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Original Article

Comparison of Biometry and Intraocular Lens Power Between Two Different Optical Biometers

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ABSTRACT

Objective: To compare refractive results after cataract surgery using AL-Scan and IOL-Master500 optical biometers for intraocular lens power calculation.

Methods: 78 eyes of 78 consecutive patients undergoing cataract surgery and implanted with the same intraocular lens (Eyecryl Plus HSAS600) were included in the study. In Group 1, preoperative biometry was performed with AL-Scan, and in Group 2, with IOL Master 500. Uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), and mean absolute refractive error (MARE) at preoperative and 6-month follow-up visits were recorded.

Results: The postoperative mean MARE was -0.28±0.30 Diopter (D) and –0.32±1.13 D in Groups 1 and 2, respectively (p=0.38). At the 6th month visit, 92% of eyes in Group 1 were within 0.50 D of target refraction in Group 1 and, 93% of eyes in Group 2 were within 0.50 D (p=0.99). Uncorrected and corrected distance visual acuity improved significantly in both groups (p<0.001). The mean postoperative UDVA were 0.72±0.12 and 0.66±0.16 in Groups 1 and 2, respectively (p=0.20). No sight-threatening complication occurred during or after the operation in either group.

Conclusion: These findings show the AL – Scan provides comparable postoperative results with the IOL Master after implantation of the same intraocular lenses.

INTRODUCTION

Accurate intraocular lens (IOL) calculation is critical for achieving the desired refractive outcome after cataract surgery. The axial length (AL), keratometry (K), and anterior chamber depth (ACD) are the main parameters for formulas calculating the necessary IOL power. Ultrasound has been the gold standard for measuring the AL of the eye for many years. However, the A-scan ultrasound scan is limited by poor image resolution because of the use of a relatively long, low-resolution wavelength (10 MHz) to measure a relatively short distance.[1] The non-contact optical biometers are the new gold standard due to their significantly higher resolution, better patient comfort, and greater acceptability.[2] The IOL Master V.5 (Carl Zeiss Meditec AG, Jena, Germany) was the first device to combine accurate partial coherence interferometry technology for AL measurements with automated keratometry and ACD measurements using slit illumination.[3] Several studies have reported the accuracy of IOL Master 500 for IOL calculation.[4–6] The AL-Scan (Nidek Co., Ltd.) is another relatively new optical biometry on the market. The device measures 6 variables, including the K value, AL, ACD, white-to-white (WTW) corneal diameter, pupil size, and central corneal thickness (CCT).[7]

In this study, we aimed to compare postoperative results obtained after cataract surgery in eyes with i the same IOL implantation using the AL-Scan optical biometer and the IOL Master 500 optical biometer to calculate IOL power.

MATERIALS AND METHODS

This comparative, retrospective study was conducted in compliance with the principles of the Declaration of Hel-

sinki. Ethics Committee approval was obtained from the Local Ethical Committee (Decision date: December 27, 2016, Decision number: 2016/514/98/7). All patients operated on by the same surgeon (AKA) and implanted with the same IOL (HSAS600 Eyecryl Plus) were retrospectively reviewed. Patients with a 6-month follow-up were included in the study. Exclusion criteria were a history of diabetes, pre-existing corneal or retinal pathology, previous ocular surgery, and astigmatic refractive error greater than 1.5 D (Diopter). Patients with missing data were also excluded.

Standard preoperative examinations were performed in all patients in the following order: measurement of the mean absolute refractive error (MARE), UDVA and CDVA, slit-lamp biomicroscopy, intraocular pressure (IOP) measurement via Goldmann applanation tonometry, and dilated fundus examination. Data from preoperative and postoperative assessments of patients implanted IOL (HSAS600 Eyecryl Plus) were collected from electronic medical records and analyzed.

Postoperative data collected at 6-month visits included MARE, UDVA and CDVA. Any adverse effects or complications observed by the investigator or reported by the patients were noted.

Optical biometry

The IOL Master is a partial coherence interferometer (PCI) operating at a wavelength of 780 nm to measure the axial length of the eye. It measures keratometry by projecting six light spots hexagonally onto the cornea (at a radius of 2.3 mm) and measuring the separation of the opposite pairs.[8] The AL-Scan also uses a PCI technique, to measure the AL of the eye, and its operation is based on PCI at a wavelength of 830 nm. It calculates two pairs of keratometry by analyzing the images of two mires of spots over 2.4 mm and 3.3 mm diameter areas, respectively.[9]

All measurements were made by the same practitioner with IOL Master or AL-Scan. The IOL power was calculated with the SRK-T formula (A-constant: 118.5) in eyes with an axial length (AL) of 22 mm to 24 mm. The Hoffer Q formula (pACD=5.61) was used in eyes with a shorter AL (<22 mm) and the Holladay 2 formula (ACD constant=5.607) was used in eyes with a longer AL (>24mm). Intraocular Lens

The HSAS600 Eyecryl Plus IOL is a single piece, modified hydrophobic surface with a 360° square edge hydrophilic acrylic IOL with aberration-free aspheric optics. The IOL has an overall size of 12.5 mm and an optic size of 6 mm. The IOL is supplied in diopters of +5.0 to +30.0 D (with 0.5 D steps from +15.0 D to +25.0 D).

Statistical analysis

The statistical analysis was performed using Statistica (Version 12, Dell Systems, USA). The data for all variables were analyzed for normality using a probability plot and a formal test of statistical significance using the Schapiro-Wilk test. The two groups were compared for normal and non-normal data using the Student's T-test and Mann-Whitney-U test, respectively. Statistical significance was set at $p \leq 0.05$ in all cases.

RESULTS

Seventy-eight eyes of 78 patients were included in the analysis. The study population consisted of 36 men and 42 women with an average age of 60.25 years (range: 46–80 years). Optical biometry measurements were performed on 39 eyes using AL-Scan and 39 eyes using IOL Master 500. The mean IOL power was 21.62±1.70 D in the AL-Scan Group and 21.37±1.93 D in IOL Master 500 Group.

The mean AL was 21.54 mm in the AL-Scan Group and 21.84 mm in the IOL Master group (p=0.339). Figure 1 shows the distribution of AL in both groups and Table 1 compares AL, simulated keratometry (Sim-K) readings, and ACD data of patients. There were no statistically significant differences between the parameters measured by the two devices.

The preoperative and postoperative refraction and visual acuities are listed in Table 2. There was no statistically significant difference in MARE preoperatively and postoperatively between the groups. At the 6th month visit, 92% of eyes in the AL – Screening Group were within 0.50 D of target refraction and 93% in the IOL Major Group (p>0.05 Regarding CDVA, there was a significant improvement of four lines on average from the preoperative visit in both groups (p<0.0001).

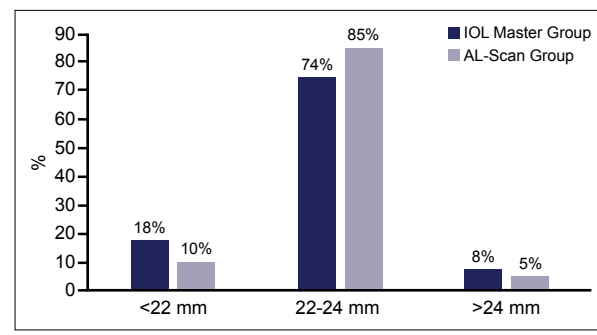

Figure 1. Distribution of axial length in the study groups.

Table 1. Comparison of parameters measured by the two biometry devices

	AL-Scan Group (n=39)	IOL Master Group (n=39)	p-value
AL (mm)	22.77±0.75	25.93±0.92	0.339
Sim-K flat (D)	45.28±2.84	43.72±1.88	0.006
Sim-K steep (D)	44.89±2.91	44.90±2.26	0.97
ACD (mm)	3.87±0.87	3.90±0.91	0.87

Data are presented with mean±standard deviation. AL: Axial length; ACD: Anterior chamber depth; D: Diopter; Sim-K: Simulated keratometry.

Table 2. Comparison of MAREs and visual acuities between two groups

	AL-Scan Group	IOL Master Group	p-value
Preoperative MARE (D)	-2.55±1.60	-2.63±2.33	0.81
Postoperative MARE (D)	-0.28±0.30	-0.32±1.13	0.38
Preoperative UDVA	0.27±0.13	0.31±0.13	0.20
Postoperative UDVA	0.73±0.12	0.66±0.16	0.04
Preoperative CDVA	0.27±0.13	0.31±0.13	0.20
Postoperative CDVA	0.85±0.11	0.88±0.18	0.24

Data are presented with mean±standard deviation. CDVA: Corrected distance visual acuity; D: Diopter; MARE: Manifest refraction spherical equivalent; UDVA: Uncorrected distance visual acuity.

No adverse events, intraoperative or postoperative complications requiring additional intervention or treatment were reported in either group.

DISCUSSION

With the advancement of cataract surgery, IOL calculation methods, and IOL technologies, patients have higher visual expectations. IOL power calculation is the most important issue in determining the IOL power in patients with a demand for emmetropia. In this study, we aimed to compare the refractive and visual outcomes obtained after cataract surgery using two optical biometry devices for the same IOL done by the same surgeon. Our results suggested that the refractive outcomes were good in both groups. A significant reduction in preoperative MARE was observed in both biometers groups at the sixth-month visit.

There are some studies that determine the optimal refractive target after cataract surgery. Gale et al.[10] have set the refractive benchmark more than 55% within ±0.50 D whereas Hahn et al.[10] have set it more than 80% within ±0.50 D. The refractive results in both groups are comparable with these results and benchmarks. These refractive outcomes can be obtained by optical axial length measurement, appropriate formula selection, and optimization of IOL constants. In our study, 92% of the AL- Scan group eyes were within 0.50 D of target refraction and 98% were within 1.00 D. Ninety-three percent of the IOL Master group eyes were within 0.50 D of target refraction and 97% were within 1.00 D. No difference was observed between the two biometers.

A previous meta-analysis revealed that the between biometric devices and reported the threshold to evaluate the clinical equivalence of measurements provided by ophthalmic biometry devices. They found that the threshold on the AL and ACD to change the IOL power on 0.125 D was 0.037 and 0.300 mm, respectively.[12] In addition, Ha et al.[13] assessed the agreement in AL, K, and ACD measurements between AL-Scan and IOL Master and concluded that the refractive outcomes of implanted eyes with the same IOL by AL-Scan calculated using SRK/T can show a slight tendency towards myopic. Akkaya et al.[14] evaluated the accuracy of the biometric measurements for intraocular lens power calculations obtained by an optical low-coherence reflectometry biometer and an immersion ultrasound biometry, and found that there was a high correlation between biometric measurements and IOL power calculations. In this study, we did not find a myopic tendency in the AL-Scan group. To our knowledge, the refractive outcomes of AL-Scan and IOL Master have not been compared in the Eyecryl Plus HSAS600 IOL implanted eyes. Similarly, Srivannaboon et al.[7] compared the AL, K, ACD and WTW corneal diameter and IOL power calculated with Holladay 1 formula using AL-Scan and IOL master 500, and found that all measurements, except the WTW were comparable between two the devices but the IOL Master was better in the corneal diameter measurements. These results may be related to the wavelength of light used by biometry devices and the infrared light used in IOL Master system might be a better choice for the WTW corneal diameter measurement. But in our study, we did not evaluate the WTW corneal diameter measurement.

Another important issue is the ACD measurement. There are studies that use the same biometry devices like ours. They found that AL Scan had slightly better repeatability and reproducibility than IOL Master 500.[9,15] This finding could be the result of the Scheimpflug image principle used for the ACD measurement by the AL Scan; the IOL Master 500 uses a scanning-slit image. The measurement from the Scheimpflug image has been shown to have better repeatability than slit imaging, ultrasound biomicroscopy, and magnetic resonance imaging. Similarly, we found no statistically significant differences in ACD measurements between two optical biometry devices in our study.

Accurate preoperative IOL power calculations are essential to achieve the desired refractive outcomes after cataract surgery. In our study, there was no significant difference between the AL-Scan and IOL Master in calculating IOL power, when 2.4 mm diameter was used. However, compared to the IOL Master, the AL-Scan produced slightly higher IOL power calculation readings (by 0.24–0.31 D) when using the 3.3 mm diameter. The distribution of the IOL powers for all formulas is shown for diameters of 2.4 mm and 3.3 mm, respectively. Overall, the accord between the two devices was higher when the 2.4 mm was chosen instead of 3.3 mm in the AL-Scan to measure K.

Newer optical laser systems based on different technologies have been developed for ocular biometry measurement. Chan et al.[16] compared the repeatability and agreement between AL-Scan and IOL Master 700 and they found statistically significant differences in anterior segment measurement repeatability and agreement between these two biometers. However, they concluded that the differences in the prediction of intraocular lens power were clinically insignificant. Ortiz et al.[17] found no clinically significant differences in AL, mean K, and

ACD measurements among 3 different biometers including IOL Master 500. Recently, an optical biometer using swept-source optical coherence tomography (SS-OCT), i.e., the IOL Master 700 (Carl Zeiss Meditec) or ARGOS (Movu, Aichi) has been using for accurate determination of IOL powers and other measurements. Villalobos et al.[18] revealed that no clinical differences were detected between the swept source optical coherence tomography biometer (IOL Master 700) and optic biometer (Lenstar 900) in terms of their measurements and IOL power predictions, but it was easier to obtain biometric measurements in eyes with dense cataract or longer AL with IOL Master 700. In the light of all these recent studies, our results are comparable and compatible with these new studies.

We found that UDVA and CDVA improved significantly in both groups. That was the expected finding as both groups had cataracts preoperatively. Although postoperative UDVA was similar, postoperative CDVA was slightly better in Group 1, close to the cut-off value of statistical significance. Slight differences in UDVA and CDVA among groups were observed. These results might be related to the the wavelength of AL-SCAN. It is known that IOL Master 500 device uses 780 nm laser diode infrared light while AL-SCAN device uses 830 nm laser diode infrared light. Therefore, long-wavelength optical biometers might be a better choice for postoperative visual acuity due to their penetration ability and might provide better results in denser cataracts.

The limitations of this study are its retrospective design. Also, we did not assess inter-operator reproducibility, intra-operator repeatability, and correlation analyses. Lastly, we did not show the distribution of IOL power for all formulas. In a prospective study, it would be possible to measure the same patients with both devices. Because of the retrospective nature of the study, we compared two groups of different cataract patients. However, the groups were not different in terms of Axial length and mean keratometry, which are the parameters used in IOL calculation. Also, all patients were operated on by the same surgeon and the same IOL was implanted in all eyes. As these parameters matched, it was still possible to compare both groups.

CONCLUSION

We found that the refractive and visual outcomes obtained after cataract surgery using IOL Master 500 or the AL-Scan were comparable in eyes implanted with Eyecryl Plus HSAS600 IOL. The refractive results after IOL Master 500 implantation and AL-Scan calculated Eyecryl Plus HSAS600 implantation were comparable to benchmarks for current cataract surgery. However, prospectively designed studies are needed to describe the precise quantification (even if not clinically significant) and its direction (myopic or hypermetropic) difference in IOL power predicted by these two biometers for a given IOL.

Ethics Committee Approval

This study approved by the Kartal Dr. Lutfi Kirdar City Hospital Clinical Research Ethics Committee (Date: 27.12.2016, Decision No: 2016/514/98/7).

Informed Consent

Retrospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: A.A.; Design: A.A., S.A.K.; Supervision: A.A.; Materials: H.S.K., M.O., U.K.; Data: H.S.K.; Analysis: H.S.K.; Literature search: H.S.K., M.O., U.K.; Writing: H.S.K., U.K.; Critical revision: A.A.

Conflict of Interest

None declared.

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İki Farklı Optik Biyometri Cihazının Biyometri ve Göz İçi Lens Gücü Sonuçlarının Karşılaştırılması

Amaç: Göz içi lens gücü hesaplaması için AL-Scan ve IOL-Master 500 optik biyometrileri kullanarak, katarakt cerrahisi sonrası refraktif sonuçları karşılaştırmak.

Gereç ve Yöntem: Çalışmaya katarakt ameliyatı geçiren ve aynı göz içi lensi (Eyecryl Plus HSAS600) implante edilen 78 ardışık hastanın 78 gözü dahil edildi. Grup 1'de ameliyat öncesi biyometri AL-Scan ile ve Grup 2'de IOL Master 500 ile yapıldı. Ameliyat öncesi ve sonrası altıncı ayda düzeltilmemiş uzak görme keskinliği, düzeltilmiş uzak görme keskinliği ve manifest sferik kırılma kusuru (MSRE) değerlendirilmeleri yapıldı.

Bulgular: Ortalama ameliyat sonrası manifesr sferik refraktif kusur, grup 1 ve 2'de sırasıyla -0.28±0.30 Diyoptri (D) ve -0.32±1.13 D olarak saptandı (p=0.38). Ameliyat sonrası altıncı ay vizitinde, Grup 1'de gözlerin %92'si hedef refraksiyonun 0.50 D içindeydi ve Grup 2'de %93'ü 0.50 D içindeydi (p=0.99). Düzeltilmemiş ve düzeltilmiş uzak görme keskinliği her iki grupta da anlamlı olarak arttı (p<0.001). Ortalama ameliyat sonrası düzeltilmemiş uzak görme keskinliği, grup 1 ve 2'de sırasıyla 0.72±0.12 ve 0.66±0.16 olarak bulundu (p=0.20). Her iki grupta da ameliyat sırasında ve sonrasında görmeyi tehdit eden bir komplikasyon gelişmedi.

Sonuç: Bu bulgular, AL-Scan biyometri cihazının, aynı göz içi lenslerin implantasyonundan sonra IOL Master ile karşılaştırılabilir ameliyat sonrası sonuçlar sağladığını göstermektedir.

Anahtar Sözcükler: Katarakt cerrahisi; optik biyometri; refraktif kusur; refraktif sonuçlar.