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Original Article

Intraobserver Repeatability of Corneal and Anterior Segment Parameters Obtained Using a Scheimpflug Camera-Placido Corneal Topography System

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Abstract

Objectives: The aim of this study was to assess the intraobserver repeatability of central corneal thickness, peripheral corneal thickness (PCT), keratometry values (steep K, flat K), white-to-white diameter, and anterior chamber depth using the Sirius topography device (Costruzione Strumenti Oftalmici, Florence, Italy) in healthy eyes.

Methods: A Sirius device was used by a single examiner to assess 100 eyes in 50 healthy patients. Two consecutive scans were acquired for each eye. Repeatability was assessed using test–retest variability, the coefficient of variation (COV), and the intraclass correlation coefficient (ICC).

Results: Fifty patients (100 eyes) met the inclusion criteria. There were 18 women (36%) and 32 men (64%), with an age range of 23 to 56 years. The mean age was 30.38±8.03 years. A COV of 0.4% or less and an ICC of more than 0.99 (showing excellent repeatability) were achieved for most parameters, with the exception of PCT (at 2.5-mm temporal, superior, inferior, and nasal thickness).

Conclusion: The anterior segment parameters obtained using the Sirius Scheimpflug camera- Placido corneal topography system were highly repeatable.

Keywords: Anterior chamber depth, central corneal thickness, keratometry, peripheral corneal thickness, repeatability, Sirius, white-to-white.

Introduction

Accurate and precise evaluation of the anterior segment parameters has become increasingly significant. The recent increase in the number of refractive surgeries and the prevalence of the use of premium intraocular lenses in cataract surgeries has increased the importance of accurate determination of anterior segment parameters for planning the surgery, achieving satisfactory postoperative results, and appropriate patient management (1).

Various tools, including optical coherence tomography, ultrasound biometry, Scheimpflug imaging, scanning-slit topography, and interferometry are used to evaluate the anterior segment (1, 2).

The Sirius topography device (Costruzione Strumenti Oftalmici, Florence, Italy) is an anterior segment analysis system that combines a Scheimpflug camera and Placido disk technology. This system can provide data regarding corneal thickness, the anterior chamber depth, aqueous depth, lens thickness, keratometry, white-to-white diameter (WTW), pupillography, anterior and posterior corneal topography, and corneal wavefront analysis (3).

For any of these tools, the repeatability of results and the agreement between different measurements are crucial for patient safety. In the literature, there are several studies on the repeatability of various devices.

The aim of this study was to assess the repeatability of

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evaluations of central corneal thickness (CCT), peripheral corneal thickness (PCT), flat K, steep K, WTW, and anterior chamber depth using Sirius topography in healthy eyes.

Methods

This was a prospective study conducted at Afyonkarahisar University of Health Sciences, with a sample consisting of 50 patients. All of the patients provided informed consent. The study parameters were approved by a local Ethical Committee performed in accordance with the Declaration of Helsinki.

All of the patients included in the study underwent comprehensive ophthalmological examinations, including refraction measurement, best-corrected visual acuity (BCVA) measurement, intraocular pressure measurement, and biomicroscopic examination. Patients with a BCVA of 20/20 were included. Patients with any ocular disease (cataract, glaucoma, dry eye, or corneal pathologies, such as scarring, edema, dystrophy, or keratoconus), history of contact lens wear or previous ocular surgery, or presence of any systemic disease were excluded from the study.

All of the patients were instructed to rest their chin in the support cup on the front of a Sirius Scheimpflug tomography device and to focus on a target in the middle of the camera and to blink a few times for each measurement. The time interval between repetitive measurements was kept as short as possible (approximately 30 seconds). Measurements were made without pupillary dilation. Measurements of CCT, PCT at 2.5 mm, anterior chamber depth (ACD; distance between corneal epithelium and lens), keratometry values (steep, flat values), and WTW were compared. All of the measurements were performed twice by the same physician (EE) using the Sirius device.

Device

Combined Scheimpflug-Placido Disk System

The Sirius device combines a rotating Scheimpflug camera and a small-angle Placido disk topographer with 22 rings. A full scan acquires a series of 25 Scheimpflug images (meridians) and 1 Placido top-view image. The Placido image provides ring edges, and height, slope, and curvature data are obtained using the arc-step method with conic curves. Scheimpflug images show the profile of the anterior cornea, posterior cornea, anterior lens, and iris. The data for the anterior surface is finally determined by merging the Placido image and the Scheimpflug images using a proprietary method. Other data of internal structures (posterior cornea, anterior lens, and iris) are obtained solely from the Scheimpflug images.

Statistical Analysis

The data were analyzed using PASW Statistics for Windows, Version 18.0 (SPSS Inc., Chicago, IL, USA). Repeatability was assessed using 2 indices.

The coefficient of variation (COV) This measure is the ratio of the SD to the mean of the measurements and was expressed as a percentage. The COV was not calculated for parameters with both positive values and negative values.

The intraclass correlation coefficient (ICC) This is defined as the ratio of the between-subjects variance to the sum of the pooled within-subject variance and the between-subjects variance. The ICC, which approaches 1.0 when there is no variance between repeated measurements, was automatically calculated using statistical software with a 2-way mixed model and absolute agreement. An ICC of <0.75 Z signifies poor agreement, 0.75 to 0.90 Z indicates moderate agreement, and an ICC of >0.90 Z is considered high agreement.

Results

Fifty patients (100 eyes) met the enrollment criteria. There were 18 women (36%) and 32 men (64%) with an age range of 23 to 56 years in the study group. The mean age was 30.38±8.03 years. Table 1 shows the mean values for each measured parameter. Table 2 illustrates the results of the

Table 1. Values for each measured parameter

	First measurement	Second measurement
Peripheral corneal		
Thickness at 2.5 mm		
Temporal		
Mean	576.28±35.22	577.80±36.65
Min-Max	511.00±689.00	503.00±656.00
Superior		
Mean	627.44±36.88	628.38±38.13
Min-Max	544.00±710.00	538.00±719.00
Nasal		
Mean	610.14±36.94	612.86±37.64
Min-Max	526.00±687.00	528.00±696.00
Inferior		
Mean	591.90±34.22	591.32±35.56
Min-Max	520.00±680.00	506.00±674.00
Central corneal thickness		
Mean	545.50±33.00	545.04±35.81
Min-Max	481.00±622.00	444.00±620.00
Anterior chamber deepth		
Mean	3.69±0.35	3.70±0.36
Min-Max	2.82±4.62	2.80±4.68
White-to-white		
(limbus-limbusdistances)		
Mean	12.11±0.42	12.11±0.42
Min-Max	10.91±12.95	10.91±13.04
Flat K (D)		
Mean	43.43±1.73	43.47±1.69
Min-Max	37.81±46.67	37.90±46.44
Steep K (D)		
Mean	44.12±1.79	44.17±1.76
Min-Max	38.58±47.50	38.62±47.29

Table 2. Intraobserver repeatability measurements obtained with Sirius

	ICC	Cov
Peripheral Corneal Thickness at 2.5mm		
Temporal	0.960	0.43
Superior	0.982	0.46
Nasal	0.956	0.56
Inferior	0.993	0.38
Central CornealThickness	0.990	0.28
AnteriorChamberDepth	0.997	0.40
WTW	0.995	0.00
Flat K(D)	0.997	0.17
Step K(D)	0.998	0.11

COV: Coefficient of variation (%); ICC: Intraclass correlation coefficient; WTW: White-to-white (limbus-limbus distance).

repeatability assessment.

A COV of 0.4% or less and an ICC of more than 0.99 (showing excellent repeatability) were achieved for most parameters, excluding PCT (at 2.5-mm temporal, superior, inferior, nasal thickness).

Discussion

A high degree of repeatability was demonstrated with the Sirius system, which uses a combination of a Scheimpflug camera and Placido-disk corneal topography, for values of CCT, PCT at 2.5 mm, ACD, keratometry values, and WTW. While ultrasonic pachymetry is the gold standard for measuring CCT, there are many methods to measure CCT (4, 5). Ultrasonic pachymetry requires direct contact with the cornea and the use of topical anesthesia. The use of local anesthetic drops can yield significantly different thickness measurements (6). Correct measurement of CCT is very important in several areas of ophthalmology practice, especially in the diagnosis and follow-up of glaucoma and in refractive surgery. Over-measuring corneal thickness may lead to excessive ablation during refractive surgery, which results in iatrogenic keratectasia (7).

In our study, an excellent degree of repeatability was found for CCT: There was an ICC of 0.990 and a COV of 0.28 between the measurements. We not only measured central thickness but also corneal thickness in 2.5-mm peripheral locations. The PCT at 2.5-mm measurements yielded an ICC and a COV value of 0.960 and 0.43 for temporal, 0.982 and 0.46 for superior, 0.993 and 0.38 for inferior, and 0.956 and 0.56 for nasal angles, respectively. CCT measurements were more consistent than PCT at 2.5 mm.

Sirius measures the ACD in a non-contact manner and does not require topical anesthesia, which is one of the most important advantages of this system. The ACD measurement has become more important in advanced calculation methods for intraocular lens (IOL) power and in cataract and refractive surgery for phakic IOL implantation. A 1-mm error in the ACD measurement leads to approximately 1.5 D postoperative refractive error in emmetropic eyes, 1 D in myopic eyes, and 2.5 D in hypermetropic eyes (8). In our study, the ICC between measurements was found to be 0.997 and the CV was found to be 0.40, demonstrating an excellent repeatability for the instrument.

WTW measurement is used to diagnose diseases such as congenital glaucoma, microcornea, and megalocornea (9). In addition, WTW is important in the calculation of haptic dimensions in capsular tension ring and angle-supported IOLs, anterior chamber IOLs, and phakic IOLs, as well as IOL calculation with third generation formulas (10). In our study, the ICC for repeated WTW measurements was 0.995 and the CV was 0.00, demonstrating an excellent repeatability for the WTW measurement with the Sirius system.

An error of 0.1 D in the keratometry value leads to a refractive error of approximately 0.1 D.8 For this reason, it is very important to check the validity of the data produced by new devices. The ICC and CV values for flat K were 0.997 and 0.17, respectively, and for steep K they were 0.998 and 0.11. The Sirius device demonstrated excellent repeatability for keratometry values. However, a previous study by Colin et al. (11) has shown a lower repeatability for steep K with Sirius (ICC=0.869).

Chen and Lam (12) reported good intra-observer repeatability (three consecutive measurements per eye) of corneal curvatures using a Pentacam device (Oculus Optikgeräte GmbH, Wetzlar, Germany): anterior central sim K, steep K, and flat K had an ICC of 0.98, which were comparable to our results. Savini et al. (13) evaluated the repeatability of measurements in healthy eyes with Sirius and found high repeatability with a COV of <0.5% and an ICC of >0.99 for all parameters. Milla et al. (3) showed that the ICC of repeated measures ranged from 0.990 to 0.997 for intraobserver repeatability and agreement with a Scheimpflug photography–based system.

In this study, all corneal power measurements yielded a COV of <0.6% and an ICC of >0.950 in normal corneas.

There are many limitations in the present study. First, the research investigated reliability in healthy subjects. Subsequent studies should include a sample of unhealthy corneas. Secondly, a single physician performed all of the measurements in this study but inter-observer repeatability was not assessed, which becomes important as the long-term evaluation of corneal diseases may require measurements by different physicians.

Conclusion

This study was an evaluation of the repeatability of measurements of CCT and other additional anterior segment anatomical parameters using the Sirius topography system. The Sirius device, which is based on a combination of a Scheimpflug camera and the Placido-disk, provided fast, noninvasive, and reproducible anterior corneal measurements.

Disclosures

Ethics Committee Approval: The study parameters were approved by a local Ethical Committee performed in accordance with the Declaration of Helsinki.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Involved in design and conduct of the study (EE, MD); preparation and review of the study (EE, MD); data collection (EE, MD); and statistical analysis (EE, MD).

References

1. Konstantopoulos A, Hossain P, Anderson DF. Recent advances in ophthalmic anterior segment imaging: a new era for ophthalmic diagnosis? Br J Ophthalmol 2007;91:551–7.[CrossRef]
2. Uçakhan OO, Ozkan M, Kanpolat A. Corneal thickness measurements in normal and keratoconic eyes: Pentacam comprehensive eye scanner versus noncontact specular microscopy and ultrasound pachymetry. J Cataract Refract Surg 2006;32:970–7.
3. Milla M, Piñero DP, Amparo F, Alió JL. Pachymetric measurements with a new Scheimpflug photography-based system: intraobserver repeatability and agreement with optical coherence tomography pachymetry. J Cataract Refract Surg 2011;37:310–6.
4. Ishibazawa A, Igarashi S, Hanada K, Nagaoka T, Ishiko S, Ito H, et al. Central corneal thickness measurements with Fourier-domain optical coherence tomography versus ultrasonic pachymetry and rotating Scheimpflug camera. Cornea 2011;30:615–9. [CrossRef]
5. Kim HY, Budenz DL, Lee PS, Feuer WJ, Barton K. Comparison of central corneal thickness using anterior segment optical coherence tomography vs ultrasound pachymetry. Am J Ophthalmol 2008;145:228–232. [CrossRef]
6. Gao L, Fan H, Cheng AC, Wang Z, Lam DS. The effects of eye drops on corneal thickness in adult myopia. Cornea 2006;25:404–7. [CrossRef]
7. Doughty MJ, Zaman ML. Human corneal thickness and its impact on intraocular pressure measures: a review and meta-analysis approach. Surv Ophthalmol 2000;44:367–408. [CrossRef]
8. Lee AC, Qazi MA, Pepose JS. Biometry and intraocular lens power calculation. Curr Opin Ophthalmol 2008;19:13–7. [CrossRef]
9. Wallace DK, Plager DA. Corneal diameter in childhood aphakic glaucoma. J Pediatr Ophthalmol Strabismus 1996;33:230–4.
10. Hoffer KJ. Clinical results using the Holladay 2 intraocular lens power formula. J Cataract Refract Surg 2000;26:1233–7. [CrossRef]
11. De la Parra-Colín P, Garza-León M, Barrientos-Gutierrez T. Repeatability and comparability of anterior segment biometry obtained by the Sirius and the Pentacam analyzers. Int Ophthalmol 2014;34:27–33. [CrossRef]
12. Chen D, Lam AK. Reliability and repeatability of the Pentacam on corneal curvatures. Clin Exp Optom 2009;92:110–8. [CrossRef]
13. Savini G, Carbonelli M, Barboni P, Hoffer KJ. Repeatability of automatic measurements performed by a dual Scheimpflug analyzer in unoperated and post-refractive surgery eyes. J Cataract Refract Surg 2011;37:302–9. [CrossRef]