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Corneal Indices in Different Corneal Thickness in Relation to Refractive Errors

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ABSTRACT

Background: Accurate preoperative assessment of corneal parameters is essential in refractive surgery to minimize complications such as corneal ectasia and biomechanical instability. Central corneal thickness and curvature are key predictors for surgical planning, and emerging technologies like the Sirius Scheimpflug-Placido topography system offer comprehensive corneal evaluation

Objective: This study aimed to evaluate the variation of corneal tomographic indices across different corneal thickness profiles and their relationship to refractive errors using the Sirius imaging system.

Patients and Methods: This retrospective observational study included 60 eyes from 60 patients who presented for refractive surgery evaluation. Patients were stratified into three groups based on thinnest corneal thickness: Group 1 (≤ 509 µm), Group 2 (510–580 µm), and Group 3 (≥ 581 µm). Comprehensive ophthalmologic examinations and corneal tomography were performed using the Sirius system. Key parameters included keratometric readings, pachymetric indices, anterior chamber depth, and ectasia risk indices.

Results: Group 1 demonstrated significantly steeper anterior corneal curvature (K1, K2, and mean Sim-K) across the 3 mm, 5 mm, and 7 mm optical zones compared to Groups 2 and 3 ($p < 0.05$). No significant differences were found in posterior corneal curvature or corneal astigmatism across groups. The BCVf index was significantly higher in Group 3 than in Group 2 ($p < 0.05$), while other ectasia-related indices showed no significant variation. Refractive status did not significantly impact tomographic indices.

Conclusion: The Sirius topography system provides accurate and consistent measurements of corneal thickness and curvature. Thinner corneas are associated with steeper anterior curvature, while posterior surface parameters remain stable.

Keywords: Sirius topography, Corneal thickness, Keratometry, Refractive error, Scheimpflug imaging.

INTRODUCTION

Identifying patients at risk for postoperative complications remains a key challenge in refractive surgery. Complications such as corneal ectasia, residual refractive errors, and biomechanical instability continue to pose significant concerns [1,2].

Accurate preoperative evaluation using tools like the Galilei analyzer, ultrasound pachymetry, Orbscan, and especially the widely adopted Pentacam system, is essential for minimizing these risks [3].

Corneal thickness, assessed via indices such as central corneal thickness (CCT), thinnest corneal thickness (TCT), and maximum corneal thickness (MCT), is a critical determinant in surgical planning [4,5]. Traditional Placido-disc topography evaluated anterior curvature but lacked pachymetric data and posterior surface assessment. The advent of elevation-based systems, such as the Pentacam and Sirius, enabled more comprehensive imaging, incorporating 3D reconstruction and full-thickness corneal mapping [6,7].

Studies have shown that biometric factors, including age and refractive status, may influence tomographic measurements, potentially requiring population-specific calibration of reference values [8–10]. This is particularly relevant in diverse populations, where standard indices may not reflect regional variations.

Refractive status, CCT, and keratometry are essential for preoperative planning and risk stratification, especially in detecting conditions like keratoconus or predicting post-LASIK ectasia [1,11,12]. However, previous studies exploring the relationship among these parameters have yielded conflicting results [13,14,16–22].

Advancements in corneal tomography have introduced composite indices such as Ambrosio Relational Thickness (ART) and the D index, enhancing early detection of keratoconus [23–25]. Other multi-parameter tools like the KISA%, Keratoconus Prediction Index, and Topographic Keratoconus Classification System also improve diagnostic accuracy [23,26–28].

The primary aim of this study was to evaluate the variation of corneal tomographic indices across different corneal thickness profiles in relation to refractive errors, utilizing the Sirius (CSO, Florence, Italy) imaging system. This device integrates Placido-disc corneal topography with Scheimpflug camera technology, enabling comprehensive assessment of both anterior corneal surface parameters and full-thickness pachymetry with high precision.

PATIENTS AND METHODS

This retrospective observational study included 60 eyes from 60 patients who presented for refractive surgery evaluation at the Cornea and Refractive Surgery Unit of a

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private ophthalmology center. This study was conducted between February 2023 and May 2025.

Inclusion criteria: Patients with either myopia or hyperopia, who exhibited normal findings on slit-lamp biomicroscopy, had no history of ocular disease, demonstrated a corrected distance visual acuity (CDVA) of 6/6 or better, and were actively seeking refractive surgical intervention.

Exclusion criteria: Patients with history of previous ocular surgery, the presence of corneal pathologies such as ectatic disorders or corneal opacities, chronic use of topical ophthalmic medications, or contact lens wear within three weeks prior to the examination.

Data Collection and Imaging Protocol

Each participant underwent a comprehensive ophthalmological evaluation, which included uncorrected and best-corrected visual acuity assessment using a chart projector (Topcon, Tokyo, Japan), and objective refraction using an autorefractometer (Nidek ARK-510A, Japan). Slit-lamp biomicroscopy and dilated fundus examination were performed to rule out anterior or posterior segment abnormalities.

Corneal tomography was conducted using the Sirius topography system (CSO, Florence, Italy), which combines a rotating Scheimpflug camera with a Placido-disc topographer to provide high-resolution images and detailed anterior segment analysis. The system offers measurements of both anterior and posterior corneal surfaces, pachymetric maps, keratometric readings, anterior chamber depth, pupil diameter, aberrometry, and meibography.

For the purpose of this study, a selection of key tomographic indices derived from the Sirius imaging system were analyzed to evaluate corneal structure and symmetry. The Thinnest Location (Thk) was identified by recording both the x and y coordinates and the corresponding value of the thinnest point on the pachymetric map. A combined parameter, Central Corneal Thickness and Anterior Chamber Depth (CCT + ACD), was assessed to provide comprehensive insight into central corneal thickness, aqueous depth, and total anterior chamber volume.

Keratometric parameters were evaluated, including steep and flat keratometry (K) readings, average keratometric values, and calculated corneal astigmatism across 3 mm, 5 mm, and 7 mm optical zones on both the anterior and posterior surfaces. To assess vertical corneal symmetry, Symmetry Indices for the front (SIF) and back (SIB) corneal surfaces were measured and expressed in diopters; positive values indicate inferior steepening, while negative values reflect superior steepening.

Ectatic changes were further analyzed through the Keratoconus Vertex on the anterior (KVf) and posterior (KVb) elevation maps, representing the apex of elevation suggestive of keratoconus. Additionally, Baiocchi-Calossi-Versaci indices (BCVf and BCVb) were calculated, based on the Zernike decomposition of higher-order aberrations, specifically targeting coma and trefoil components commonly associated with early keratoconic changes. The combined vectorial BCV index was also utilized, providing a summative value that reflects the overall ectatic burden.

For statistical comparisons, eyes were stratified into three groups based on central corneal thickness (CCT): Group 1 (CCT ≤ 509 μm), Group 2 (CCT 510–580 μm), and Group 3 (CCT ≥ 581 μm). Both eyes of each patient were scanned using the Sirius system, adhering strictly to the manufacturer's standardized imaging protocol to ensure consistency and reliability in data acquisition

***Ethical Consideration*:**

This study was ethically approved by the Institutional Review Board of Menoufia University (IRB approval number: 2/2023 OPHT 45). Prior to enrollment, all participants were informed about the purpose of the study, and written informed consent was obtained from each participant. The study protocol adhered to the Declaration of Helsinki, the ethical standard of the World Medical Association for research involving human subjects.

Statistical Analysis

The collected data were coded, entered, and statistically analyzed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or as median with range, depending on their distribution, while categorical variables were presented as counts and percentages. Data normality was verified using the Shapiro–Wilk test, and variance homogeneity was evaluated with Levene's test. For comparisons across the three CCT groups, one-way analysis of variance (ANOVA) was applied to normally distributed variables. When a significant overall difference was observed, post hoc analysis was performed using Tukey's Honestly Significant Difference (HSD) test. A p-value <0.05 was considered statistically significant, and <0.01 was regarded as highly significant.

RESULTS

Our study included a total of 60 eyes from 60 individuals, with a mean age of 29.87 ± 9.41 years (range: 20–50 years). The cohort comprised 26 male participants (43.3%) and 34 female participants (56.7%), indicating a slight female predominance. The distribution of examined eyes was equal, with 30 right eyes (50%) and 30 left eyes (50%) included in the analysis.

Regarding refractive classification, compound myopic astigmatism was the most prevalent, observed in 47 eyes (78.3%). This was followed by compound hypermetropic astigmatism, identified in 7 eyes (11.7%). Simple myopic astigmatism and simple myopia were each documented in 3 eyes (5%).

The mean thinnest corneal location was 542.93 ± 37.20 µm (range: 481–606 µm), with an interquartile range of 509–581 µm. Based on this parameter, eyes were categorized into three groups:

- Group 1 (≤ 509 µm): 15 eyes (25%)
- Group 2 (510–580 µm): 29 eyes (48.3%)
- Group 3 (≥ 581 µm): 16 eyes (26.7%).

Table 1 shows that there was no statistically significant difference in aqueous depth (AD) or total anterior chamber depth (CCT + AD) among the groups stratified by thinnest corneal location (P = 0.304 and P = 0.060, respectively). In contrast, a statistically significant difference was observed in central corneal thickness (CCT) across the groups (P < 0.001), with CCT values progressively increasing in parallel with higher thinnest corneal thickness measurements. This finding highlights a strong correlation between thinnest corneal location and overall CCT.

Table (1): Comparison of CCT, AD and anterior chamber (CCT+AD) according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
CCT	0.50 ± 0.01	0.54 ±0.02	0.59 ± 0.01	F = 152.64 **P < 0.001***	**P1=0.001*** **P2=0.001*** **P3=0.001***
AD	3.07 ± 0.15	3.08 ± 0.32	3.21 ± 0.32	F = 1.216 P = 0.304	P1=0.988 P2=0.375 P3=0.346
Anterior chamber (CCT+AD)	3.57 ± 0.15	3.63 ± 0.32	3.81 ± 0.33	F = 2.964 P = 0.060	P1=0.801 P2=0.067 P3=0.126

The Simulated Keratometry K1 (Sim-K K1) was significantly higher in Group 1 (≤ 509 µm) compared with both Group 2 (510–580 µm) and Group 3 (≥ 581 µm). Similarly, the Sim-K K2 value was significantly greater in Group 1 than in Group 2. Moreover, the mean Sim-K reading showed a significant increase in Group 1 compared with both Group 2 and Group 3. Collectively, these findings demonstrate a consistent trend of steeper anterior corneal curvature in eyes with thinner corneas (Table 2).

Table (2): Comparison of SIM-K parameters according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
K1	44.10 ± 1.10	42.97 ± 1.47	42.72 ± 1.54	F = 4.3 **P=0.017***	**P1=0.037*** **P2=0.023*** P3=0.843
K2	45.50 ± 1.14	44.12 ± 1.67	44.18 ± 1.64	F = 4.347 **P=0.017***	**P1=0.018*** P2=0.055 P3=0.989
Average	44.79 ± 1.04	43.60 ± 1.60	43.44 ± 1.52	F = 4.161 **P=0.021***	**P1=0.035*** **P2=0.033*** P3=0.931
Cylinder	-1.40 ± 0.81	-1.15 ± 0.78	-1.46 ± 0.92	F= 0.896 P=0.414	P1=0.608 P2=0.977 P3=0.452

A statistically significant variation was observed in the anterior 3 mm Simulated Keratometry (Sim-K) parameters (K1, K2, and mean values) across the three study groups. Specifically, K1 was significantly higher in Group 1 (≤ 509 µm) compared with Group 3 (≥ 581 µm) (P = 0.034). Likewise, K2 was significantly greater in Group 1 relative to Group 2 (510–580 µm) (P = 0.024). In addition, the mean Sim-K value within the central 3 mm zone was higher in Group 1 than in the other two groups. These findings suggest that thinner corneas are associated with steeper anterior curvature within the central optical zone. Conversely, no significant differences were found in corneal astigmatism (cylinder) among the groups (P = 0.364) (Table 3).

Table (3): Comparison of Anterior =Ø3MM parameters according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
K1	44.16 ± 1.09	43.04 ± 1.53	42.80 ± 1.63	F = 3.909 **P = 0.026***	P1=0.051 **P2=0.034*** P3=0.866
K2	45.54 ± 1.18	44.19 ± 1.72	44.30 ± 1.61	F = 3.940 **P = 0.025***	**P1=0.024*** P2=0.081 P3=0.972
Average	44.83 ± 1.06	43.60 ± 1.58	43.53 ± 1.56	F = 4.158 **P = 0.021***	**P1=0.028*** **P2=0.043*** P3=0.988
Cylinder	-1.39 ± 0.81	-1.15 ± 0.77	-1.49 ± 0.90	F= 1.029 P = 0.364	P1=0.633 P2=0.930 P3=0.372

A statistically significant variation was observed in the anterior 5 mm keratometric parameters (K1, K2, and mean Sim-K) across the study groups. Specifically, K1 was significantly higher in Group 1 (≤ 509 µm) compared with the other two groups. In addition, K2 was significantly greater in Group 1 than in Group 2 (P = 0.020). The mean Sim-K value within the 5 mm zone was also significantly higher in Group 1 compared with the other two groups, indicating a steeper corneal curvature in thinner corneas. In contrast, no significant differences were found in corneal cylinder (astigmatism) values among the groups (P = 0.378) (Table 4).

Table (4): Comparison of ANTERIOR =Ø5MM parameters according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
K1	44.09 ± 1.09	42.97 ± 1.48	42.72 ± 1.58	F = 4.215 **P = 0.020***	**P1=0.043*** **P2=0.026*** P3=0.834
K2	45.47 ± 1.14	44.11 ± 1.67	44.18 ± 1.62	F = 4.238 **P = 0.019***	**P1=0.020*** P2=0.060 P3=0.987
Average	44.77 ± 1.04	43.53 ± 1.53	43.43 ± 1.53	F = 4.487 **P = 0.016***	**P1=0.023*** **P2=0.032*** P3=0.975
Cylinder	-1.38 ± 0.78	-1.13 ± 0.77	-1.46 ± 0.91	F= 0.989 P = 0.378	P1=0.609 P2=0.957 P3=0.400

In the 7 mm anterior corneal zone, the Simulated Keratometry (K1) was significantly higher in Group 1 (≤ 509 µm) compared with both Group 2 (510–580 µm) and Group 3 (≥ 581 µm). Similarly, K2 was significantly greater in Group 1 than in Group 2. The mean Sim-K value within this zone was also significantly elevated in Group 1. Collectively, these findings demonstrate that thinner corneas are consistently associated with steeper anterior curvature across wider corneal regions (Table 5).

Table (5): Comparison of ANTERIOR =Ø7MM parameters according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
K1	43.89 ± 1.10	42.81 ± 1.41	42.51± 1.54	F = 4.393 **P = 0.017***	**P1=0.045*** **P2=0.020*** P3=0.761
K2	45.24 ± 1.07	43.94 ± 1.57	44 ± 1.63	F = 4.223 **P = 0.019***	**P1=0.020*** P2=0.059 P3=0.990
Average	44.55 ± 1.03	43.37 ± 1.45	43.24 ± 1.52	F = 4.538 **P = 0.015***	**P1=0.024*** **P2=0.027*** P3=0.953
Cylinder	-1.35 ± 0.69	-1.12 ± 0.73	-1.49 ± 0.86	F= 1.306 P = 0.279	P1=0.618 P2=0.862 P3=0.271

The differences among the study groups were not statistically significant for the posterior 3 mm keratometric parameters, including K1, K2, mean Sim-K, and cylinder. This finding indicates that corneal thickness variations did not significantly affect posterior corneal curvature within the central 3 mm zone (Table 6).

Table (6): Comparison of posterior =Ø3MM parameters according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
K1	-6.07 ± 0.13	-5.93 ± 0.23	-5.98 ± 0.25	F = 2.083 P = 0.134	P1=0.112 P2=0.492 P3=0.726
K2	-6.51 ± 0.19	-6.33 ± 0.31	-6.42 ± 0.28	F = 2.074 P = 0.135	P1=0.118 P2=0.620 P3=0.593
Average	-6.28 ± 0.14	-6.12 ± 0.26	-6.19 ± 0.25	F = 2.318 P = 0.108	P1=0.090 P2=0.530 P3=0.617
Cylinder	0.44 ± 0.18	0.40 ± 0.17	0.44 ± 0.15	F= 0.341 P = 0.712	P1=0.751 P2=0.995 P3=0.806

The differences among the study groups were not statistically significant for any of the posterior 5 mm keratometric parameters, including K1, K2, mean Sim-K, and cylinder. This finding suggests that posterior corneal curvature within the 5 mm zone remains relatively stable regardless of central corneal thickness (Table 7).

Table (7): Comparison of posterior =Ø5MM parameters according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
K1	-6.09 ± 0.13	-5.96 ± 0.23	-6.01 ± 0.25	F = 1.818 P = 0.172	P1=0.146 P2=0.530 P3=0.764
K2	-6.52 ± 0.16	-6.33 ± 0.29	-6.41 ± 0.27	F = 2.592 P = 0.084	P1=0.068 P2=0.455 P3=0.625
Average	-6.30 ± 0.12	-6.14 ± 0.25	-6.20 ± 0.25	F = 2.496 P = 0.091	P1=0.075 P2=0.470 P3=0.633
Cylinder	0.45 ± 0.19	0.38 ± 0.15	0.41 ± 0.15	F= 0.879 P = 0.421	P1=0.387 P2=0.740 P3=0.873

No statistically significant differences were observed among the study groups with respect to posterior 7 mm K1, mean Sim-K, or cylinder values. In contrast, posterior 7 mm K2 was significantly lower in Group 1 (≤ 509 µm) compared with Group 2 (510–580 µm), indicating a slight flattening of the posterior corneal surface along the vertical meridian in thinner corneas (Table 8).

Table (8): Comparison of posterior =Ø7MM parameters according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
K1	-6.13 ± 0.13	-5.94 ± 0.29	-6.03 ± 0.26	F = 2.654 P = 0.079	P1= 0.067 P2= 0.548 P3= 0.509
K2	-6.47 ± 0.15	-6.28 ± 0.26	-6.35 ± 0.26	F = 3.125 P = 0.052	**P1= 0.040*** P2= 0.329 P3= 0.646
Average	-6.29 ± 0.11	-6.13 ± 0.24	-6.18 ± 0.25	F = 2.813 P = 0.068	P1= 0.054 P2= 0.363 P3= 0.679
Cylinder	0.35 ± 0.14	0.30 ± 0.13	0.32 ± 0.15	F= 0.503 P = 0.607	P1= 0.578 P2= 0.819 P3= 0.943

Table 9 demonstrates that, when stratified by the thinnest corneal location, there were no statistically significant differences among the study groups in terms of SIF, KVF, SIb, KVb, and BCVb. However, Group 3 (≥ 581 µm) exhibited a significantly higher BCVf compared with Group 2 (510–580 µm).

Table (9): Comparison of SIF, KVF, BCVF, SIb, KVb and BCVb according to the thinnest location

Variables	Group 1 (≤509 µm) (N=15)	Group 2 (510-580 µm) (N=29)	Group 3 (≥ 581 µm) (N=16)	Test of significance	Intergroup significance
SIF (D)	-0.09 ± 0.38	-0.29 ± 0.40	0.01 ± 0.56	F = 2.469 P = 0.094	P1= 0.367 P2= 0.804 P3= 0.095
KVF (µm)	4.20 ± 1.26	3.97 ± 1.50	4.38 ± 1.36	F = 0.458 P = 0.635	P1= 0.860 P2= 0.936 P3= 0.622
BCVF (D)	0.15 ± 0.14	0.08 ± 0.11	0.19 ± 0.21	**F = 3.323** **P = 0.043***	P1= 0.248 P2= 0.770 P3= 0.046*
SIb (D)	-0.06 ± 0.15	-0.01 ± 0.13	0.04 ± 0.11	F = 2.105 P = 0.131	P1= 0.427 P2= 0.110 P = 0.527
KVb (µm)	14.87 ± 4.44	12.21 ± 3.54	13.19 ± 2.07	F = 2.888 P = 0.064	P1= 0.051 P2= 0.378 P3= 0.640
BCVb (D)	0.09 ± 0.20	0.10 ± 0.18	0.21 ± 0.20	F = 2.048 P = 0.138	P1= 0.993 P2= 0.212 P3= 0.161

Table 10 indicates that, when stratified according to refractive status, the groups showed no statistically significant differences in SIF, KVF, BCVf, SIb, KVb, or BCVb.

Table (10): Comparison of SIF, KVF, BCVF, SIb, KVb and BCVb according to the state of refraction

Variables	Compound myopic astigmatism (N=47)	Compound hypermetropic astigmatism (N=7)	Myopia (N=3)	Simple myopic astigmatism (N=3)	Test of significance	Intergroup significance
SIF (D)	-0.20 ± 0.45	-0.20 ± 0.45	0.17 ± 0.76	0.16 ± 0.22	F = 1.163 P = 0.332	P1= 1 P2= 0.525 P3=0.547 P4=0.641 P5=0.661 P6=1
KVF (µm)	4 ± 1.38	5.14 ± 1.35	3.33 ± 0.58	4.67 ± 1.53	F = 1.925 P = 0.136	P1=0.176 P2=0.844 P3=0.844 P4=0.230 P5=0.957 P6=0.631
BCVF (D)	0.11 ± 0.14	0.12 ± 0.16	0.31 ± 0.17	0.24 ± 0.27	F = 2.199 P = 0.098	P1=0.99 P2=0.129 P3=0.49 P4=0.281 P5=0.689 P6=0.934
SIb (D)	0 ± 0.13	0.02 ± 0.06	-0.04 ± 0.10	-0.15 ± 0.24	F = 1.299 P = 0.284	P1=0.97 P2=0.97 P3=0.26 P4=0.923 P5= 0.265 P6= 0.734
KVb (µm)	13.15 ± 3.58	11.86 ± 3.67	14 ± 2.65	15 ± 5.20	F = 0.611 P = 0.611	P1= 0.81 P2=0.97 P3=0.827 P4=0.827 P5=0.595 P6= 0.987
BCVb (D)	0.15 ± 0.21	0.04 ± 0.06	0.10 ± 0.13	0.03 ± 0.05	F = 0.877 P = 0.459	P1=0.542 P2=0.979 P3=0.75 P4=0.97 P5=1 P6=0.97

DISCUSSION

This study aimed to evaluate the variation in corneal indices across different ranges of central corneal thickness and assess their association with refractive errors using the Sirius CSO system, a hybrid imaging device that integrates Scheimpflug camera technology with Placido disk corneal topography. This combined approach provides enhanced accuracy in measuring both anterior corneal surface parameters and full-thickness corneal mapping.

The study enrolled 60 patients, who were stratified into three groups based on the thinnest corneal thickness: Group 1 (≤509 µm), Group 2 (510–580 µm), and Group 3 (≥581 µm). The mean CCT values were 500 ± 10 µm, 540 ± 20 µm, and 590 ± 10 µm for groups 1, 2, and 3, respectively. Across these groups, average keratometric values (K1 and K2) showed a gradual decrease with increasing corneal thickness. Mean K1 was 44.10 ± 1.10 D in group 1, compared to 42.97 ± 1.47 D and 42.72 ± 1.54 D in groups 2 and 3, respectively. Similarly, K2 was highest in group 1 (45.50 ± 1.14 D), followed by 44.12 ± 1.67 D in group 2 and 44.18 ± 1.64 D in group 3. Refractive cylinder values showed minimal variation across the groups.

Our findings were consistent with those reported by ***Jin et al.*** [29], who conducted a systematic review involving 862 normal eyes to compare CCT measurements obtained with the Sirius device versus ultrasound pachymetry (USP). They reported a mean CCT of 537 µm using the Sirius system, which aligns closely with our mean values, particularly in group 2.

Huang et al. [30] assessed the repeatability and reproducibility of CCT measurements using the Sirius device in post-LASIK eyes. Their study demonstrated a high level of agreement between Sirius and USP, despite minor underestimations (2–4 µm) by the Sirius. This supports the reliability of Sirius-based measurements, even in surgically altered corneas.

Similarly, ***Bayhan et al.*** [31] compared CCT measurements obtained using spectral-domain optical coherence tomography (SD-OCT), Lenstar, Sirius, and USP in 50 eyes. The mean CCT values obtained via Sirius (525.92 ± 34.10 µm) were nearly identical to those obtained with SD-OCT and closely correlated with measurements from other modalities, reinforcing the precision of Sirius in clinical practice.

Maresca et al. [32] further confirmed the strong correlation between Sirius and ultrasound pachymetry ($r = 0.92$; $p < 0.001$), although the Sirius readings were significantly lower. They highlighted the higher repeatability and lower coefficient of variation of the Sirius system, which underscores its consistency in clinical use.

Jorge et al. [33] evaluated CCT and anterior chamber depth (ACD) measurements using the Sirius device compared to ultrasound-based methods. Their findings demonstrated statistically significant differences between methods, yet strong agreement in repeated measures, confirming the Sirius system's potential as a reliable alternative to ultrasound in both CCT and ACD assessments.

Pierro et al. [34] conducted a cross-sectional study comparing one ultrasound and nine optical devices, including Sirius, for CCT measurement. The mean CCT values ranged between 536 ± 42 µm and 577 ± 40 µm across devices, a range that includes our results, further supporting the validity of Sirius-derived data.

Simsek et al. [35] also compared multiple modalities, including RTVue OCT, Lenstar, Sirius, and USP in 128 participants. They observed statistically significant differences among the devices, particularly between Sirius and USP ($p = 0.011$), attributing these differences to varying measurement principles. Nevertheless, the Sirius device still provided clinically acceptable measurements that fell within the expected range. ***Teberik et al.*** [36] compared contact-based CCT measurements using iPac and Echoscan US-500 with non-contact devices including Pentacam HR and Sirius in 76 healthy individuals. The mean CCT reported was 551.2 ± 37.2 µm, aligning closely with the values obtained in our study. These findings underscore the Sirius system's accuracy and consistency compared to the gold-standard ultrasound technique.

Despite these promising findings, our study has some limitations. The relatively small sample size limited the generalizability of the results. Additionally, single-arm design without a comparative control group restricted the strength of our conclusions regarding diagnostic accuracy. Future research should incorporate larger sample sizes and direct comparisons with established gold-standard instruments to determine the Sirius system's sensitivity, specificity, and accuracy in the assessment of corneal indices, particularly in the context of corneal pathologies such as keratoconus.

CONCLUSION

Sirius Scheimpflug-Placido topography system demonstrates reliable performance in measuring various corneal parameters, particularly central corneal thickness. The results are consistent with those obtained using conventional and widely accepted diagnostic tools, supporting its utility in routine preoperative refractive assessment and corneal evaluation

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