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ORIGINAL RESEARCH

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Comparison of scansys and pentacam HR in healthy eyes

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ABSTRACT

Background: To determine the interchangeability of Scansys (MediWorks, Shanghai, China) and entacam HR (Oculus, Wetzlar, Germany) in anterior segment measurements.

Research designs and methods: 42Forty-two healthy individuals' right eye (mean age 31.5 ± 7.3 years) were assessed for keratometry (K), central corneal thickness (CCT), thinnest corneal thickness (TCT), pupil center pachymetry, corneal volume, anterior chamber volume (ACV), anterior chamber depth (ACD), terior chamber angle (ACA), intraocular pressure (IOP) sum, Q-value (asphericity), and horizontal white-to-white (WTW). Intraclass correlation coefficient (ICC), linear regression analysis, difference of mean, and Bland-Altman plots [bias line and 95% limits of agreement (LoA)] were analyzed.

Results: Scansys repeated excellently the Pentacam HR for keratometry (except for anterior steep K), ACD, pupil center pachymetry, CCT, TCT, IOP sum, and corneal volume (all ICC > 0.9, r^2 > 0.8, and narrow LoAs). There was strong correlations in measuring WTW and ACV (r^2 = 0.631 and r^2 = 0.623, respectively) and weak correlations in measuring ACA and Q values (all r^2 < 0.5).

Conclusion: The interchangeability of devices were confirmed in measuring ACD, pupil center achymetry, CCT and TCT, IOP sum, corneal volume, and keratometry except for the anterior steep K. However, in measuring WTW, ACV, asphericity, and ACA, Scansys should not be used instead of Pentacam HR.

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KEYWORDS
Scansys; pentacam HR; anterior segment; scheimpflug imaging; interchangeability

1. Introduction

The examination of the corneal profile is widely used in planning corneal and intraocular surgeries [1,2]. Accurate preoperative and postoperative evaluation of the corneal morphology is essential for cornea surgeons to screen the refractive surgery candidates and analyze the surgery outcomes [3–5]. It is also important for the detection and following the progression of corneal ectatic disorders [6]. Another clinical application of corneal morphology examination is fitting specialized contact lenses, such as gas-permeable and mini-scleral contact lenses [6–8]. Corneal topography is an optical procedure that is commonly used for the clinical evaluation of the corneal profile and its morphology. Modern corneal topographers, which are known as corneal tomography systems, can evaluate both the anterior and posterior surfaces of the corneal profile, providing three-dimensional corneal maps [6].

The anterior segment analysis using optical systems is a noncontact method that provides convenience and speed for both practitioners and surgery candidates [9]. It can obtain numerous anterior segment biometry parameters, including central corneal thickness (CCT), corneal curvature, anterior chamber depth (ACD), and corneal diameter in one measurement. Scheimpflug imaging technology is an accurate method of corneal tomography that is frequently used for the evaluation of the anterior segment parameters [10]. There are several devices in the market that work according to the Scheimpflug principle, with the most popular ones being Pentacam HR (Oculus, Wetzlar, Germany), Sirius Topographer (CSO, Firenze, Italy), and Galilei (Ziemer ophthalmic Systems, Port, Switzerland). Scansys (MediWorks, Shanghai, China), as a novel three-dimensional anterior eye analysis system, also has the Scheimpflug imaging technology for comprehensive analysis of the anterior segment of the eye. With the availability of state-of-the-art instrumentation for evaluation of the anterior segment parameters, comparative studies between devices are as essential as the independent investigation of each equipment. This subject becomes more important when patients may undergo anterior segment measurements through different tomography machines [11].

Several studies have validated the repeatability, precision, and agreement between different corneal tomography devices [12–14]. However, very little work has been undertaken to evaluate the agreement between Scansys and other corneal tomography systems. At the time of undertaking the current study, few studies examined the reliability of Scansys and its agreement with other instruments such as Pentacam HR, which is a well-established and widely used device for the anterior segment analysis [15–17]; however, they did not cover all the anterior segment variables including anterior chamber angle (ACA), asphericity (Q-value), and horizontal white to white (WTW). Therefore, we set up this study to determine the reliability and

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agreement of a wide range of anterior segment measurements between Scansys and Pentacam HR. The main purpose of this study is to determine the interchangeability of these two Scheimpflug-based imaging technologies in healthy participants to provide a basis for future clinical application of Scansys.

2. Patients and methods

This cross-sectional study was conducted in healthy individuals over 18 years old who were referred for routine eye examination to Farabi Eye Hospital, Tehran, Iran, from January 2022 to September 2022. Following a thorough explanation of the aims and procedures of the study, the informed consent forms were signed and provided from all participants. The ethical committee of Tehran university of medical sciences approved the protocols of this study (ethics number: IR.TUMS.FARABIH.REC.1400.084). The study was executed in accordance with the tenets of the Declaration of Helsinki. Healthy individuals without any history of eye diseases were included. Exclusion criteria were history of ocular surgery and trauma, presence of corneal diseases, including corneal opacity and scar, history of wearing gas-permeable or mini-scleral contact lenses, dry eye, acute and progressive ocular comorbidities, and systemic diseases affecting the eyes. Also, all soft contact lens users were requested to discontinue wearing their contact lenses at least two weeks before the examination day.

2.1. Instruments and procedures

2.1.1. Scansys anterior segment 3D analyzer

Scansys Anterior Segment 3D Analyzer (MediWorks, Shanghai, China, 2021, Serial Number: 517 J202103301-01-01) uses Scheimpflug imaging technology to generate 28/60 slit images in high-resolution (1280 × 1024 pixels) from 107,520/230400 data points within one second per measurement. The horizontal and vertical measurement ranges over the corneal surface are up to 14 mm and 10 mm, respectively. Scansys examination was performed in a dark environment. The patient was instructed to sit, fix their head in the given area, and keep their eyes wide open while looking at the circular blue fixation point. After the fixation was obtained, the Scansys shooting program was automatically activated, and the instrument began scanning and provided 28 Scheimpflug images within one second.

Based on the tomography images, in addition to corneal keratometry (range, 12–72 D) and pachymetry (range, 300–900 µm), this device provides ACD as measured from posterior surface of the cornea to anterior surface of the lens (range, 0.8–6 mm), ACA which is the angle formed between the iris and cornea (range, 16–60°), anterior chamber volume (ACV) or the space between cornea and iris (range, 15–300 mm3), and the corneal volume (value range not provided by company). Also, a special Angle Opening Distance (AOD) graph shows the distance between iris and cornea and its trend from periphery to center. For this study, the horizontal (3 and 9 o'clock) ACA values were used.

2.1.2. Pentacam anterior segment analyzer

Pentacam Anterior Segment Analyzer is a three-dimensional anterior segment diagnosis and analysis system based on the optical principle of Scheimpflug. It uses visible light (blue light) with a wavelength of 475 nm to perform rotational photography and collect 25 or 50 images of the anterior segment profile. It can measure up to 25,000 corneal data points for three-dimensional reconstruction and computational analysis of the cornea.

The operating principles of Pentacam HR are similar to the Scansys. After adjusting the position, the patient was instructed to open their eyes and look straight at the center of the rotation axis (the red circular fixation light) in the middle of the blue light band. The Scheimpflug three-dimensional imaging system accomplishes a 360° scan within two seconds.

2.2. Measurements

First, routine examinations were performed, including uncorrected and best-corrected distance visual acuity, refraction, and slit lamp examination. Each patient then underwent Scansys followed by Pentacam. In order to avoid external light sources interfering with the image, the examinations were performed in a dark room. All examinations were performed by the same experienced optometrist. For considering the diurnal fluctuations, all examinations were performed from 10:00 to 13:00. Also, all subjects were examined at least 3 hours after waking up to minimize the effect of closed eyelids-induced hypoxia during sleep on the corneal tissue thickness [18,19].

The measurements were repeated three times with each device for the right eye, and only the images with the imaging quality (quality statement, QS) as OK were recorded. Corneal measurements including anterior and posterior keratometry, CCT, thinnest corneal thickness (TCT), pupil center pachymetry, ACD, ACA, corneal volume, ACV, intraocular pressure (IOP), asphericity (Q-value), and WTW were extracted from the measurements of both devices for analysis.

2.3. Statistical analysis

The collected data was analyzed using SPSS-26 software (IBM, Armonk, NY). The normality of data distribution was confirmed using the Shapiro-Wilk test. For normally distributed parameters, differences between devices were compared using paired samples t-test. For non-normal data, the non-parametric Mann-Whitney U test was utilized for comparisons. A p-value < 0.05 was considered statistically significant. Intraclass correlation coefficient (ICC) and a linear regression analysis including R square coefficient was calculated to evaluate the different topographic indices between Pentacam HR and Scansys. Bland–Altman plots were applied to describe the agreement between devices with 95% limits of agreement (LoA) and bias line. ICC > 0.9 and a narrow 95% LoA were considered as the key indicators of good agreement and interchangeability of the devices. Medcalc® software version 19.0.4 was used for

drawing Bland – Altman plots. P-value less than 0.05 was considered statistically significant.

For the purpose of sample size calculation, previous studies on Scheimpflug devices have shown a 6 µm SD of difference for corneal thickness [16], 0.16 D for steepest keratometry, and 0.05 mm forACD measurements [20]. Considering a two-sided level of significance (α) = 5% and power (1-β) = 99%, for detecting a difference of 5 µm in thickness, 0.125 D in corneal power, and 0.05 mm in ACD, a minimum sample size of 29, 33, and 21 was calculated. All sample size calculations were conducted using G Power version 3.1.9.6.

3. Results

A total of 42 right eyes from 42 participants were included in the study. The mean age was 31.3 ± 7.8 years (range, 19–47) and 18 (42.8%) were male. Comparisons of keratometry and asphericity of the anterior and posterior corneal surfaces between Pentacam HR and Scansys are reported in Table 1. As shown in this table, the ICC of flat K and steep K between the two devices were 0.998 and 0.993 in the anterior corneal surface and 0.932 and 0.973 in the posterior corneal surface, respectively. Moreover, the linear regression analysis between the two devices in the anterior cornea showed $r^2 = 0.992$, $p < .001$ for the flat K and $r^2 = 0.953$, $p < .001$ for the steep K and in the posterior cornea, it was $r^2 = 0.853$, $p < .001$ for the flat K and $r^2 = 0.906$, $p < .001$ for the steep K. Asphericity showed $r^2 = 0.403$, $p < .001$ with ICC = 0.745 in the anterior cornea and $r^2 = 0.451$, $p < .001$ and ICC = 0.764 in the posterior cornea. Bland–Altman plots and scatter plots for the flat K and steep K in the anterior and posterior corneal surfaces comparing Pentacam HR and Scansys are shown in Figure 1.

Comparisons of pachymetry indices, ACD, ACA, IOP sum, WTW, corneal volume, and ACV between Pentacam HR and Scansys are reported in Table 2. ICC > 0.9 was observed in all the variables except ACA, WTW and ACV. The linear regression analysis showed $r^2 > 0.8$ and $p < .001$ in all variables except ACA, WTW, and ACV. Bland–Altman plots and scatter plots for CCT and TCT comparing Pentacam HR and Scansys are shown in Figure 2. Also, in Figure 3, Bland–Altman plot and scatter plot for ACD comparing Pentacam HR and Scansys are presented.

4. Discussion

The newly introduced Scansys incorporates a Scheimpflug camera for assessing the cornea and anterior segment parameters. Before a new device can be used for routine clinical examinations, is necessary to determine the reliability of its measurements and their agreement with already available and popular instruments. This study aimed to compare the corresponding parameters between Scansys and Pentacam HR, which either warrants or abolishes their possible interchangeable use in the anterior segment examination. There was excellent agreement between two devices for the ACD measurement. Moreover, there was good agreement for the anterior flat K, posterior flat and steep K readings, IOP sum and corneal volume. However, in the corneal thickness parameters, Scansys and Pentacam might be used with caution. In the ACA and WTW, the obtained analyses were not satisfying for interchangeability of the devices. The results are further discussed below.

The accuracy of measurements of CCT and corneal curvature is of great significance for refractive surgery preoperative screening and diagnosis of corneal ectasias [21–23]. As the current study demonstrated, there was a strong agreement between two devices for the flat K in the anterior cornea, considering ICC, linear regression analysis, bias line and Bland–Altman plots and the difference of mean.

However, for the steep K, 95% LoA was not narrow (about 1 diopter) in spite of the strong correlation in the ICC, linear regression and the low difference of mean. Therefore, in the anterior cornea, both devices measured flat K very similar, but for the steep K, Scansys should not be used interchangeably with Pentacam HR. Xu et al. [17] evaluated corneal and anterior segment parameters in 204 myopic subjects and suggested that Scansys and Pentacam can be interchangeably used for the anterior corneal parameters. In comparison to them, we had a relatively smaller sample size that might have been related with observing a wide 95% LoA in anterior steep K.

Table 1. Comparison of keratometry and sphericity of anterior and posterior corneal surfaces between Pentacam HR (oculus, Wetzlar, Germany) vs. Scansys (MediWorks, Shanghai, China).

						Linear regression						95% CI of differences of means		
		Device	Mean ± SD	Minimum	Maximum	R Square	*P*-value	ICC	95% LoA		Difference of mean ± SD*	Lower	Upper	*P*-value**
Anterior	Flat K (D)	Pentacam	43.09 ± 1.36	40.00	45.80	0.992	<.001	0.998	−0.59	0.61	−0.005 ± 0.124	−0.043	0.034	0.805
		Scansys	43.09 ± 1.36	39.92	45.85									
	Steep K (D)	Pentacam	44.24 ± 1.45	40.40	47.40	0.953	<.001	0.993	−0.50	0.44	−0.025 ± 0.244	−0.101	0.051	0.514
		Scansys	44.27 ± 1.49	40.49	47.53									
	Q value	Pentacam	−0.33 ± 0.12	−0.76	−0.14	0.403	<.001	0.745	−0.02	0.07	0.052 ± 0.134	0.010	0.094	0.018
		Scansys	−0.38 ± 0.17	−0.95	−0.11									
Posterior	Flat K (D)	Pentacam	−6.12 ± 0.20	−6.50	−5.70	0.853	<.001	0.932	−0.39	0.03	−0.194 ± 0.078	−0.218	−0.169	<.001
		Scansys	−5.93 ± 0.20	−6.28	−5.59									
	Steep K (D)	Pentacam	−6.46 ± 0.24	−7.00	−6.00	0.906	<.001	0.973	−0.32	−0.02	−0.198 ± 0.074	−0.221	−0.175	<.001
		Scansys	−6.26 ± 0.22	−6.73	−5.84									
	Q value	Pentacam	−0.29 ± 0.13	−0.61	−0.03	0.451	<.001	0.764	−0.05	0.11	0.060 ± 0.144	0.015	0.105	0.010
		Scansys	−0.35 ± 0.19	−0.81	−0.01									

*Differences of the mean values calculated by subtracting measurements of Pentacam HR from Scansys.
**Based on paired t-test. D, diopter; ICC, intraclass correlation coefficient; LoA, limit of agreement; CI, confidential interval.

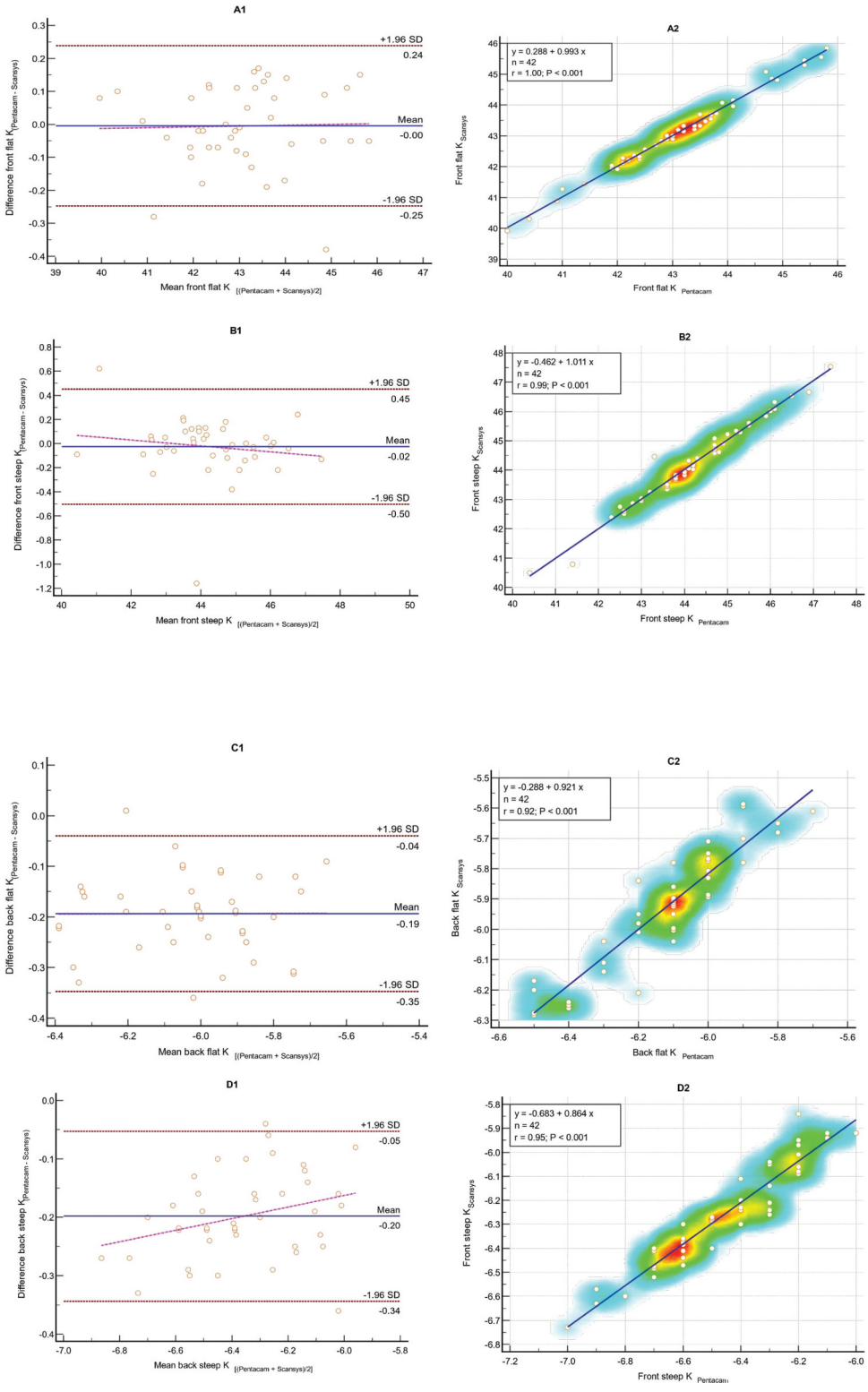


Figure 1. (a) Bland–Altman plot for A1- front flat keratometry (diopter), B1- front steep keratometry (diopter), C1- back flat keratometry (diopter) and D1- back steep keratometry (diopter) comparing pentacam HR (oculus, Wetzlar, Germany) vs. Scansys (MediWorks, Shanghai, China). The mean difference, 95% limits of agreement and regression line are shown by blue solid line, red and pink dash-dotted lines, respectively. (b) Scatter plots to compare mean values of A2- front flat keratometry (diopter), B2- front steep keratometry (diopter), C2- back flat keratometry (diopter) and D2- back steep keratometry (diopter) measured with pentacam HR (oculus, Wetzlar, Germany) and scansys (MediWorks, Shanghai, China). The blue dash-dotted lines show the regression lines. K, keratometry.

In the posterior cornea, in both steep and flat keratometries, there were strong correlations in the ICC and linear regression analysis and 95% LoA were narrow in spite of observing a significant difference in mean posterior keratometry for the flat and steep K and bias line which was not zero, but close to zero (less than 0.25 diopter), which might not be clinically meaningful. This finding demonstrates that both devices can be used interchangeably for the

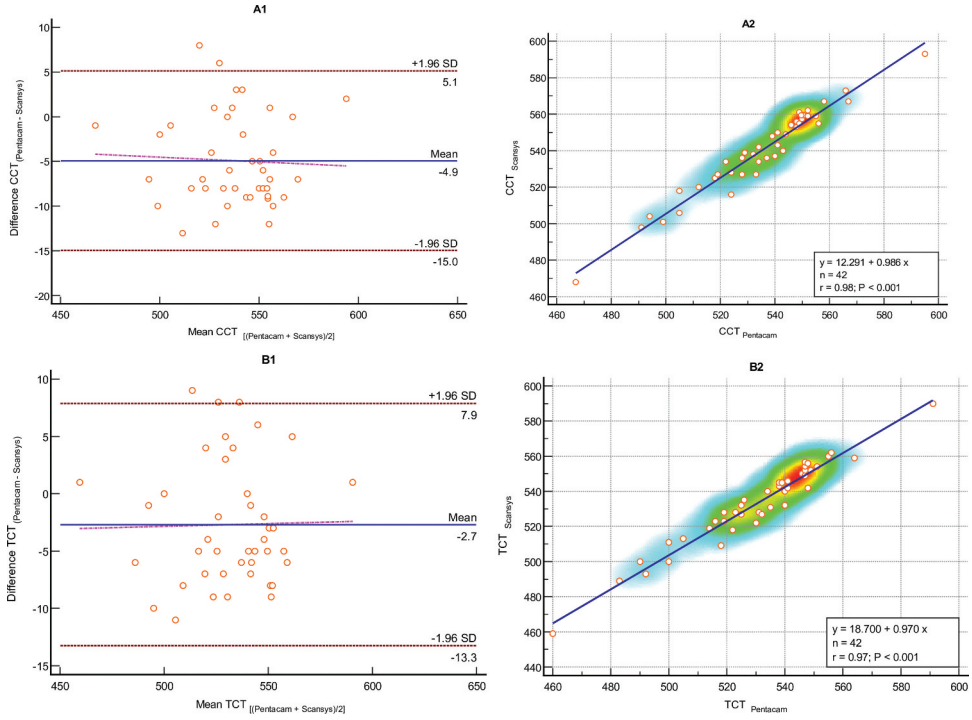


Figure 2. (a) Bland–Altman plot for A1- central corneal thickness (µm) and B1- thinnest corneal thickness (µm) comparing pentacam HR (oculus, Wetzlar, Germany) vs. Scansys (MediWorks, Shanghai, China). The mean difference, 95% limits of agreement and regression line are shown by blue solid line, red and pink dash-dotted lines, respectively. (b) Scatter plots to compare mean values of A2- central corneal thickness (µm) and B2- thinnest corneal thickness (µm) measured with pentacam HR (oculus, Wetzlar, Germany) and scansys (MediWorks, Shanghai, China). The blue dash-dotted lines show the regression lines. CCT, central corneal thickness; TCT, thinnest corneal thickness.

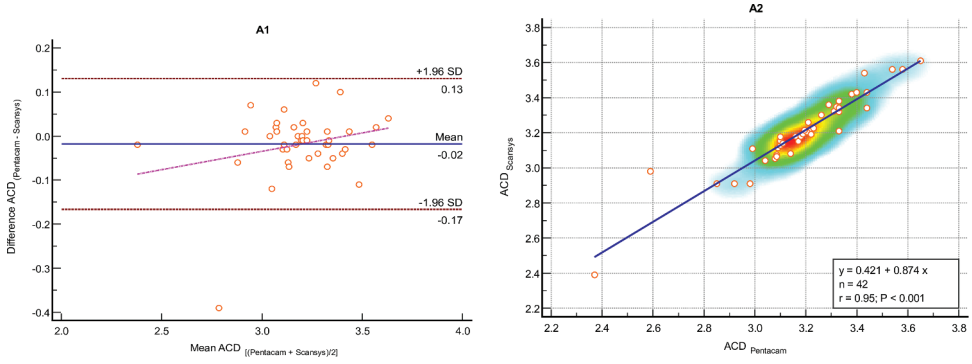


Figure 3. A1- Bland–Altman plot for anterior chamber depth (mm) comparing pentacam HR (oculus, Wetzlar, Germany) vs. Scansys (MediWorks, Shanghai, China). The mean difference, 95% limits of agreement and regression lines are shown by the blue solid line, red and pink dash-dotted lines, respectively. A2- scatter plots to compare mean values of anterior chamber depth (mm) measured with pentacam HR (oculus, Wetzlar, Germany) and scansys (MediWorks, Shanghai, China). The blue dash-dotted lines show the regression lines. ACD, anterior chamber depth.

posterior cornea evaluation. Consistently, Wang et al. [15] reported good agreement between Scansys and Pentacam in keratometry measurements; however, Xu et al. [17] reported interchangeability of the devices, only in the anterior corneal curvature measurements.

Looking at the pupil center pachymetry, CCT and TCT showed a strong agreement between two devices in linear regression and ICC; however, 95% LoA was slightly wide in CCT and TCT parameters in the Bland–Altman plots and the difference of mean was significant between two devices with 4.5, 4.9, and 2.7 µm difference in the pupil center pachymetry, CCT, and TCT, respectively. In line with the current findings, Yu et al. [16] also observed almost the same 95% LoA in CCT (−6.6 µm to 13.4 µm) and in TCT (−5.9 µm to 14.8 µm). However, they considered this limit as narrow and reported high agreement between two devices. In contrast with these findings, Wang et al. [15] reported LoA for the CCT, for comparison of Scansys and Pentacam HR, between −11.26 µm and −4.26 µm which is very narrow compared to current results and Yu et al. [16]. The bias line was −4.9 µm and −2.7 µm for CCT and TCT, respectively, in the current study in comparison to Yu et al. [16] who reported −3.4 µm and −4.5 µm for CCT and TCT, respectively. This can demonstrate that Pentacam underestimates the CCT and TCT than Scansys [16] and other devices such as Galilei and ultrasound [24].

Table 2. Comparison of pachymetric indexes, ACD, ACA, IOP sum, WTW, corneal volume and chamber volume between Pentacam HR (oculus, Wetzlar, Germany) vs scansys (MediWorks, Shanghai, China).

					Linear regression						95% CI of differences of means		
	Device	Mean± SD	Minimum	Maximum	R Square	*P*-value	ICC	95% LoA		Difference of mean ± SD*	Lower	Upper	*P*-value**
Pupil center pachymetry (μm)	Pentacam	534.52 ± 23.22	465.00	595.00	0.949	<.001	0.978	−15.8	8.1	−4.500 ± 5.348	−6.166	−2.834	<.001
	Scansys	539.02 ± 23.64	464.00	593.00									
CCT (μm)	Pentacam	535.10 ± 23.32	467.00	595.00	0.953	<.001	0.988	−15.5	7.2	−4.929 ± 5.120	−6.524	−3.333	<.001
	Scansys	540.02 ± 23.56	468.00	593.00									
TCT (μm)	Pentacam	530.29 ± 23.85	460.00	591.00	0.949	<.001	0.987	−15.1	8.5	−2.690 ± 5.390	−4.370	−1.011	.002
	Scansys	532.98 ± 23.74	459.00	590.00									
ACD (mm)	Pentacam	3.19 ± 0.24	2.37	3.65	0.898	<.001	0.972	−0.27	0.29	−0.018 ± 0.076	−0.041	0.006	.133
	Scansys	3.21 ± 0.22	2.39	3.61									
ACA (degree)	Pentacam	41.18 ± 4.37	25.80	50.80	0.305	<.001	0.619	−0.09	11.4	−0.538 ± 3.647	−1.675	0.599	.345
	Scansys	41.71 ± 2.23	33.00	45.00									
IOP sum (mmHg)	Pentacam	0.59 ± 0.93	−1.80	3.30	0.953	<.001	0.988	0.09	0.24	0.188 ± 0.207	0.122	0.253	<.001
	Scansys	0.40 ± 0.95	−1.72	3.28									
WTW (mm)	Pentacam	11.80 ± 0.33	11.10	12.50	0.631	<.001	0.884	−0.31	0.54	−0.245 ± 0.217	−0.313	−0.178	<.001
	Scansys	12.04 ± 0.35	11.06	12.70									
Corneal volume (mm^3)	Pentacam	60.12 ± 2.52	53.30	67.50	0.804	<.001	0.944	−5.6	−.08	−0.707 ± 1.202	−1.087	−0.328	.001
	Scansys	60.79 ± 2.69	53.71	67.91									
Chamber volume (mm^3)	Pentacam	195.26 ± 27.28	104.00	255.00	0.623	<.001	0.880	−10.9	59.9	30.069 ± 17.035	24.760	35.377	<.001
	Scansys	165.19 ± 24.66	93.75	220.97									

*Differences of the mean values calculated by subtracting measurements of Pentacam HR from Scansys.
**Based on paired t-test. CI, confidential interval; ICC, intraclass correlation coefficient; LoA, limit of agreement;CCT, central corneal thickness; TCT, thinnest corneal thickness; ACD, anterior chamber depth; ACA, anterior chamber angle; IOP, intraocular pressure; WTW, horizontal white to white.

The only parameter in which showed a strong agreement between two deices in all the analyses was ACD. Xu et al. [17] also showed a good repeatability of Scansys in measuring ACD. ACD is an established anterior segment parameter, which is predominantly important for preoperative evaluation of cataract and phakic intraocular lens implantation surgeries [25,26]. Some studies reported that Scheimpflug corneal imaging devices are interchangeable in measuring ACD and the differences were within the acceptable clinical levels [27–30]. Also, we found a very strong correlation between devices in measuring ACD. However, in the ACA, there was a weak correlation between devices in the linear regression analysis ($r^2 = 0.305$) and ICC (0.619), in spite of no significant difference in the mean ACA between two devices. Therefore, two devices cannot be used interchangeably in this variable. The analysis for the asphericity also did not show a good agreement between two devices, so they cannot be used interchangeable.

IOP sum and corneal volume showed a good correlation in the linear regression analysis and in the ICC. However, the difference of mean was significant in both parameters, although it might not be clinically meaningful. Corneal volume data in conjunction with corneal thickness measurements and other corneal surface data improve sensitivity and specificity for the detection of very early forms of keratoconus, where there is an abrupt increase from the TCT to the periphery in the corneal volume [31]. In WTW and ACV, the only strong agreement between two devices was obtained from the ICC analysis; however, the linear regression analysis did not show a strong correlation. The ACV is of significant importance, as it is closely related to the diagnosis of primary closed angle glaucoma [32].

In spite of the importance of the WTW diameter in determining the power calculation of refractive IOLs, few studies have investigated the agreement between different corneal tomography devices, and their results have been inconsistent [33,34]. Some studies reported that corneal topography devices could be used interchangeably regarding WTW measurements [27]; whereas, others argued that practitioners should not consider different devices as interchangeable in clinical practice [35–37]. Regarding Scheimpflug-based imaging devices, Domínguez-Vicent et al. [38] evaluated the agreement between Pentacam HR and Galilei. The authors reported that 95% LoA were large enough to be clinically significant and these two Scheimpflug imaging systems could not be used interchangeably. We also did not find a good correlation ($r^2 = 0.631$) in WTW measurements between Scansys and Pentacam HR.

According to Dominguez-Vicent et al. [34] the difference between devices for WTW measurement could be related with digital image processing in each device. The gray scale steps for detection of limbus point which lies between the white sclera and the darker iris image could be affected by any darkness during the measurement such as, eyelash shadow, nose shadow or device shadow.

Despite the advantages, Pentacam HR is an expensive device costs about $40,000, which is not affordable for some primary eye care centers in comparison to Scansys which costs less than half price of the Pentacam HR (≈ $18.822). Scansys anterior segment analyzer is a new Scheimpflug imaging system that can acquire data of 107,520/230,400 points over the corneal surface. As mentioned earlier, there is a not much published data on the reliability of Scansys in corneal curvature and other anterior segment measurements. This study evaluated the agreement of Scansys in measuring anterior segment parameters compared to Pentacam HR measurements to explore its clinical application value. The different findings of this study compared to previous studies on Scheimpflug imaging devices could be explained by different sample sizes, different examiners and their skills, different refractive statuses of the

participants, and difference in specifications of the devices. Therefore, in clinical applications, devices could be used interchangeably with caution and for research purposes, interchangeability is not recommended.

In terms of limitation, it should be noted that we had a relatively small sample size, therefore, statistical significant results obtained especially in difference of mean might not be clinically significant. In addition, the measurements of other tomography systems with different imaging modalities, such as slit scanning and optical biometry devices, were not compared. Another limitation is that we only included healthy eyes and there is still no data about the clinical use of Scansys on non-healthy eyes. Further research is recommended to assess the clinically use of Scansys in different clinic situations, such as keratoconus diagnosis and follow up, pre refractive surgery patient assessment, IOL calculation and contact lens practice. It is necessary to understand the potential, but also the limitations of this new device (Scansys) in comparison to other available corneal tomography devices in clinical practice as well as its potential application in research.

5. Conclusion

To sum up, the current results confirmed that Scansys agreed well with Pentacam HR in measuring ACD, pupil center pachymetry, CCT and TCT, IOP sum, corneal volume and keratometry readings except for the anterior steep k in healthy young adults. However, in measuring WTW, ACV, asphericity and ACA, Scansys should not be used instead of Pentacam HR. For research purposes, the only reliable findings was obtained for ACD and for the other parameters, devices cannot be used interchangeably.

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Declaration of interest

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Authors' contribution

Hesam Hashemian, Mehdi Khodaparast, Hooman Ahmadzadeh, and Majid Akhzari Hamedani contributed to the design of the research and providing the facilities. Marrwan Hisham Mohmmed and Yasir Adil Shakor collected the data. Elham Azizi and Masoud Khorrami-Nejad analyzed the results and wrote the original draft and revised the manuscript critically before submission.

Ethics approval and consent to participate

The ethical committee of Tehran University of medical sciences approved the protocol of this study (IR.TUMS.FARABIH.REC.1400.084) and the study adhered to the tenets of the Declaration of Helsinki and HIPAA. Informed written consent was obtained from all participants.

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