between LENSTAR and VERION in toric intraocular lens power calculation

Abdel H. El Hofi

Ophthalmology Department, Faculty of Medicine, Alexandria University, Alexandria, Egypt

Correspondence to Abdel H. El Hofi, MD, PhD, Ophthalmology Department, Faculty of Medicine, Alexandria University, Alexandria, 52100, Egypt. Tel: +20 122 217 4095; e-mail: abdelhamidelhofi@yahoo.com

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Purpose
To compare and assess the accuracy of both Lenstar T-cone toric platform and Verion in toric intraocular lens (IOL) power calculation regarding postoperative refraction.
Design
The study design was a retrospective one.
Participants and methods
A total of 33 eyes (33 patients) with astigmatism at least 1 D underwent cataract surgery. The eyes included in the study were divided into two groups. Group 1 included 17 eyes where IOL was implanted according to Verion IOL power calculations, and group 2 included 16 eyes where IOL was implanted according to Lenstar T-cone power calculations. The keratometric readings of the 33 eyes of both devices were compared. Postoperative manifest refraction data of all patients that were taken 1 month postoperative were collected. The manifest postoperative refraction values of both groups were compared with both the expected refraction predicted by Lenstar toric T-cone and with that of the Verion.
Results
There were no statistical differences between the two devices used in this study regarding keratometric values. There were no statistical differences between the two devices used in this study regarding neither the final residual postoperative spherical refractive error nor the final residual postoperative cylindrical refractive error, nor the final residual postoperative spherical equivalent.
Conclusion
Both the Lenstar LS 900 T-cone biometer and the Verion image-guided system provide excellent, accurate, reproducible, and comparable postoperative results.

Keywords:
Lenstar, toric intraocular lens power calculation, Verion

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Introduction

Cataract is the leading cause of visual impairment throughout the world [1]. Expectations and demands of patients require correction of refractive errors after cataract surgery. In addition to spherical refractive errors, astigmatism should be addressed at the time of surgery to achieve the best postoperative refractive outcomes [2]. The prevalence of corneal astigmatism more than 1.5 diopters (D) ranges between 15 and 29% as reported by different studies [3–6].

There are several methods for treating coexisting astigmatism in patients undergoing cataract surgery [7]. These methods include steep meridian incision [8,9], opposite clear corneal incisions [8,10–12], limbal or corneal relaxing incisions [13,14], and toric intraocular lens (IOL) [15–17]. The AcrySof IQ Toric IOLs offer spherical powers in half diopter increments from +6.0 to +34.0 D and seven cylinder powers to treat +0.75 to +4.11 D and greater of preexisting corneal astigmatism [18].

The Lenstar LS 900 is a noninvasive, noncontact optical biometer that is based on optical low-coherence reflectometry using a broadband light source (20–30 nm) with a center wavelength of 820 mm. It can measure central corneal thickness, anterior chamber depth (ACD; from corneal endothelium to lens surface), lens thickness (LT), and axial length (AL), in addition to keratometric (*K*) readings, corneal diameter, pupil size, eccentricity of the visual optical line, and retinal thickness at the point of fixation (macula). With the optional T-Cone toric platform, the axis and astigmatism measurement of Lenstar is extended with true 11-ring Placido topography. These additional data improve the efficacy and safety of toric IOL surgery, eliminating the risk of

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irregularities and allowing the user to double check the axis location [19].

The Verion image-guided surgery system enables the measurement of keratometry parameters and anterior segment imaging-based biometric identification. The system is able to adjust focus for corneal astigmatism using three infrared projections on to the front corneal surface. The combination of 12 corneal-reflected light spots from monochromatic LED sources allows for a measurement area with a diameter of 2.8 mm [20]. Advantages of the Verion image-guided system include noninvasive, minimizing data transcription errors, digital marker, increasing toric and multifocal IOL confidence, ensuring surgical consistency, and optimizing visual outcomes [21].

Patients and methods

The methods were discussed, revised, and approved by the Ethics Committee of Faculty of Medicine, Alexandria University. The study was conducted in accordance with the tenets and principles of the 1964 World Medical Association Declaration of Helsinki and its later amendments.

This was a retrospective study performed on 33 eyes (33 patients). They were divided into two groups. Group 1 included 17 eyes of 17 patients, where IOL is implanted according to Verion IOL power calculations, and group 2 included 16 eyes, where IOL was implanted according to Lenstar (Hag Streit inc., USA) T-cone power calculations.

The inclusion criteria were eyes with corneal astigmatism more than 1° that underwent uneventful phacoemulsification surgery by the same surgeon with implantation of Alcon AcrySof IQ Toric IOLs (Alcon Co., Novartis, Switzerland).

The exclusion criteria were as follows: patients with corneal disease such as keratoconus, rotation of IOL within 6 months after surgery more than 5° of intended axis, any complications during surgery, incomplete data, posterior segment disorders such as foveal disease and scleral buckle, or patients who had silicone injection in vitreous cavity after vitrectomy surgery. Moreover, patients with previous corneal surgeries such as previous RK and previous LASIK, subluxated lens and pseudoexfoliation syndrome, high myopes with AL more than 25, and dense cataract were also excluded.

The preoperative best-corrected visual acuity and postoperative uncorrected visual acuity data were obtained from the patients' records. Details of patients' preoperative ophthalmic examination, including slit lamp examination of anterior segment to exclude presence of corneal opacities, rubeosis iridis, etc.; intraocular pressure, measured using the Goldmann applanation tonometry, and dilated fundus examination, using stereoscopic slit-lamp biomicroscopy and 90 D noncontact lens were also acquired.

Procedure

All preoperative Lenstar LS 900 T-cone platform data and preoperative Verion data of all patients were collected and compared with postoperative data.

The Lenstar LS 900 with its toric T-cone platform was used to calculate the power of the toric IOL using the Holladay I equation for the 33 patients. The Lenstar measured also the AL, ACD, LT, K_1, K_2, average K, and astigmatism.

In the Verion imaging procedure, AL, ACD, and LT measured by the Lenstar for the 33 patients were introduced to the Verion's reference unit. The Verion reference unit measured K_1, K_2, average K, and astigmatism. The Verion reference unit was used to calculate the power of the toric IOL using the Holliday I equation for the 33 patients.

One eye was operated for each of the 33 patient, and the patients were divided into two groups: group I included 17 patients in which the power of the implanted Alcon AcrySof IQ Toric IOLs was determined according to the Verion's reference unit IOL calculation. Group II included 16 patients in which the power of the implanted Alcon AcrySof IQ Toric IOLs was determined according to the Lenstar LS 900 IOL calculation. The keratometric readings of the 33 eyes of both devices were compared.

The Alcon AcrySof IQ Toric IOLs were implanted in all 33 patients using the IOL implantation under saline technique to prevent further inadvertent change of IOL implantation axis.

Postoperative manifest refraction data of all patients that were taken one month postoperative were collected.

The manifest postoperative refraction values of both groups were compared with both the expected refraction predicted by Lenstar toric T-cone and with that of the Verion.

Statistical analyses

The data were collected and entered into the computer using statistical package for the social sciences (SPSS) program for statistical analysis (version 21) [22]. Data were entered as numerical or categorical, as appropriate.

Results

Patient demographics were similar in both groups.

The mean age was 56.35±9.09 years (range: 41–69) in group I (Verion group) and 58.31±7.19 years (range: 41–69 years) in group II (P=0.437).

In group I, four (23.53%) patients were males and 13 (76.47%) were females, whereas in group II, seven (43.75%) patients were males and nine (56.25%) were females (P=0.218).

In group I, six (35.29%) eyes were right eyes and 11 (64.71%) eyes were left eyes, whereas in group II, eight (50.00%) eyes were right eyes and eight (50.00%) eyes were left eyes (P=0.393).

The preoperative keratometric measurements were measured for the 33 patients twice using both devices (the Verion's reference unit and the Lenstar LS 900) independently to compare both devices regarding their keratometric measurement acquisition.

The Mann–Whitney–Wilcoxon U-test was used to compare between the two devices regarding their keratometric measurement acquisition, and it demonstrated no statistical differences between the two group regarding the K_1 values (P=0.072), K_2 values (P=0.394), and astigmatism values (P=0.218); however, there was a statistical difference between the two group regarding the average K values (P=0.010; Table 1).

Agreement between the two devices regarding the residual postoperative spherical refractive parameters

(1) Residual postoperative spherical refractive error: The final residual postoperative refractive error was compared in the two groups to determine which device resulted in residual spherical refractive error within the predetermined limits.

Table 1 Preoperative patients' keratometric measurements obtained from both devices (n=33)

	Device used		Test of significance (P value)
	Verion	Lenstar	
K_1			
n	33	33	$Z_{(WSR)}$=1.800
Minimum–maximum	40.96–46.94	40.66–46.66	P=0.072 (NS)
Mean±SD	43.77±1.58	43.67±1.56	
95% CI of the mean	43.20–44.32	43.11–44.22	
Median (IQR)	43.72 (42.99–44.88)	43.72 (42.97–44.75)	
KS test of normality	D=0.107, P=0.200 (NS)	D=0.084, P=0.200 (NS)	
K_2			
n	33	33	$Z_{(WSR)}$=0.852
Minimum–maximum	42.40–50.00	42.26–49.70	P=0.394 (NS)
Mean±SD	45.71±1.65	45.68±1.67	
95% CI of the mean	45.12–46.29	45.08–46.27	
Median (IQR)	45.98 (44.25–46.55)	45.80 (44.44–46.69)	
KS test of normality	D=0.085, P=0.200 (NS)	D=0.084, P=0.200 (NS)	
Average K			
n	33	33	$Z_{(WSR)}$=2.592
Minimum–maximum	41.73–48.34	41.62–48.13	P=0.010*
Mean±SD	44.74±1.53	44.66±1.56	
95% CI of the mean	44.19–45.28	44.10–45.21	
Median (IQR)	44.70 (43.58–45.56)	44.65 (43.72–45.56)	
KS test of normality	D=0.145, P=0.076 (NS)	D=0.128, P=0.189 (NS)	
Astigmatism			
n	33	33	$Z_{(WSR)}$=1.232
Minimum–maximum	0.33–4.88	0.84–4.93	P=0.218 (NS)
Mean±SD	1.94±1.06	2.03±0.96	
95% CI of the mean	1.56–2.31	1.69–2.37	
Median (IQR)	1.62 (1.13–2.72)	1.80 (1.35–2.77)	
KS test of normality	D=0.167, P=0.200 (NS)	D=0.151, P=0.054 (NS)	

*Statistically significant.

Table 2 Agreement between the two devices regarding the residual postoperative spherical refractive error (*n*=33)

Postoperative	Verion group	Lenstar group	Test of significance (*P* value)
Spherical grade			
Out of determined limits	4 (23.53)	4 (25.00)	χ^2=0.010
Between −0.5 and +0.5	13 (76.47)	12 (75.00)	$P_{(FE)}$=1.000 (NS)
Spherical grade			
Out of determined limits	0	2 (12.50)	χ^2=2.262
Between −1 and +1	17 (100.00)	14 (87.50)	$P_{(FE)}$=0.227 (NS)

The Fisher's exact test was used, and it demonstrated no statistical difference between the two groups regarding which device resulted in final residual postoperative spherical refractive error within the predetermined range between −0.5 and +0.5 D [$P_{(FE)}$=1.000]. After broadening the acceptance range to be between −1 and +1 D, there was also no statistical difference between the two groups as well [$P_{(FE)}$=0.22].

Table 3 Agreement between the two devices regarding the residual postoperative cylindrical refractive error (*n*=33)

	Verion group	Lenstar group	Test of significance (*P* value)
Cylinder grade			
Out of determined limits	2 (11.76)	7 (43.75)	χ^2=4.251
Between −0.5 and +0.5	15 (88.24)	9 (56.25)	$P_{(FE)}$=0.057 (NS)
Cylinder grade			
Out of determined limits	2 (11.76)	0	χ^2=2.004
Between −1 and +1	15 (88.24)	16 (100.00)	$P_{(FE)}$=0.485 (NS)

The Fisher's exact test was used, and it demonstrated no statistical difference between the two groups regarding which device resulted in final residual postoperative cylindrical refractive error within the predetermined range between −0.5 and +0.5 D [$P_{(FE)}$=0.057]. After broadening the acceptance range to be between −1 and +1 D, there was also no statistical difference between the two groups as well [$P_{(FE)}$=0.485].

(2) Residual postoperative cylindrical refractive error: The final residual postoperative cylindrical refractive error was compared in the two groups to determine which device resulted in residual cylindrical refractive error within the predetermined limits.
(3) Residual postoperative spherical equivalent: The final residual postoperative spherical equivalent was compared in the two groups to determine which device resulted in residual postoperative spherical equivalent within the predetermined limits (Tables 2–4).

Table 4 Agreement between the two devices regarding the residual postoperative spherical equivalent (*n*=33)

	Device used	
	Verion	Lenstar
Postoperative SE		
Out of determined limits	3 (17.65)	6 (37.50)
Between −0.5 and +0.5	14 (82.35)	10 (62.50)
Test of significance	$\chi^2_{(d.f.=1)(Y)}$=0.790	
P value	$P_{(Y)}$=0.374	

The Fisher's exact test was used, and it revealed no statistical difference between the two groups regarding which device resulted in final residual postoperative spherical equivalent within the predetermined range between −0.5 and +0.5 D [$P_{(Y)}$=0.374].

Discussion

Femtosecond lasers may revolutionize the way cataract surgery is performed, with promising preliminary results showing precise and self-sealing corneal incisions; consistently accurate capsulorrhexis [23], which optimizes adequate centration and positioning of an IOL; decreased phacoemulsification energy; effective phaco time; and decreased incidence of endothelial cell loss [24–26].

In our study, the Mann–Whitney–Wilcoxon *U*-test was used to compare between the two devices regarding their keratometric measurements acquisition, and it demonstrated no statistical differences between the two group regarding the K_1 values (*P*=0.072), K_2 values (*P*=0.394), and astigmatism values (*P*=0.218); however, there was a statistical difference between the two group regarding the average *K* values (*P*=0.010). The difference in the average *K* values between the two devices can be attributed to the different technologies implemented in both devices for *K* reading acquisition.

This came in agreement with the results reported by Lin *et al.* [20] in their article that was published in 2017, which included 115 patients with cataract. In that study, Lin *et al.* [20] found that none of the measured Verion's keratometric parameters were significantly different from those of the Lenstar LS 900. Nemeth *et al.* [27] – in his study that was published in 2015 and included 50 eyes of 50 healthy volunteers – 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. Asena *et al.* [28] – in his study that was published in 2017 and included the right eyes of 52 patients – found that the agreement between the Verion system and the IOLMaster was excellent, with intraclass correlation coefficients close to one.

In this study, the Fisher's exact test was used, and it demonstrated no statistical difference between the two groups regarding which device resulted in final residual postoperative spherical refractive error within the predetermined range between −0.5 and +0.5 D [$P_{(FE)}$=1.000]. After broadening the acceptance range to be between −1 and +1 D, there was also no statistical difference between the two groups as well [$P_{(FE)}$=0.227].

To our knowledge and after reviewing the literature, we found that this study is the first study worldwide to study the agreement between the Verion system and the Lenstar LS 900 regarding the residual postoperative spherical refractive error.

In this study, the Fisher's exact test was used, and it demonstrated no statistical difference between the two groups regarding which device resulted in final residual postoperative cylindrical refractive error within the predetermined range between −0.5 and +0.5 D [$P_{(FE)}$=0.057]. After broadening the acceptance range to be between −1 and +1 D, there was no statistical difference between the two groups as well [$P_{(FE)}$=0.485].

To our knowledge and after reviewing the literature, we found that the present study is the first study worldwide to study the agreement between the Verion system and the Lenstar LS 900 regarding the residual postoperative cylindrical refractive error.

In this study, the Fisher's exact test was used, and it revealed no statistical difference between the two groups regarding which device resulted in final residual postoperative spherical equivalent within the predetermined range between −0.5 and +0.5 D [$P_{(Y)}$=0.374].

To our knowledge and after reviewing the literature, we found that this study is the first study worldwide to study the agreement between the Verion system and the Lenstar LS 900 regarding the residual postoperative spherical equivalent values.

Addressing astigmatism at the time of surgery resulted in better postoperative refractive outcomes and higher patient satisfaction rate. Toric IOL implantation is a reliable method for treating coexisting astigmatism in patients undergoing cataract surgery.

The Alcon AcrySof IQ Toric IOL is a good choice to correct spherical as well as cylindrical refractive errors. The Alcon AcrySof IQ Toric IOL has exceptional durability and long-term rotational stability owing to its adhesive properties.

In this study, there were no statistical differences between the two devices used in this study regarding neither keratometric values, nor the final residual postoperative spherical refractive error, nor the final residual postoperative cylindrical refractive error, nor the final residual postoperative spherical equivalent.

Conclusion

This study revealed that both the Lenstar LS 900Tcone biometer and the Verion image-guided system provide excellent, accurate, reproducible, and comparable postoperative results.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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