DOI: 10.4274/tjo.43.72691

Is it Possible to Replace Automated Keratometry with Current Devices: Comparison with LenStar and OPD II

Yeni Cihazlar Otomatize Keratometre Yerine Kullanılabilir mi? Lenstar ve OPD ile Karşılaştırılması

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Summary

Purpose: To compare the keratometry results obtained with optical low-coherence reflectometer, corneal topography, and automated keratometry readings and to assess the interexaminer reproducibility of each device.

Material and Method: This comparative study examined 65 eyes of 65 healthy subjects. Detailed ophthalmic examination was performed in all cases following keratometry measurements with a KR 8100A (Topcon, Japan), an OPD Scan II (Nidek, Japan), and a LenStar LS900 (Haag-Streit, Switzerland). Patients with spheric values over ±3.0D or cylindric values over ±1.0D and with history of chronic ocular/systemic disease or contact lens usage were excluded from the study. The keratometry readings were compared by using ANOVA test (SPSS 16.0). A p-value lower than 0.05 was taken as statistically significant. Bland-Altmann analysis was used to demonstrate agreement between methods, and Spearman rank correlation coefficient (r) was calculated for the correlation. To assess the interexaminer reproducibility, intraclass correlation coefficient was calculated in 30 eyes for each device.

Results: The mean age of the 65 patients enrolled in the study was 21.9±3.25 years. The mean keratometric values obtained with the autorefractokeratometer, OPD Scan II, and LenStar LS 900 were 43.30±1.47, 43.42±1.44, and 43.29±1.42 respectively. No statistically significant difference was observed among the three groups (p=0.840). Interexaminer intraclass correlation was found as 78.9%, 99.9%, and 99.7% for ARK, OPD, and LenStar, respectively.

Discussion: LenStar has provided comparable and well-correlated keratometry measurements in comparison with automated keratometer and corneal topography. *(Turk J Ophthalmol 2013; 43: 73-6)*

Key Words: Corneal topography, keratometry, keratometry index, optical-low coherence reflectometry

Özet

Amaç: Düşük koherans optik reflektometre, korneal topografi ve otomatize keratometre ile elde edilen keratometre sonuçlarını karşılaştırmak ve her cihaz için ölçüm yapan kişiler arasındaki tekrarlanabilirliği değerlendirmek.

Gereç ve Yöntem: Bu karşılaştırmalı çalışmada 65 sağlıklı hastanın 65 gözü incelenmiştir. Her olguda KR 8100A (Topcon, Japonya), OPD Scan II (Nidek, Japonya) ve Lenstar LS 900 (Haag-Streit, İsviçre) ile keratometre ölçümleri alındıktan sonra detaylı göz muayenesi yapılmıştır. Sferik değerleri ±3.0D'nin, silendirik değerleri ±1.0D'nin üzerinde olan olgular, kronik oküler ya da sistemik hastalığı olan ya da kontakt lens kullanan olgular çalışmaya dahil edilmemiştir. Keratometre ölçümleri ANOVA testi (SPSS 16.0) ile karşılaştırılmıştır. 0,05'den düşük p değeri istatistiksel olarak anlamlı kabul edilmiştir. Kullanılan yöntemler arasındaki anlaşmayı göstermek için Bland-Altmann analizi kullanılmış ve uyum için Spearman rank korelasyon katsayısı (r) hesaplanmıştır. Ölçüm yapan kişiler arasındaki tekrarlanabilirliği değerlendirmek için, her cihaz için 30 gözde sınıfiçi korelasyon katsayısı hesaplanmıştır.

Sonuçlar: Çalışmaya dahil edilen 65 hastanın ortalama yaşları 21,9±3,25 yıl idi. Otorefraktokeratometre (ORK), OPD Scan II, ve Lenstar LS 900 ile elde edilen keratometrik değerler sırasıyla 43,30±1,47, 43,42±1,44 ve 43,29±1,42idi. üç grup arasında istatiksel olarak anlamlı fark görülmedi (p=0,840). Ölçüm yapan kişiler arasındaki sınıf-içi korelasyon katsayısı ORK, OPD Scan II ve Lenstar LS 900 için sırasıyla %78,9, %99,9, %99,7 olarak bulundu.

Tartışma: Lenstar, otomatize keratometre ve corneal topografiyle karşılaştırılabilir ve korelasyonu iyi olan keratometre ölçümleri vermiştir. *(Turk J Ophthalmol 2013; 43: 73-6)*

Anahtar Kelimeler: Korneal topografi, keratometre, keratometre indeksi, düşük koherans optik reflektometre

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Received/Geliş Tarihi: 23.09.2012 **Accepted/Kabul Tarihi:** 23.11.2012

Introduction

Accurate measurements of corneal power and shape is crucial for any refractive procedure including contact lens application, refractive surgery, and intraocular lens power calculation for cataract surgery.[1,2] Even though early research comparing manual keratometry and automated keratometry suggested that manual keratometry was the gold standard, keratometry is usually performed by an autorefractokeratometer (ARK) to obtain simultaneous refraction and keratometry information in current clinical practice.[3] As time went by, new devices with extended capabilities were developed. The OPD Scan II (Nidek, Japan) is a device that gives information about corneal topography, wavefront, autorefraction, keratometry, and pupillometry, all in one instrument.[4] It measures the corneal refractive power by means of the corneal topography through the Placido disc technology. The LenStar LS 900 (Haag-Streit AG, Köniz, Switzerland) is an optical low coherence reflectometer that determines keratometry as well as other optical components, such as central corneal thickness, anterior chamber depth, lens thickness, axial length, retinal thickness, white-to-white distance, and pupillometry, all at the same time.[5,6]

The aim of this study was to compare the keratometry readings obtained by optical-low coherence reflectometry with those derived by automated keratometry and corneal topography and to assess interexaminer reproducibility of each device.

Material and Methods

This comparative study adhered to the tenets of Declaration of Helsinki, and the study protocol was approved by the local ethics committee. All patients gave their informed consent for the study.

Sixty-five eyes of 65 patients (29 male and 36 female) were included in the study. The inclusion criteria were as follows: no ocular or systemic disease, spherical values lower than ±3.0D, cylindrical values lower than ±1.0D, and no history of using contact lenses or intraocular surgery. Measurements were performed under natural pupil conditions (in a 150 lux illuminated room) without any topical medication.

Detailed ophthalmic examination was performed in all cases. Keratometry measurements were performed in random order, with the KR 8100A autokeratorefractometer (Topcon, Japan), with the OPD Scan II (Nidek, Japan), and finally with the LenStar LS 900 (Haag-Streit, Switzerland), according to the manufacturer's recommendations. Each measurement was performed at 10-minute intervals.

The calibration for all three devices was checked before starting the measurements of the eyes.

Five consecutive measurements were obtained with the KR 8100A, and a mean value was calculated. With the OPD Scan II, K values of corneal curvature were obtained by corneal topography. The subjects were told to fixate on the internal fixation light and to blink often until an image was acquired. The images with no distortions of the rings were processed and used for comparison. Five measurements were taken and averaged. The autokeratometer module of the OPD-Scan providing conventional keratometry (Avg Sim-K) was used for the comparison.

The LenStar uses an 820 µm superluminescent diode with a Gaussian shaped spectrum to provide high axial resolution, and the effect of time domain interferometric or coherent superposition of light waves, to measure ocular distances. Moreover, the device acquires corneal radius measurements in the flat and steep meridian of the cornea by analyzing a pattern of 32 light-emitting diodes (LEDs), which are arranged on 2 rings with 16 measuring points each. After five serial measurements, the mean corneal curvature was measured in two meridians.

The keratometry results for two meridians were averaged in all patients, and the mean values obtained with each device were compared.

Provided that each of the three compared instruments measures the curvature of the cornea instead of its dioptric power, the same keratometry index (1.3375) was set in all instruments for converting the corneal radius to corneal power.

To assess the interexaminer reproducibility, two different examiners who were trained on the respective instruments prior to the study consecutively obtained keratometry measurements using ARK, OPD, and LenStar in 30 eyes.

Statistics

Data obtained from all 65 eyes were used for statistical analysis using SPSS 16.0 software (SPSS, Inc, Chicago, IL, USA). Comparison of measurements performed with the three devices was conducted with an ANOVA test. Dual comparison of each pair was performed with the Tukey test. A p-value of less than 0.05 was defined as being statistically significant. The Spearman rank correlation coefficient (r) was calculated for the correlation among the three methods. For the interexaminer reproducibility, intraclass correlation was calculated for each device.

Results

The mean age of the 65 subjects was 21.9±3.25 years (range: 18 to 36 years).

The mean values, standard deviations (SD), ranges, and significance (p) values are summarized in Tables 1 and 2, respectively. The mean keratometric value was 43.30±1.47 with the KR 8100A, while it was 43.42±1.4 and 43.29±1.42 with the OPD Scan II and LenStar, respectively.

There was no significant difference found for the keratometry measurements among the three groups (p=0.840). In a dual comparison, no significant difference was observed between the

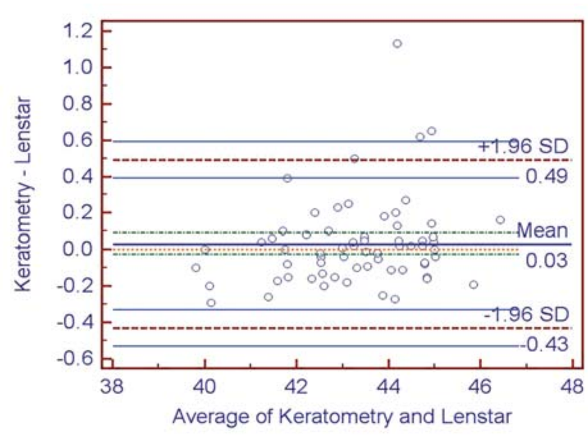

Figure 1. Bland-Altmann analysis of LenStar and automated keratometry measurements

LenStar vs. ARK and LenStar vs. OPD measurements (p=0.998 and p=0.852), or between the ARK and OPD measurements (p=0.880).

The intraclass correlation was high for all three comparisons: 99.34% (95% confidence interval between 98.92% and 99.60%) for the LenStar and ARK comparison, 98.63% (95% confidence interval between 97.76% and 99.17%) for the LenStar and OPD comparison, and 98.61% (95% confidence interval between 97.72% and 99.15%) for the ARK and OPD comparison. The Spearman rank correlation coefficient (r) was 0.981 for the correlation between the keratometry measurements done by ARK and LenStar, r was 0.973 between the measurements by LenStar and OPD Scan II, and was 0.965 between ARK and OPD Scan II (p<0.001). The Bland-Altman graphs are demonstrated in Figures 1, 2, and 3.

Interexaminer reproducibility was high in keratometry measurements in all devices. The intraclass correlation was 78.9% (95% confidence interval: 70.2%-95.3%) for ARK, while it was found as 99.9% (95% confidence interval: 99.90%-99.98%) and 99.7% (95% confidence interval: 99.4%-99.9%) for OPD and LenStar, respectively.

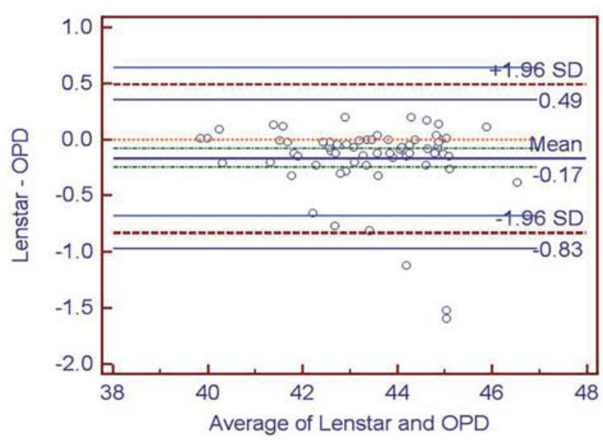

Figure 2. Bland-Altmann analysis of LenStar and OPD keratometry measurements

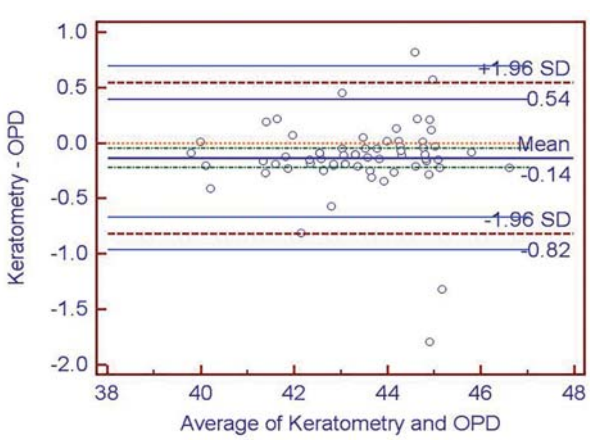

Figure 3. Bland-Altmann analysis of automated keratometry and OPD keratometry measurements

Discussion

A precise keratometry measurement is essential ophthalmology practice. Although the traditional way of performing keratometry measurements was through manual keratometer, automated refractokeratometers are used practically. Today, many new devices are available for both corneal power calculations and for measurement of ocular dimensions. For example, the LenStar is an optical low-coherence reflectometer that is capable of performing keratometry and determining many other ocular components. This instrument can be used as a first-line tool to calculate the intraocular lens power for modern cataract surgery.[7] These developments in ophthalmic technology, and the new devices that have come available, have prompted studies to compare these devices with the conventional ones, to determine the practicality of replacing older instruments with new technology. In the present study, keratometry results obtained with the LenStar were found to give values 0.12 diopters lower than the keratometry results obtained with the OPD Scan II and only 0.01D lower than the readings given by ARK. These differences were not statistically significant when the LenStar measurements were compared to those of the OPD Scan II and ARK.

Savini et al.[8] compared the keratometry results obtained with Scheimpflug camera imaging (Pentacam, Oculus, Germany), corneal topography, or partial coherence interferometer (PCI) for intraocular power calculations in cataract surgery. They reported that the Scheimpflug results were accurate, but the mean results were lower than the measurements with either corneal topography or PCI. In our study, we also obtained lower but not significantly different measurements with the LenStar than with corneal topography and ARK, in agreement with the results of Savini et al. Their mean corneal power measurements obtained with the Pentacam Scheimpflug system (software version 1.16) were not significantly different than their corneal topography measurements, but the agreement was poor.

Modis et al.[9] conducted a study about keratometry evaluations with the Pentacam high resolution (HR) and compared the results with automated keratometry and conventional topography. They reported statistically significant differences in keratometry measurements among Pentacam HR, automated keratometry and corneal topography systems and for patient follow-up, they recommended one certain keratometry device. We have found no significant difference in keratometry measurements among LenStar, automated keratometry and corneal topography (OPD) in our study. In the aforementioned study, they found automated keratometry to be the most repeatable. In our study, intraclass correlation was high among different examiners for ARK (78.9%),

Table 1. Comparison of keratometry measurements

	Mean±SD	Range	P value (Anova test)
Keratometry measurements (D)			
- Lenstar	43.29±1.42	39.85-46.34	
- OPD	43.42±1.44	39.84-46.72	0.840
- ARK	43.30±1.47	39.75-46.50	

Table 2. Multiple comparison of keratometry results obtained by automated keratometer, OPD Scan II and Lenstar

Keratometry Measurement Methods	Mean Difference (diopters)	p value (Tukey Test)	Intraclass correlation	95% confidence interval	Spearman rank coefficient
Lenstar-ARK	-0.01	0.998	99.34	98.92 -99.60	0.981 (p<0.001)
Lenstar-OPD	-0.13	0.852	98.63	97.76 -99.17	0.973 (p<0.001)
OPD-ARK	0.12	0.880	98.61	97.72 -99.15	0.965 (p<0.001)

but the highest repeatability was found in corneal topography (OPD). The agreement between the three different devices in the manner of keratometry measurement was also high in our study (rho: 0.965-0.981).

Shammas and Hoffer performed a study for repeatability and reproducibility of biometry and keratometry measurements with LenStar.[10] They reported that the precision of the average K readings was high with an intraclass correlation (ICC) of 0.989. In our study, we have found an ICC of 0.997, regarding keratometry measurements with LenStar.

The difference in the measurement of corneal power might be more significant when a toric or multifocal IOL is planned for implantation. The manufacturers recommend using manual keratometer when implanting toric IOLs, but the measured values might differ among different observers. Thus, it may be more convenient to perform corneal topography in native patients. The LenStar might be a better choice than OPD for measurement of corneal power in patients with a history of refractive surgery, as they have smaller optic zones.[11]

Reuland et al.[12] compared the Pentacam and PCI for corneal curvature and stated that the difference observed is not clinically relevant and that the Pentacam could be used as a biometric device. Savini et al.[8] proposed that the difference in overestimation and underestimation of corneal power with these devices could be compensated by constant optimization. In our study, for the comparison of K-values in diopter form, LenStar, OPD and ARK were set to the same keratometric index (1.3375, in all three devices). Since our study was designed to compare results of keratometry measurements, the values have not been used for intraocular lens calculation; but in case the mean keratometry values of ARK, OPD and LenStar were used in an IOL calculation formula (SRK-II) for error estimation hypothetically; with LenStar, the mean IOL power would be 0.01 and 0.12 diopters lower than obtained with ARK and OPD. This difference would again be not significant in clinical practice. However, the significance level of this difference should also be supported by clinical studies.

Acar et al.[13] compared the keratometry readings from keratometer, corneal topography and automated keratometer in keratoconus patients. They have reported that corneal topography measurements were flatter than with the other two methods. We have found similar results with ARK and corneal topography; however, our patients were healthy adults.

Our study has some limitations, as our sample size is small due to the voluntary participation of the subjects from the outpatient clinics. Our subjects were also healthy and not candidates for cataract surgery or intraocular lens implantation. Therefore, intraocular power calculation and postoperative error assessment were not performed, but only a hypothetical IOL power error estimation was performed by the mean keratometric results. However, the current study provides preliminary data for our future studies. We can use our findings for better applications of contact lens procedures and corneal refractive operations, as a first-line screening.

In conclusion, our study data showed good correlation, and no significant difference, between keratometry readings of the LenStar, the OPD Scan II, and ARK. Moreover, the repeatability of all devices was found high. Even though the differences between these devices were not significant, each one has its own operating principles and the field of utility, thus, we do not recommend them to be used interchangeably for keratometry measurements.

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