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Comparison of Biometric Measurements and Intraocular Lens Power Calculation Measured by Dual Scheimpflug-Based and Partial Coherence Interferometry-Based Optic Biometers

Parsiyel Koherens İnterferometri ve Çift Scheimflug Tabanlı İki Ayrı Biometri ile Ölçülen Göz İçi Lens Sonuçlarının Karşılaştırılması

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ABSTRACT Objective: To compare the biometric values measured by Dual Scheimpflug-based and partial coherence interferometry-based optic biometers and to evaluate the intraocular lens (IOL) power calculations performed by using different formulas including SRK-2, SRK-T, Holladay 1 and Hoffer Q. **Material and Methods:** Patients who applied to our clinic with visual impairment and diagnosed as senil cataract were recruited in the current study. After detailed ophthalmologic examination, biometric measurements including mean anterior chamber depth (ACD), axial length (AL) and keratometric parameters (K1, K2) were performed by using the Galilei G6 Dual Scheimpflug Analyzer and IOL Master 500. The IOL power (Sensar AAB00 hydrophobic acrylic IOL AMO) calculations targeting emmetropia were performed by using SRK-2, SRK-T, Holladay 1 and Hoffer Q formulas with the two devices. These parameters were compared with statistical analysis. **Results:** One hundred and six eyes of 94 patients with nuclear sclerosis were recruited. The mean age of patients (40 female, 54 male) was 67.44±8.99 years. The value of K1 was found to be statistically higher in measurement performed by IOL Master 500 ($p<0.001$). The IOL power was calculated statistically higher with all formulas measured by IOL Master 500 ($p<0.001$). **Conclusion:** The mean ACD, AL and K2 values did not differ between the two devices. Average K and K1 parameter was measured higher when measured with IOL Master 500. The mean IOL power was calculated statistically significantly different between these two devices.

Keywords: Biometry; intraocular lens implantation; cataract

ÖZET Amaç: Çift Scheimflug analizatörü ve parsiyel koherens interferometri, optik biometri ile göz içi lensinin (GİL) SRK-2, SRK-T, Holladay-1 ve Hoffer Q formülleri ile ölçümlerinin karşılaştırılması amaçlandı. **Gereç ve Yöntemler:** Kliniğimize görme azlığı şikâyeti ile gelen ve senil nükleer katarakt tanısı konulan hastalar çalışmaya dâhil edildi. Hastalara ayrıntılı oftalmolojik muayene sonrası, Gallilei G6 çift Scheimflug analizörü ve İOL Master 500 parsiyel koherens interferometri optik biometri ile ön kamara derinliği (ÖKD), aksiyel uzunluk (AU), keratometrik parametreler (K1, K2), SRK-2, SRK-T, Holladay-1 ve Hoffer Q formülleri ile GİL ölçümleri (Sensar AAB00 hidrofobik akrilik GİL AMO) postoperatif emetropi hedeflenerek ölçüldü ve istatistiksel analiz yapıldı. **Bulgular:** Kırk kadın, 54 erkek; 94 senil nükleer katarakt hastasının, 106 gözü çalışmaya alındı. Hastanın yaş ortalaması 67,44±8,99 idi. Ortalama K1 değeri İOL Master 500 parsiyel koherens interferometri optik biometri ile istatistiksel olarak daha yüksek bulundu. ($p<0,001$). Ortalama GİL ölçüm sonuçları, İOL Master 500 parsiyel koherens interferometri optik biometri ile istatistiksel olarak daha yüksek bulundu. ($p<0,001$). **Sonuç:** Ortalama ÖKD, AU ve K2 değerleri bakımından 2 ölçüm arasında fark yoktu. Ortalama K1 değeri İOL Master 500 parsiyel koherens interferometri optik biometri ile istatistiksel olarak daha yüksek bulundu. İki cihaz arasında, göz içi mercek ölçümleri arasında tüm formüllerde farklılık mevcuttur.

Anahtar Kelimeler: Biometri; intraoküler lens implantasyonu; katarakt

Optical biometry is an important component of pre-cataract surgery planning. Accurate and reproducible biometric measurements are very important to achieve refractive error accuracy and to minimize postoperative refractive errors. For decades, contact biometric methods were used and accepted as gold standard. In this type of biometry, corneal indentation may cause errors and may lead to transmission of infections.[1] The non-contact, optical biometric methods have became more popular because of axial length (AL) and anterior chamber depth (ACD) calculations.[2] Although new generation biometrics devices have de-

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veloped new software compared to traditional devices, it is not clear which biometric device gives the most ideal result. One of the first developed partial coherence interferometry-based instrument was IOL Master 500 (Carl Zeiss Meditec, Jena, Germany).

Because of the increasing incidence of premium intraocular lens (IOL) implantation and cataract surgery in postrefractive eyes, posterior corneal curvature measurements and the evaluation of irregular astigmatism have become crucial.[3] New devices which are based on Schiempflug camera has begun to use for optical biometry.[4,5] One of these devices is the Galilei G6 Lens professional (Ziemer Ophthalmic Systems AG, Port, Switzerland). A dual rotating Scheimpflug camera is an optical biometry device that combines a placido disc topograph and an A scan-based on optical coherence tomography. Galilei G6 can calculate IOL power by combining biometric and anterior segment calculations. Ventura et al. compared the IOL and biometric measurement results of IOL Master 500 and Galilei G6 devices using the Haigis formula. They found that these 2 devices were comparable in terms of the mean IOL power, AL, ACD and keratometry measurements.[6] The purpose of this study is to compare ACD, AL and keratometric values measured with IOL Master 500 and Galilei G6 and to evaluate IOL calculations using different formulas such as SRK-2, SRK-T, Holladay 1 and Hoffer Q.

MATERIAL AND METHODS

This study was conducted with the approval of the Sakarya University Medical Faculty Scientific Research Ethics Committee (26.01.2018, 71522473/050.01). The study was carried out in compliance with the requirements of the Declaration of Helsinki, patients who applied to our clinic with visual impairment and diagnosed as senil cataract were recruited in the current study. The exclusion criteria were presence of corneal diseases, complicated cataracts, previous ocular trauma, retinal diseases which may affect biometric measurements such as degenerative myopia, extreme long and short eyes. Besides, patients with diseases which decreased the quality of measurements such as severe ocular surface disease and dense cataracts were not included. Including best corrected visual acuity with Snellen chart, intraocular pressure measurements with Goldmann aplanation tonometer, slit lamp biomicroscopy and fundus imaging with +90 diopter lens in all patients.

Ophthalmological examination was performed. Biometric measurements were performed at different visits using Galilei G6 Dual Scheimpflug Analyzer and IOL Master 500. Measurements were made by the same ophthalmologist (S.O.) with undiluted students under scotopic conditions. Poor quality measurements were excluded and average values of three measurements were used for statistical analysis. The keratometric findings including average K, K1, K2, AL and ACD which were measured by the two devices were noted. The IOL power (Sensar AAB00 hydrophobic acrylic IOL, AMO) calculations targeting emmetropia were performed by using SRK-2, SRK-T, Holladay 1, Hoffer Q formulas with the two devices. The IOL Master 500 device is an optical biometer with 780 nm diode infrared light. It measures the ACD, with lateral slit illumination, uses calculation from six points in a 2.3 mm diameter area for keratometry measurement.[2] The Galilei G6 Dual Scheimpflug Analyzer is a new generation optical biometer that combines a dual rotating Scheimpflug camera, Placido disc topograph and Y-based optical coherence tomography Y-based optical A scanning. The illumination wavelength is an ultraviolet-free blue light-emitting diode (LED) 470 nm for Scheimpflug images, near-infrared LED 750 nm for Placido images, and 880 nm for optical biometry. Anterior simulated keratometry (SimK) values are calculated from the 0.5-2.0 mm circular (semi-strip) region and represented as diopters using a refractive index of 1.3375.

The Galilei G6 conducts a corneal topography scan followed by two-step biometry scans; it includes three scans of the anterior part (from the cornea to the crystalline lens) and three scans of the posterior retina. Galilei G6 uses A-scan parameters and sim k values for IOL power calculation.[5] Measurements with two devices were compared statistically. SPSS for Windows version 23.0 was used for statistical analysis. (SPSS Inc., Chicago, IL, USA). All data are reported as mean±standard deviation. Normality was determined by Kolmogorov-Smirnov test for the distribution of variables. Pearson's test was used to determine the relationship between variables. Bonferroni correction was used for multiple comparisons. p<0.05 value was determined as significant value.

RESULTS

In the current study, 106 eyes of 94 patients with nuclear sclerosis were recruited. The mean age of patients (40 female, 54 male) was 67.44±8.99 years.

Table 1 revealed the results of average K, K1, K2, ACD and AL measurements performed by IOL Master 500 and Galilei G6. The value of average K and K1 were found to be statistically higher in measurement done by IOL Master 500 (p=0.09, p<0.001, respectively). Table 2 revealed the IOL powers calculated with different formulas (SRK-2, SRK-T, Hoffer Q, Holladay 1) performed by IOL Master 500 and Galilei G6. The IOL power was calculated statistically higher with all formulas measured by IOL Master 500 (p<0.001).

DISCUSSION

In this study, we purposed to compare the ACD, AL and keratometric values measured with a reference device (IOL Master 500) and a new device (Galilei G6). The average AL was not found different between measurements with different devices. Shajari et al. compared keratometry values between IOL Master 500 and the other Schiempflug-based optical biometry device and did not find any differences.[7] On the other hand, Muzyka-Woźniak et al. found difference between these devices in terms of keratometry.[3] In this study, no difference was found between the two devices in terms of AL. Ventura et al. also found a strong positive correlation between these devices in AL measurements.[6] Muzyka-Woźniak et al. compared the AL measurements between IOL Master and another Schiempflug-based optical biometry device and found difference between measurements.[3] Shajari et al. found a minimal difference in AL measurements, although it was not statistically significant.[7] Polat et al. compared another dual Scheimpflug-based device and Aladdin optical biometer and found no difference in AL measurements.[8] Other studies which compared AL measurements between IOL Master 500 and Lenstar LS 900 devices, reported different findings.[9-11] Shin et al. found a statistically significant difference in AL values between Galilei G6 and Lenstar devices.[12] The characteristics of patients, sample size and refractive variations might cause these alterations of the results.

While lateral slit illumination has been used for measuring ACD value in IOL Master 500 device, Scheimpflug system has been used in Galilei G6. In this study, a statistically significant difference was not found in terms of ACD values between these two devices. Ventura et al. also did not find a difference.[6] Other studies which compared biometric measurements with new optical biometers also reported strong agreement between these devices.[7,8,13,14]

The mean IOL powers calculated by using SRK-2, SRK-T, Holladay 1 and Hoffer Q formulas with Galilei G6 and IOL Master 500 devices were different in the current study. The source of this difference was keratometric value, K1.

Recent studies about optical biometer measurements has focused on the assessment of swept-source optical corneal tomography and comparison of measurements between these devices and IOL Master 500, Scheimpflug-based devices.[15-18] Shajari et al. compared Pentacam AXL, IOL Master 500 and IOL Master 700 and found no differences in terms of AL and ACD parameters.[7]

The refraction after cataract surgery was the most important factor which can be affected by biometric measurements. Savini et al. reported postoperative refraction results in their study.[19] They performed cataract surgery after IOL measurement with Gallilei G6 on 15 patients, and they reached

TABLE 1: Comparison of K1, K2, ACD and AL between IOL Master and Galilei G6 groups.

	IOL Master 500 group	Galilei G6 group	p value
K1 (diopter)	43.56±1.97	43.15±1.97	<0.001
K2 (diopter)	44.04±1.94	44.12±2.37	0.63
K (Average)	44.06±0.19	43.35±1.92	0.09
ACD (mm)	3.21±0.50	3.27±0.49	0.19
AL (mm)	23.39±1.2	23.37±1.2	0.68

ACD: Anterior chamber depth; AL: Axial length; IOL: Intraocular lens.

TABLE 2: Comparison of IOL measurements with different formulas between IOL Master and Galilei G6 groups.

IOL formulas (diopter)	IOL Master 500 group	Galilei G6 group	p value
SRK-2	21.54±2.15	20.81±2.46	<0.001
SRK-T	21.50±2.25	20.71±2.38	<0.001
Hoffer Q	21.56±2.33	21.01±2.51	<0.001
Holladay 1	21.45±2.35	20.69±2.34	<0.001

IOL: Intraocular lens.

postoperative refraction values of 0.5 diopters and below in 75% of the patients. In our study, we aimed to compare the keratometric values, AL and ACD parameters between refrence device and a new one.

The most important deficiency in this study is the patients' lack of refractive status after surgery and the possible difference due to the IOL power calculation. Extremely short and long eyes were excluded, so the results might be altered.

CONCLUSION

In conclusion, the comparison of biometric parameters between IOL Master 500 and Galilei G6 devices were assessed in this study. The mean ACD, AL and K2 values did not differ between the two devices. Average K and K1 parameter was measured higher when measured with IOL Master 500.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

***Idea/Concept:** Sedat Özmen, Burçin Çakır; **Design:** Sedat Özmen, Burçin Çakır; **Control/Supervision:** Sedat Özmen, Burçin Çakır, Emine Doğan; **Data Collection and/or Processing:** Sedat Özmen, Burçin Çakır; **Analysis and/or Interpretation:** Sedat Özmen, Emine Doğan, Burçin Çakır; **Literature Review:** Sedat Özmen, Emine Doğan, Burçin Çakır; **Writing the Article:** Sedat Özmen, Burçin Çakır, Emine Doğan; **Critical Review:** Nilgün Özkan Aksoy, Erkan Çelik; **References and Fundings:** Sedat Özmen; **Materials:**Sedat Özmen.*

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