Comparison of ocular biometry and refractive outcome between ANTERION and IOL Master 700

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Purpose: To assess the comparability of ocular biometry measurements and refractive outcomes between ANTERION and IOL Master 700. Methods: This comparative prospective study was conducted from December 2020 to February 2021. A total of 225 patients who had cataracts were enrolled for the study and different parameters such as anterior keratometry (Steep K, Flat K) with axis, Sim K, central corneal thickness (CCT), aqueous depth (AOD), lens thickness (LT), and axial length (AL), white-to-white (WTW) were evaluated in IOL master 700 first and then with ANTERION. Finally, 203 patients completed the 6-week follow-up and the postoperative refraction was done at the 6th week. To assess the agreement between the devices, intraclass coefficient (ICC) and Bland–Altman analysis with 95% limits of agreement (LoA) were used. To analyze the agreement for postoperative residual refractive error between the two devices, Kappa statistics were used. Results: The mean difference for steep K, flat K, and Sim K between ANTERION and IOL Master 700 were −0.18 +/-0.26 D, −0.13 +/- 0.28D, −0.15 +/-0.23, respectively. The CCT, ACD, and LT also showed excellent agreement (ICC > 0.9) but the similarity for the keratometry axis was not up to the mark (ICC = 0.794). For postoperative refractive outcomes, the Kappa value was 0.437, indicating moderate agreement. Conclusion: ANTERION showed a good agreement for the majority of parameters with IOL Master 700 in measuring ocular biometry, except for the keratometry. The accuracy of the intraocular lens power calculations was clinically acceptable with both biometers though the IOL power given by ANTERION remained slightly on the hypermetropic side.

Key words: ANTERION, biometry, IOLMaster 700

Modern advanced surgical technique with novel intraocular lens design is a quantum-leap in cataract surgery evolution. The prime objective of contemporary cataract surgery is to bestow the patient with a postoperative spectacle-free satisfactory visual outcome and not just merely get rid of the opaque lens. This outcome mainly relies on the explicit prediction of the power of the implanted intraocular lens, which in turn has to entrust on precise preoperative biometry data.[1]

Optical biometers based on swept-source OCT (ss-OCT) systems have been a major breakthrough in the current scenario. Swept-source OCT-based optical biometer system utilizes a laser source of wavelength ranging from 1000 to 1350 nm. This wavelength range has a superior tissue penetration capability in contrast to the predecessor biometry models utilizing the partial coherence interferometry (PCI) principle. Hence, they are able to furnish perfect biometric data even in arduous situation such as posterior subcapsular cataract and dense nuclear cataract.[2-4]

Among different swept source systems, IOLMaster 700 is an excellent entry in the Zeiss cataract suit. This unique technology being fostered with a number of exceptional features has become imperative for cataract surgeons for accurate computation of IOL power. OCT image-based biometry permits visual verification of all measurements and also identifies unusual eye geometry such as lens tilt or decentration, which is for the first time in an optical biometer. Repeatability, acquisition of images in quick succession, and the unique foveal fixation checkers are the highlighting features giving very negligible postoperative refractive surprises.[3]

Similarly, ANTERION, the latest launch by Heidelberg Engineering is another SS-OCT-based biometer. This multimodal imaging system can provide high-resolution images with an optimizable platform. The standard version of ANTERION mainly comes up with an image app that can be customized with the availability of additional applications such as cornea app, cataract app, and metrics app depending upon surgeons’ needs. This remodeled software may enable for comprehensive biometric evaluation of the anterior segment of the eyes, which is an added advantage over IOLMaster 700. The cornea app can display the spatial thickness of the cornea as well as axial and tangential curvature data of both

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anterior and posterior surfaces, whereas the metrics app aids in glaucoma evaluation.\[6\]

To date, even though a number of research papers have highlighted that the biometric measurements of both the aforementioned systems are in good agreement with each other, there is still no available literature mentioning whether the postoperative refractive outcomes are well correlated or there is any significant discrepancy in this regard. So, this study has focused on and analyzed both the above aspects of the devices.

Methods

This was a prospective study in which 225 patients who were scheduled to be operated on for cataract by a single surgeon between December 2020 and March 2021 were enrolled. The study protocol was approved by the local ethics committee review board. The trial was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent that the data and the results can be used for research and publication is routinely obtained from all patients before surgery. The patients who had a history of any previous ocular surgeries or the presence of degenerative corneal disorders and pterygium were excluded. People whose optical biometry was not possible due to the advance stage of cataract were also excluded. None of the study patients had both eyes included in the analysis. All patients’ biometric measurements were taken in IOLMaster 700 and then on ANTERION before any drops were put in their eyes by a single optometrist. The following parameters of optical biometry were recorded in both the instruments: Steep K with its axis, Flat K, Sim K, central corneal thickness (CCT), aqueous depth (AQD), lens thickness (LT), axial length (AL), and white-to-white (WTW).

The IOL power of all patients was calculated by Barrett’s Universal II formula in both the machines and the IOL power, which was nearest to emmetropia on the myopic side, was implanted. The predictive postoperative refractive error was also noted in the master chart for the same IOL power as calculated by both machines. All patients were operated through a clear corneal 2 mm phaco incision on the steep axis and a hydrophobic IOL was implanted. They were reviewed at 1 week and 6 weeks after the surgery. On the sixth week follow-up, all parameters were once again measured in both the biometers and the patients were also refracted by an auto refractometer (Topcon KR 800). Both refractive acceptance and the spherical power obtained in the auto refractometer were also recorded. The difference between the predicted postoperative residual refraction by both machines and the spherical power obtained in the refraction was also calculated.

Results

Out of the 225 patients enrolled, 7 patients could not have their biometry done in both machines and from the rest 218 patients, 203 patients completed the 6-week follow-up and were considered for analysis of the results. All patients were between 45 and 78 years of age. The majority were in the age group of 51 to 60 years (31%) and 61 to 70 years (45.3%), and males were (56.2%) [Table 1].

Table 1: Age and gender distribution of cases

| Age in years | No. | %   |
|--------------|-----|-----|
| ≤50          | 20  | 9.9 |
| 51-60        | 63  | 31  |
| 61-70        | 92  | 45.3|
| ≥71          | 28  | 13.8|
| Gender       |     |     |
| Male         | 114 | 56.2|
| Female       | 89  | 43.8|
| Total        | 203 | 100 |

The objective of the paper was to analyze the agreement of the biometric parameters of the eye such as STEEP K, its axis, FLAT K, SIM K, CCT, aqueous depth (AQD), lens thickness (LT), axial length (AL), and white-to-white (WTW). The difference in the predicted spherical power to the actual postoperative spherical power is compared in Table 4 using the Kappa statistics. The differences in postoperative spherical value from the predicted refractive values of ANTERION
and IOLMaster 700 have been categorized into four classes: the difference between −1.9 D to −0.5 D, −0.5 D to 0.0 D, 0.0 D to +0.5 D, and +0.5 D to +1.9 D. A closer analysis of the bivariate classification in Table 4 revealed a lot of disagreement between the differences from predicted refraction observed between ANTERION and IOLMaster 700. In analyzing the difference in actual refraction from the predicted refraction from ANTERION, it was seen that 23.2% of patients had postoperative refraction within 0 to +0.5 D from the predicted refraction power and 25.6% of patients had postoperative refraction within 0 to −0.5 D from the predictive refraction. Thus, 48.8% had a difference within + or − 0.5 D from the predicted refractive outcome. In the case of IOLMaster 700, 28.1% had the refractive outcome difference within the range of 0 to +0.5 D and 28.6% in the range of 0 to −0.5 D from the predictive refraction. Thus, 56.7% have the difference within + or −0.5 D from the predicted refractive outcome. This indicated that IOLMaster 700 had a better prediction of postoperative residual refraction though it was not statistically significant. Similarly, 39.9% of patients had a hyperopic refractive outcome of more than +0.5 D when we compared postoperative spherical power with predicted refractive power by ANTERION as against 26.1% from predicted power by IOLMaster 700. Myopic postoperative refraction of more than −0.5D was seen in 11.3% of patients when we compared with the predictive power from ANTERION as against 17.2% from the predicted value from IOLMaster 700. Closely looking at the results, it appeared that the ANTERION predicted residual refraction errors more to the hypermetropic side (63.1%) than that of IOLMaster 700 (54.2%).

### Discussion

In this study, we have elucidated both aspects of the two swept source-based OCT devices, out of which IOLMaster 700 uses an equivalent refractive index, whereas ANTERION uses the segmental refractive index. [8,12]

Until date, from the perspective of biometric evaluation, the available research sources have demonstrated significant unanimity. However, there is still a deficiency of scientific studies pertaining to refractive sequelae. To the best of our knowledge, this study is the first of its kind to analyze the postoperative refractive outcomes of IOLMaster 700 and ANTERION.

Postoperative gratifying visual outcome devoid of any refractive surprise has now become the ultimate desire for every cataract patient. For this, optimal biometry is the prerequisite and with the increasing demand for toric and multifocal IOLs, it has even become more indispensable.

IOL master 700 and ANTERION are very well known for their repeatability, reproducibility, accuracy, and high data acquisition speed. [9,10] The specific advantage of ANTERION is that it incorporates SS-OCT with ray tracing technology to provide high-definition imagery of the anterior segment with the added benefit of utilizing the option of Barrett Universal II formula.

Even though the mean difference for steep K, flat K, and Sim K were similar between ANTERION and IOLMaster 700, with ICC agreement more than 0.9, the individual comparison of steep and flat K values also was found to be different by more

### Table 3: Difference of measured parameters in ANTERION and IOLMaster 700 beyond pre-defined clinically acceptable range

| Difference                  | Classification | No. | %    |
|-----------------------------|----------------|-----|------|
| ANTERION Steep K - IOLMaster 700 | >0.25 D        | 88  | 43.3 |
| Steep K                     | ≤0.25 D        | 115 | 56.7 |
| ANTERION Axis - IOLMaster 700 Axis | >10°           | 95  | 46.8 |
| ANTERION Flat K - IOLMaster 700 | >0.25 D        | 82  | 40.4 |
| FLAT                        | ≤0.25 D        | 121 | 59.6 |
| ANTERION SIM K - IOLMaster 700 | >0.25 D        | 65  | 32.1 |
| SIM K                       | ≤0.25 D        | 138 | 66.9 |
| ANTERION CCT - IOLMaster 700 CCT | >10 microns | 12  | 5.9  |
|                            | ≤10 microns    | 191 | 94.1 |
| ANTERION AOD - IOLMaster 700 AOD | >0.1 mm       | 21  | 10.3 |
| AOD                         | ≤0.1 mm        | 182 | 89.7 |
| ANTERION LT - IOLMaster 700 LT | >0.1 mm       | 48  | 23.6 |
| LT                          | ≤0.1 mm        | 155 | 76.4 |
| ANTERION AL - IOL Master 700 AL | >0.1 mm       | 9   | 4.4  |
| AL                          | ≤0.1 mm        | 194 | 95.6 |
| ANTERION WTW - IOLMaster 700 WTW | >0.1 mm     | 156 | 76.8 |
The higher wavelength of the light source ensures better photography of anterior segment structures because of its superb penetration through ocular tissue with trivial loss of optical signal.

ANTERION uses a longer wavelength (1300 nm) than IOLMaster 700 (1050 nm). RPE can also reflect back longer wavelength light pretty well, providing high-definition imagery.

In our study, we also obtained axial length measurements with the two machines that showed a significant resemblance in spite of different acquisition methods. IOLMaster 700 measures AL by the average values of three scans in each of the six meridians.[10] ANTERION obtains AL by averaging three consecutive subsets of data. The measured mean difference in the axial length was only $-0.02 \pm 0.09$ mm. However, several studies comparing ss-OCT devices and IOLMaster 500 with PCI technology have drawn controversial conclusions for these parameters. Some studies revealed a general agreement for this parameter, whereas others refuted it. A study conducted by Huang J et al.[14] revealed great unison between AL measurement values of the two machines. This is further supported by the earlier study conducted by Norrby S.[15] Our study has ended up with a similar outcome as concluded by Fişuş et al.[16] while comparing the two SS-OCT devices, Fişuş AD et al. finally obtained a similarity in AL measurement that was statistically significant with $P$ value $< 0.001$. In their study, the mean axial length was $23.55 \pm 1.18$ mm (range: $20.09–28.99$ mm) of IOLMaster 700 and $23.54 \pm 1.18$ mm (range: $20.10–29.19$ mm) of ANTERION, and the mean arithmetic difference between devices was $0.01 \pm 0.03$ mm. In our study, the AL measured in IOLMaster was $23.4 \pm 1.1$ and that in ANTERION was $23.4 \pm 1.2$, with a mean difference of $-0.02 \pm 0.09$ and a $P$ value of $0.001$. As a variation, an AL of $0.02$ mm would be clinically irrelevant and would produce a very negligible difference (less than $0.1$ D difference) in postoperative refractive errors the AL values of both machines can be interchangeable in IOL power calculation.[17]

The ANTERION measured marginally thinner CCT values ($525.0 \pm 31.6$) compared with the IOLMaster 700 ($526.33.0$). The $95\%$ LoA was narrow. This difference is not crucial for either IOL power calculation or glaucoma diagnosis and refractive surgery. The mean arithmetic difference between the two devices was only $1.48 \pm 5.73$ µm ($P$-value $< 0.05$). Similar results were also obtained by previous comparative studies.[16-18]

With the ANTERION, the mean ACD was $2.8 \pm 0.4$ mm, and with the IOLMaster 700 it was $2.7 \pm 0.4$ mm. Even with this parameter of biometry, the similarity between these two devices was statistically significant. The mean LT with the ANTERION and the IOLMaster 700 was almost the same ($4.4 \pm 0.4$ mm) and the similarity was statistically significant. Previous studies have revealed that an increase of $0.2$ mm in LT produces approximately $0.20$ D alternation in the final IOL power calculation.[14] The mean arithmetic difference between the devices was $0.08 \pm 0.12$ mm. In our study, $23.6\%$ of patients had an LT measurement difference of greater than $0.1$ mm and none greater than $0.2$ D. Similar comparative studies have shown a good agreement for this parameter measurement.[16,18] Though the mean WTW measures between both biometers were comparable, WTW measured by ANTERION was longer by more than $0.1$ mm than that measured by IOLMaster 700 device in $76.8\%$ of cases. This difference may be accredited to the varying measurement techniques of each device. Although IOLMaster 700 estimates WTW from the corneal contour in a camera-based image, ANTERION relies on the endpoint of the posterior cornea (Schwalbe’s line) in the SS-OCT image for measuring the value.

As far as the postoperative residual refractive outcome is concerned, the predicted refractive error (PE) was more with ANTERION ($56.7\%$ had residual sphere more than $\pm 0.5$ D) than IOL master 700 ($48.8\%$). In our study, we got a better prediction of postoperative refractive outcome with IOLMaster 700 than ANTERION even though it was not statistically significant. The median arithmetic prediction errors (PEs) were closer to zero with the IOLMaster 700 than with the ANTERION and the trend of residual refractive error shifting to the hyperopic side was more pronounced with ANTERION. This can be attributed to the difference in the measured keratometric values between these two devices.

As a general consideration, the formula used for the calculation of IOL power may have a clinically significant influence. If a formula considers more variables and they have been found different between devices, it is more likely
to produce differences in the IOL powering as we have used Barrett universal II formula, which takes into account many more parameters than the conventional formula. It might be responsible for producing the difference in PE between the two devices.

The present study has some pitfalls. First, although the variation and agreement of the biometric parameters between two devices have been analyzed in this study, the segregation and evaluation for short eyes (<22 mm) and long eyes (>26 mm) were not done. Second, we have not taken into account different grades of nuclear sclerosis. For ANTERION, the segmental refractive index of the lens has been defined as 1.408 D; however, the refractive index of the lens is subjected to change depending on advancement nuclear sclerosis although we have excluded very advanced stages of cataract. This factor requires further research work. Finally, all included patients had cataract as we were interested to look into the refractive outcome and compare it to the predicted postoperative refraction by the biometers. Because different grades of cataracts can alter optical physics during measurements, there might be some biases. Further research with normal eyes will provide more precise information about the agreements between these devices.

Conclusion
In conclusion, most of the biometric parameters were statistically in agreement in both the biometers as measured by ICC, except the measured axis of the steep K was not comparable. However, clinically, the keratometric values, their axis, and WTW were not in agreement and therefore this measurement cannot be used interchangeably. But rest of the measurements of the parameters showed excellent agreement and repeatability for the two devices as substantiated in previous studies and seem to be interchangeable. The postoperative refractive outcomes of ANTERION are in a moderate degree of agreement with those of the IOLMaster 700, both of which were clinically acceptable. The refractive outcomes of ANTERION showed a mild hyperopic trend perhaps as it uses a segmental refractive index for biometric measurement and we did not compare the biometric parameters based on the grades of cataract.

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Conflicts of interest
There are no conflicts of interest.

References
1. Hirnschall N, Varsits R, Doeller B, Findl O. Enhanced penetration for axial length measurement of eyes with dense cataracts using swept source optical coherence tomography: A consecutive observational study. Ophthalmol Ther 2018;7:119-24.
2. Srivannaboon S, Chirapapaian C, Chompimai P, Loket S. Clinical comparison of a new swept-source optical coherence tomography-based optical biometer and a time-domain optical coherence tomography-based optical biometer. J Cataract Refract Surg 2015;41:2224-32.
3. Shammas HJ, Ortiz S, Shammas MC, Kim SH, Chong C. Biometry measurements using a new large-coherence-length swept-source optical coherence tomographer. J Cataract Refract Surg 2016;42:50-61.
4. Chirapapaian C, Srivannaboon S, Chompimai P. Efficacy of swept-source optical coherence tomography in axial length measurement for advanced cataracts. Optom Vis Sci 2020;97:186-91.
5. Yang CM, Lim DH, Kim HJ, Chung TY. Comparison of two swept-source optical coherence tomography biometers and a partial coherence interferometer. PLoS One 2019;14:e0223114.
6. Kim KY, Choi GS, Kang MS, Kim US. Comparison study of the axial length measured using the new swept-source optical coherence tomography ANTERION and the partial coherence interferometry IOL Master. PLoS One 2020;15:e0244590.
7. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med 2016;15:155-63.
8. McHugh ML. Interrater reliability: The Kappa statistic. Biochem Med (Zagreb) 2012;22:276-82.
9. Omoto MK, Torii H, Masui S, Ayaki M, Tsubota K, Negishi K. Ocular biometry and refractive outcomes using two swept-source optical coherence tomography-based biometers with segmental or equivalent refractive indices. Sci Rep 2019;9:65575.
10. Tamaoki A, Kojima T, Hasegawa A, Yamamoto M, Kaga T, Tanaka K, et al. Clinical evaluation of a new swept-source optical coherence biometer that uses individual refractive indices to measure axial length in cataract patients. Ophthalmic Res 2019;62:11-23.
11. Akman A, Asena L, Gungör SC. Evaluation and comparison of the new swept source OCT-based IOLMaster 700 with the IOLMaster 500. Br J Ophthalmol 2016;100:1201-5.
12. Shetty N, Kaferi L, Koshy A, Shetty R, Nuijts RMMA, Sinha Roy A. Repeatability of biometry measured by three devices and its impact on predicted intraocular lens power. J Cataract Refract Surg 2021;47:585-92.
13. Schiano-Lomoriello D, Hoffer KJ, Abicca I, Savini G. Repeatability of automated measurements by a new anterior segment optical coherence tomographer and biometer and agreement with standard devices. Sci Rep 2021;11:983.
14. Huang J, Chen H, Li Y, Chen Z, Gao R, Yu J, et al. Comprehensive comparison of axial length measurement with three swept-source OCT-based biometers and partial coherence interferometry. J Refract Surg 2019;35:115-20.
15. Norrbjörk S. Sources of error in intraocular lens power calculation. J Cataract Refract Surg 2008;34:368-76.
16. Fişuş AD, Hirnschall ND, Findl O. Comparison of 2 swept-source optical coherence tomography-based biometry devices. J Cataract Refract Surg 2021;47:87-92.
17. Eibschitz-Tsimhoni M, Tsimhoni O, Archer SM, Del Monte MA. Effect of axial length and keratometry measurement error on intraocular lens implant power prediction formulas in pediatric patients. J AAPOS 2008;12:173-6.
18. Oh R, Oh JY, Choi HJ, Kim MK, Yoon CH. Comparison of ocular biometric measurements in patients with cataract using three swept-source optical coherence tomography devices. BMC Ophthalmol 2021;21:62.
19. Montés-Micó R, Pastor-Pascual F, Ruiz-Mesa R, Tañá-Rivero P. Ocular biometry with swept-source optical coherence tomography. J Cataract Refract Surg 2021;47:802-14.