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Original article

Reliability of Scheimpflug versus Anterior Segment Optical Coherence Tomography after Epithelial_off Crosslinking in Keratoconus

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Abstract:

Background: Corneal thickness monitoring is critical in the diagnosis and follow-up of keratoconic patients. This study aimed to evaluate the inter-device reliability in corneal pachymetry after epithelium-off crosslinking using anterior segment optical coherence tomography (AS-OCT) and Scheimpflug tomography. **Method:** This was a cross-sectional observational study conducted on patients who had epithelial-off crosslinking. Patients were subjected to follow-up imaging using Pentacam (Oculus) and AS-OCT (RTVue). The inter-device reliability was compared. **Results:** 40 eyes, were included. Regarding central corneal thickness (CCT); pentacam measured a mean of 483.2 µm, versus 477.2 µm using AS-OCT. The thin thickness (thickness (TCT) measured mean 470.05 µm with pentacam versus 444.7µm using AS-OCT, the mean paracentral superior corneal thickness (STC 2mm) by pentacam was 519.49µm versus 539.9µm by AS-OCT. Regarding mean paracentral inferior corneal thickness (ICT 2mm), pentacam measured 519.6µm versus 489.18µm by AS-OCT, the mean peripheral superior thickness by pentacam measured 589.6µm versus 565.43µm by AS-OCT. the mean peripheral inferior thickness (ICT 5mm), pentacam measured 578.7µm versus 529µm by AS-OCT . On evaluating the reliability between pentacam and AS-OCT by ICC it was excellent in (CCT), good in (TCT and STC 2mm), moderate in (STC 5mm), questionable in (ICT 2mm) and poor in (ICT 5mm). **Conclusion:** Based on the results, both AS-OCT and pentacam demonstrate comparable measurements with excellent reliability in the central corneal region, and good reliability in the thinnest location while this similarity decreased in the peripheral part, especially the inferior region.

Keywords: keratoconus, crosslinking, pentacam, optical coherence tomography, central corneal thickness, peripheral corneal thickness.

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Introduction

Keratoconus is the most common ectatic disorder, characterized by bilateral asymmetric progressive focal corneal thinning in the inferior temporal region of the cornea, Identification of this characteristic corneal thinning pattern is a beneficial new method for keratoconus diagnosis. [1]

The time course for the development of keratoconus signs and symptoms, and their association with disease severity are highly variable, making the classification of keratoconus severity challenging. Yet several classification systems have been developed, which primarily rely on corneal morphology or changes such as corneal thinning, anterior and posterior corneal curvature, and cone position and shape.[1]

The main treatment options include corneal crosslinking, intracorneal ring implantation, photorefractive keratectomy, combined procedures (cross-linking plus), and keratoplasty. [2]

Corneal crosslinking (CXL) is useful in slowing the advancement of keratectasia and enhancing visual acuity by around 1-2 lines [3], Riboflavin acts as a photosensitizer to ultraviolet radiation to strengthen the collagen bonds in the cornea.[4] the standard CXL procedure involves the removal of the epithelium (epithelium-off CXL) to enhance riboflavin penetration. [5] Crosslinking can also be performed with an intact epithelium (epithelial-on CXL); However, the corneal epithelium may act as a barrier for riboflavin diffusion and hinder the CXL photochemical reaction and affect its efficacy.[6]

To diagnose and monitor corneal diseases such as keratoconus, precise corneal thickness (CT) measurement is essential.[7]

CT evaluation is also important in refractive surgery to reduce the risk of developing iatrogenic corneal ectasia. After CXL FDA approval the significance of thinnest corneal thickness (TCT) evaluation has increased because values greater than 400 µm following epithelial debridement are considered necessary to protect the corneal endothelium from ultraviolet-A radiation.[3]

Both the anterior and posterior surfaces could be detected by devices that use tomographic imaging techniques, such as Scheimpflug and optical coherence tomography (OCT) [3]. Although pentacam allows noncontact, simple measurement and analysis of the cornea to the posterior surface of the lens [8], topographic screening techniques are not without flaws, though. First, tear film breakdown or corneal irregularity may prevent the availability of satisfactory topographical maps. Second, these topography-based techniques have trouble differentiating between keratoconus and other causes of corneal distortion [9]., such as lid artifact, uneven tear film, subepithelial deposits or scarring, and warpage caused by contact lenses[10]. These may cause false diagnosis of keratoconus or potential to hide real keratoconus.

OCT is a more recent non-contact imaging technique that has excellent and high-quality pictures that compensate well for the shortcomings of Scheimpflug imaging, [11] also it can measure epithelial thickness maps and detect early epithelial remodeling in keratoconus. [12]

Optovue AS-OCT is a light-based imaging technique that provides high-resolution images of the anterior segment of the eye. Detailed examination of the anterior segment up to 20 mm in diameter and the central 5 mm diameter area of the pachymetry map can also be used in the diagnosis of keratoconus.[13]

its great reproducibility and reliability in assessing central corneal thickness have been confirmed by numerous studies. [14-17]

However, most of the earlier research was carried out on healthy corneas; definitive information regarding corneas that had previous surgery is still lacking.

This study compared regional corneal thickness measured using pentacam and As-oct to assess the inter-device repeatability and reproducibility after epi-off CXL in keratoconus.

Methods

Patients

This cross-sectional observational study was performed on 40 eyes of 21 keratoconic patients who had epithelial-off CXL at Damietta Ophthalmic Hospital between November 2022 to November 2023. All participants signed informed consent forms. The present study gained approval from the Research Ethics Committee (REC) of Benha University (**MS 57-10-2022)** and conformed to the principles outlined in the Declaration of Helsinki.

Inclusion criteria were subjects over 18 years of age diagnosed as keratoconus who had uneventful epi-off CXL, were able to participate in the investigations, had no history of wearing contact lenses in the short term (for soft lenses less than 2 weeks and rigid lenses less than 4 weeks), intraocular pressure (IOP) within the normal range.

Patients who recently had corneal haze, scarring, elevated intraocular pressure, active ocular inflammation, and dry eye were excluded.

Corneal crosslinking technique

The procedure of epithelial-ff CXL was carried out by riboflavin solution 0.146% (RIBOFAST: 1.5 ml - riboflavin 0.1%, Vit E TPGS (penetration enhancer), Sodium phosphate dibasic dodecahydrate, Sodium phosphate monobasic monohydrate, Sodium chloride, Purified water) and UV illuminator (CF-X Linker)

The corneal surface was prepared with a drop of proparacaine, followed by the placement of the lid speculum. Then debridement of the central 8–9 mm using a micro sponge soaked with 20% ethyl alcohol applied for 15 seconds, epithelium removed using a forceps, followed by topical administration of riboflavin for 30 min. The device focus system was used to align the optical head on the patient's eye under ultraviolet radiation, which emitted radiation at a wavelength of 365-370 nm with a radiation intensity of 3mW/cm2. After 30 minutes of UVA exposure, the total energy delivered was (5.4 J/ cm2), and the light source was then switched off. Gatifloxacin was administered four times daily for one week, and prednisolone acetate was administered four times daily in the first week, then gradually withdrawn over a period of three weeks. All patients used bandage contact lens, which was removed after seven days.

Follow-up

The patients were subjected to follow-up until re-epithelization occurred.

Corneal imaging

Pentacam examination was conducted utilizing the OCULUS device, Germany.) which uses a rotating Scheimpflug camera with 475 nm wavelength diode light, providing a 3-dimensional scan of the anterior eye segment; 25 images are taken within two seconds. [10]

The pentacam tomographic data included measurements of corneal parameters. These parameters were Central corneal thickness (CCT) in micrometers (µm), Thinnest corneal thickness (TCT) in micrometers (µm), Curvature power of the flat meridian (K1) in diopters (D), Curvature power of the steep meridian (K2) in diopters (D), Maximum curvature power (K Max) in diopters (D), keratoconus index (KI), Central keratoconus index (CKI), Minimum sagittal curvature (R min) in millimeters (mm), Index of surface variance (ISV), Index of vertical asymmetry (IVA), Index of height asymmetry (IHA), Index of height decentration (IHD), and Belin/Ambrosio enhanced ectasia total deviation value (BAD-D).

Secondly, A spectral-domain OCT system (Avanti, Optovue, Inc. Fermont, CA, USA) with a corneal adaptor lens was used to acquire corneal thickness and epithelial thickness maps. It runs at a scan speed of 70,000 axial scans per second and has a working wavelength of 840 nm [13]. A scan pattern centered on the pupil was used to

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map the cornea. OCT maps were divided into zones by octants and annular rings (2.0, 5.0, and 6.0mm diameters). The minimum thickness locations were marked on corneal and epithelial thickness maps. The study employed various parameters for analysis, including central corneal thickness (CCT) measured in micrometers (µm), thinnest corneal thickness (TCT) in µm, superior corneal thickness (SCT), inferior corneal thickness (ICT)

Each participant's eyes were measured twice using both devices in a random sequence by a skilled operator in a dark room.

The participants sat upright, positioned on the headrest, and asked to fixate, and not to blink during each scan. Between the two scans, they were asked to sit back and blink several times to ensure tear film spread before the examination.

Statistical analysis

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 27 (from IBM, Chicago, IL, USA). Quantitative variables were described using their means and standard deviations or median and interquartile range (IQR) according to the type of data. Categorical variables were described using their absolute frequencies and percentages. Kolmogorov-Smirnov (distribution-type) and Levene (homogeneity of variances) tests were used to verify assumptions for use in parametric tests. To compare the same variable in one group over two points of time, paired sample t-test (for normally distributed data). The intraclass correlation coefficient (ICC), was used to assess the consistency or reproducibility of quantitative measurements made by different observers measuring the same quantity, CI Confidence interval >0.9 is excellent ICC, ICC <0.5 poor reliability 0.5 to 0.75moderate reliability 0.75 and 0.9 good reliability, and any value above 0.9 indicates excellent reliability. Cronbach's alpha, coefficient alpha, a reliability coefficient used to measure internal consistency of tests Cronbach alpha 0.5 to <0.6 is poor, 0.6 to <0.7 is questionable, 0.7 to <0.8 is good p 0.8 to <0.9 is good p≥0.9 is excellent agreement. Bland–Altman plots were used to evaluate the agreement between the two measurement techniques. The level of statistical significance was set at P<0.05. A highly significant difference was present if p≤0.001.

Results

This observational cross-sectional study included 14 females (66.7%), with ages ranging from 20 to 36 years and a mean age of 29.19 years who had epithelial-off crosslinking. BCVA values ranged from 0.3 to 0.9. Furthermore,7 (17.5%) 12(30%) 11 (27.5%) 10 (25%) cases were of stages KC1, KC2, and KC3, respectively.

We evaluated the agreement between pentacam and AS-OCT in measuring central corneal thickness, ICC ranged from 0.907 to 0.984, which reflected excellent reliability. Cronbach alpha was 0.964 and demonstrated excellent agreement. in the thinnest corneal thickness, ICC ranged from 0.025 to 0.882, which reflected good reliability. Cronbach alpha was 0.82 demonstrated good agreement. Table (1)

We do ABland–Altman plot to analyze the agreement between the two devices.

Bland-Altman plot showing good agreement between two measures in CCT where the difference between the two methods ranged from [-13.9 to 26.9] and 7.5% below the lower range and 0% above the upper range (yet the model had no fixed and proportional bias) (figure 1)

Bland-Altman plot showing good agreement between two measures in TCT where the difference between the two methods ranged from [-25.247 to 75.947] and 0% below the lower range and 5% above the upper range (yet model had no fixed and proportional bias) (figure 2)

Corneal maps were divided into zones by annular rings (2.0, 5.0, and 6.0mm diameters), we compared mean superior (superior, superonasal, and superotemporal) and mean inferior (inferior, inferonasal and inferotemporal) at 2mm diameter and 5mm diameter map. Figure (3)

We evaluate corneal thickness among studied patients in the 5mm zone. The agreement between Pentacam and AS-OCT in measuring SCT 5mm, ICC was 0.603, which reflected moderate reliability. Cronbach alpha was 0.694 demonstrating questionable agreement.

Agreement in measuring ICT 5mm, ICC was 0.372, which reflected poor reliability. Cronbach alpha was 0.772 demonstrating acceptable agreement.

Agreement in measuring SCT 2mm, ICC was 0.788, which reflected good reliability. Cronbach alpha was 0.882 demonstrating good agreement.

agreement in measuring ICT 2mm, ICC was 0.641, which reflected questionable reliability. Cronbach alpha was 0.906 demonstrating good agreement. Table (1)

Table (1) Agreement between AS-OCT and pentacam regarding Corneal thickness:

	Pentacam Mean ± SD	**AS-OCT Mean ± SD**	**p¥**	**ICC (95% CI)**	**Cronbach alpha**	**p**
CCT	483.2±32.13	477.2±33.26	0.023*	0.965 (0.907 –0.984)	0.973	<0.001**
TCT	470.05±31.71	444.7±34.33	<0.001**	0.701(0.025 – 0.882)	0.82	<0.001**
Superior mid peripheral	589.68±35.27	565.43±34.37	<0.001**	0.603(0.123– 0.808)	0.694	<0.001**
Superior paracentral	519.49±30.92	539.96±31.09	<0.001**	0.788(0.116 – 0.923)	0.882	<0.001**
Inferior mid peripheral	578.79±28.09	529.01±24.91	<0.001**	0.372(-0.165 – 0.731)	0.772	<0.001**
Inferior paracentral	519.63±22.68	489.18±26.52	<0.001**	0.641(-0.175 – 0.891)	0.906	0.096

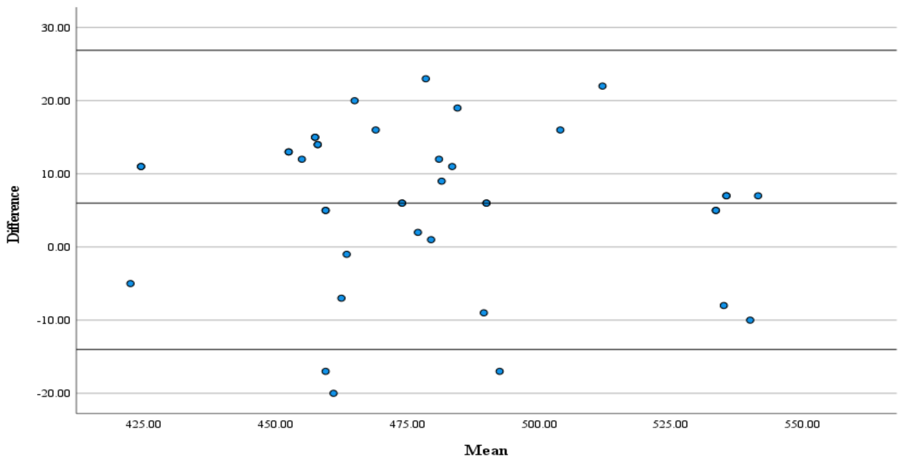

Figure (1) Bland-Altman plot showing good agreement between two measures in diagnosis of CCT where the difference between the two methods ranged from [-13.9 to 26.9] and 7.5% below the lower range and 0% above the upper range (yet the model had no fixed and proportional bias)

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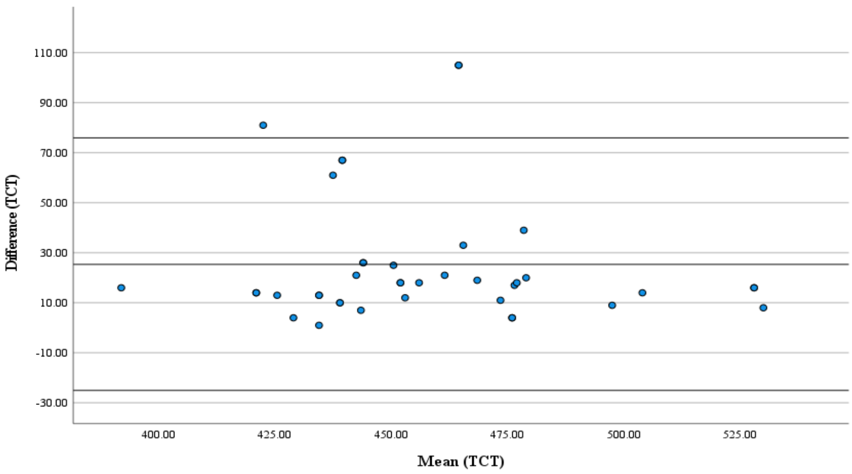

Figure (2) Bland-Altman plot showing good agreement between two measures in diagnosis of TCT where the difference between the two methods ranged from [-25.247 to 75.947] and 0% below the lower range and 5% above the upper range (yet model had no fixed and proportional bias)

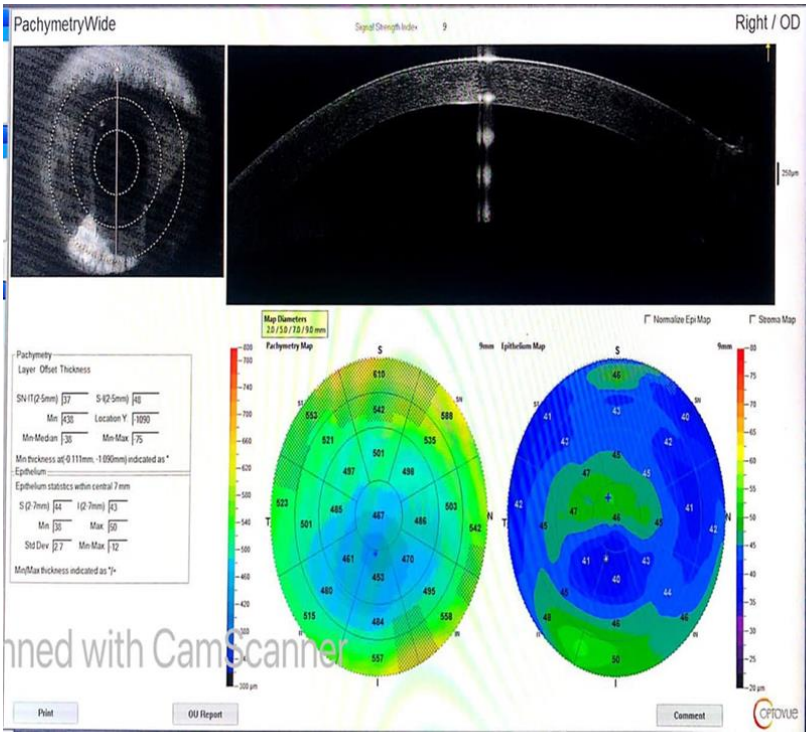

Figure (3) AS-OCT Optovue scan of keratoconus patient from our cases with high resolution cornea scan and corneal and epithelial thickness maps

The thickness results were re-evaluated according to the stage of keratoconus, this staging was determined based on The Belin ABCD classification/staging system which was introduced on the Oculus Pentacam. In grade 1 keratoconus we evaluated the agreement between pentacam and AS-OCT in measuring CCT, ICC was 0.982, which reflected excellent reliability. Cronbach alpha was 0.997

demonstrating excellent agreement, agreement in measuring TCT, ICC was 0.438, which reflected poor reliability. Cronbach alpha was 0.647 demonstrating questionable agreement, agreement in measuring SCT 2mm, ICC was 0.685, which reflected questionable reliability. Cronbach alpha was 0.915 demonstrating excellent agreement, agreement in measuring ICT 2mm, ICC was 0.707, which reflected moderate reliability. Cronbach alpha was 0.938 demonstrating good agreement, agreement in measuring SCT 5mm, ICC was 0.486, which reflected poor reliability. Cronbach alpha was 0.846 demonstrating good agreement, and agreement in measuring ICT 5mm, ICC was 0.422, which reflected poor reliability. Cronbach alpha was 0.825 demonstrating good agreement. Table (2)

Among patients with grade 2 KC, we evaluated the agreement between pentacam and AS-OCT in measuring CCT, ICC was 0.824, which reflected good reliability. Cronbach alpha was 0.854 demonstrating good agreement, agreement in measuring TCT, and ICC was 0.869, which reflected good reliability. Cronbach alpha was 0.955 demonstrating excellent agreement, agreement in measuring SCT 2mm, ICC was 0.726, which reflected moderate reliability. Cronbach alpha was 0.864 demonstrating good agreement, agreement in measuring SCT 2mmICC was 0.589, which reflected moderate reliability. Cronbach alpha was 0.903 demonstrating excellent agreement, agreement in measuring SCT 5mm, ICC was 0.863, which reflected good reliability. Cronbach alpha was 0.933 demonstrating excellent agreement. And agreement in measuring ICT 5mm, ICC was 0.539, which reflected moderate reliability. Cronbach alpha was 0.873 demonstrating good agreement. Table (3)

Among patients with grade 3 kc; we evaluated the agreement between pentacam and AS-OCT in measuring CCT, ICC was 0.965, which reflected excellent reliability. Cronbach alpha was 0.964 demonstrating excellent agreement, agreement in measuring TCT, ICC was 0.711, which reflected moderate reliability. Cronbach alpha was 0.808 demonstrating good agreement, agreement in measuring SCT 2mm, ICC was 0.974, which reflected excellent reliability. Cronbach alpha was 0.973 demonstrating excellent agreement, agreement in measuring ICT 2mm, ICC was 0.517, which reflected moderate reliability. Cronbach alpha was 0.814 demonstrating good agreement, agreement in measuring SCT 5mm, ICC was 0.881, which reflected good reliability. Cronbach alpha was 0.877 demonstrating good agreement, and agreement in measuring ICT 5mm, ICC was 0.233, which reflected poor reliability. Cronbach alpha was 0.613 demonstrating poor agreement. Table (4)

Table (2) Agreement between AS-OCT between Pentacam as regard corneal thickness in grade 1:

	Pentacam mean	AS OCT mean	ICC (95% CI)	Cronbach alpha	p
CCT	**482.58** ± 39.33	**472.58** ± 41.38	0.982 (0.146 –0.997)	0.997	<0.001**
TCT	**472.42** ±34.03	**433.42** ± 34.64	0.438(-0.298 – 0.814)	0.647	0.049*
Superior peripheral	**610.11** ±37.55	**549.58** ± 37.32	0.486(-0.172 – 0.852)	0.846	0.002*
Superior paracentral	**546.56** ± 36.46	**507.39** ± 33.06	0.685(-0.191 – 0.928)	0.915	<0.001**
Inferior peripheral	**586.92** ± 37.93	**525.89** ± 28.56	0.422(-0.152 – 0.819)	0.825	0.004*
Inferior paracentral	**523.28** ± 27.09	**490.5** ± 31.31	0.707(-0.153 – 0.936)	0.938	<0.001**

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Table (3) Agreement between AS-OCT between Pentacam as regard corneal thickness in grade 2:

	Pentacam mean	AS OCT mean	ICC (95% CI)	Cronbach alpha	p
CCT	**482.64** ± 16.79	**475.91** ± 15.41	0.824 (0.361 –0.952)	0.854	0.0013*
TCT	**465.45** ± 19.46	**453.82** ± 17.59	0.869(-0.124 – 0.974)	0.955	<0.001**
Superior peripheral	**577.15** ±28.4	**562.48** ±22.5	0.863(0.043 – 0.97)	0.933	<0.001**
Superior paracentral	**534.79** ± 18.97	**519.03** ± 18.34	0.726(-0.208 – 0.934)	0.864	0.002*
Inferior peripheral	**569.48** ± 20.84	**535.18** ±24.78	0.539(-0.17 – 0.881)	0.873	0.002*
Inferior paracentral	**514.58** ± 16.3	**490.67** ± 17.64	0.589(-0.153 – 0.901)	0.903	<0.001**

Table (4) Agreement between AS-OCT between Pentacam as regard corneal thickness in grade 3:

	Pentacam mean	AS OCT mean	ICC (95% CI)	Cronbach alpha	p
CCT	**481.22** ± 30.93	**484.67** ± 35.88	0.965 (0.805 –0.992)	0.964	<0.001**
TCT	**460.89** ± 29.11	**436.44** ± 37.66	0.711(-0.145 – 0.934)	0.808	0.016*
Superior peripheral	**576.85** ± 33.69	**583.85** ± 40.13	0.881(0.499 – 0.973)	0.877	0.004*
Superior paracentral	**539.7** ± 33.34	**536.96** ± 37.33	0.974(0.882 – 0.994)	0.973	<0.001**
Inferior peripheral	**581.85** ± 27.62	**526,67** ± 22.38	0.233(-0.173 – 0.706)	0.613	0.1
Inferior paracentral	**520.7** ±24.62	**485.3** ± 25.4	0.517(-0.236 – 0.88)	0.814	0.014*

Discussion

Measurements of corneal thickness are becoming more significant, particularly in cases of keratoconus where the corneal thickness is critical in diagnosis and course of treatment. Also, Accurate corneal thickness measurements are important when undergoing deep lamellar keratoplasty.[18] and replacement of corneal stroma,[19] therefore corneal parameters taken by pentacam alone are no longer satisfactory in the clinical practice, increasing the demand for a complementary device like oct for imaging through corneal scarring and detecting early changes. Therefore, in our study, we assessed the reliability of corneal thickness measurements provided by Optovue OCT and oculus Pentacam in patients who had epithelial-off crosslinking.

We found that the CCT measurements obtained by Pentacam and RTVue have an excellent agreement.

TCT measurements have good agreement. We used Bland–Altman plots to illustrate the agreements between the two devices for CCT and TCT measurements; a good agreement was noted this is supported by other studies, Herber et al assessed a novel-swept source OCT machine and compared its readings to those obtained from Pentacam, and the Galilei G6 (dual Scheimpflug-Placido system). The results showed that all three machines had comparable readings.[20] Li et al., studied (CCT) and (TCT) in KC eyes using both Pentacam and AS-OCT measurements both machines demonstrated good repeatability.[21] Another study by Said et al demonstrated that both Pentacam imaging and AS-OCT provide comparable readings with a good agreement regarding corneal thickness in the keratoconus and healthy group.[22], many other studies have also demonstrated. [7 ,9]

However, AS-OCT revealed thinner values than pentacam. This finding is supported by a group of studies that showed that CCT measurements by Pentacam were statistically higher than that of AS-OCT in healthy and keratoconic groups. [21,22, 23,24]

We further evaluate agreement in paracentral(2mm) and mid-peripheral (5mm) corneal areas, to our knowledge this is the first study to assess the agreement in paracentral and peripheral cornea in patients with epi-off crosslinking.

The agreement in SCT 2mm, and SCT 5mm reflected moderate reliability and questionable agreement.

The agreement in ICT 2mm and 5mm, reflected poor reliability and accepted agreement.

We noticed a decrease in agreement in the inferior part possibly due to the location of the cone and thinnest location, A study by Bingqing Sun and his colleagues in 2023 said that the location of the thinnest location as detected by both devices was markedly different [25].

We further evaluated thickness in each keratoconus grade, and there was excellent reliability for CCT in all keratoconus grades. However, TCT had poor reliability in grade 1 and moderate for grades 2 and 3.

SCT2mm and SCT5mm had moderate reliability, and this agreement diminished and became poor in the inferior part of the cornea and decreased more with the advancement of keratoconus grade.

This difference could be due to distortion of the anterior corneal surface, potentially causing inaccurate positioning of the thinnest corneal point [26]. studies have also reported that the corneal thickness measured by Pentacam was even lower than that measured by OCT in thin and flat corneas after laser-assisted in situ keratomileusis surgery, which may be related to the decreased reliability of Pentacam in thin corneas.[27] A recent study, by Jhanji et al., revealed that AS-OCT images could accurately characterize the epithelial and corneal thickness changes at different stages of the KC progression[26]. Moreover, W. Zhou and Stojanovic revealed that the epithelium and stroma in keratoconic eyes were thinner inferotemporal and thicker supranasally compared with the control eyes. [28]

Many other factors affect the measurements of the two devices. A study from Keiichi Fujimoto et al. said that there were significant differences in the CCT, TCT, and the distribution of the thinnest corneal point between Pentacam and AS-OCT in severe dry eyes. [29]

The presence and degree of corneal edema can also be a contributing variable in corneal thickness assessment using different modalities, this was confirmed by a study from Wongchaisuwat et al., that demonstrated good agreement between methods in measuring CCT up to 650 μm; however, in corneal thicknesses above 650 μm, Pentacam measurements tended to be overestimated.[30] Another factor that may affect measurements is diabetes mellitus. A study demonstrated that when measuring the corneal thickness in the eyes of diabetic patients, the Pentacam overestimated the CCT. This is because the diabetic condition affects the tear film status and acts as a cause of severe dry eye.[31] In those cases, AS-OCT is a better option. This supports the findings of Maloca et al that demonstrated the superiority of ASOCT in CCT measurements.[32]

In the study performed by Claudia and colleagues comparing pentacam and OCT in post-LASIK eyes, OCT maps were more accurate than Scheimpflug maps.[33]

Therefore, in clinical practice, we recommend using the same device for patients with keratoconus, especially for monitoring corneal thickness changes during follow-up. Overall, RTVue has a

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good agreement for CCT and TCT measurements. compensate for the disadvantages of Pentacam, especially in patients with poor ocular surface conditions.

This study has some limitations. First, the sample size was small and could be expanded in future studies, absence of a healthy or control group, the study didn't focus on determining the thinnest point location, and the measurements were not taken at uniform intervals among all participants.

Conclusions

Based on the results of corneal pachymetry after epi-off crosslinking it can be concluded that AS-OCT revealed thinner values than pentacam moreover, the RTVue and Pentacam devices had an excellent agreement for CCT, and good agreement for TCT measurement, but similarity decreased in the peripheral thickness especially inferior corneal thickness.

Conflict of interest

None of the contributors declared any conflict of interest

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