

Agreement of Central Corneal Thickness and Anterior Chamber Depth between Oculus Pentacam and Advanced Anterior Segment Optical Coherence Tomograph (CSO MS-39)

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ABSTRACT

Purpose: To access the agreement between central corneal thickness and anterior chamber depth using two anterior segment imaging devices, Oculus Pentacam and CSO MS-39.

Study Design: Cross-sectional study.

Place and Duration of Study: Amanat Eye Hospital from July 2025 to October 2025.

Methods: A total of 263 patients were included through consecutive sampling. Patients aged 18 years or above having clear corneas, no active ocular surface disease and no history of ocular surgery or corneal refractive procedures were included in this study. Central corneal thickness (CCT) and anterior chamber depth (ACD) were determined for each eye using the Oculus Pentacam and Advanced Anterior Segment Optical Coherence Tomograph (CSO MS-39). Paired t-test, Correlation analysis, and Bland-Altman plots were used to estimate mean differences and limits of agreement between the two devices.

Results: The paired t-test showed no statistically significant changes between Pentacam and MS-39 for CCT and ACD measurements. The CCT mean difference was $-0.51\mu\text{m}$ ($p=0.4189$), while for ACD the mean difference was -0.0154mm ($p=0.2115$). Intraclass correlation analysis demonstrated excellent reliability for both CCT (ICC = 0.956, 95% CI: 0.945–0.966) and ACD (ICC = 0.813, 95% CI: 0.768–0.851) values. Bland-Altman analysis showed relatively low mean bias with 95% limits of agreement.

Conclusion: The Pentacam and MS-39 showed good agreement in measuring CCT and ACD, with no systematic bias and no statistically significant differences. These findings support the use of either instrument for routine clinical evaluation and clinical decision making.

Keywords: Central Corneal Thickness, Anterior Chamber Depth, Optical Coherence Tomography, Diagnostic Imaging.

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INTRODUCTION

A thorough evaluation of anterior segment is necessary for clinical evaluation of different ocular pathologies.¹ CCT is required for precise intraocular pressure (IOP) assessment, corneal condition monitoring and refractive surgery procedure planning.² CCT is considered to have an effect on the precision of IOP measurements, as thinner corneas result in an

underestimation of IOP and an increased risk of glaucoma.³ CCT is essential for planning of refractive surgery because it ensures proper patient selection for safe and effective surgical results and assists in determining whether enough corneal tissue will remain to maintain postoperative structural integrity. In ophthalmology, ACD assessment is also used for identifying primary angle closure glaucoma, to rule out the power of intraocular lenses that should be implanted after cataract extraction and finding the relationship with systematic parameters.⁴ The anterior chamber of the eye has an average depth of 3.0mm, with a range of 1.5 to 4.0mm.⁵ As people grow older and develop hypermetropia, it tends to get shallower. Angle closure glaucoma likelihood increases as depth falls below 2.5mm. Small variations in ACD can significantly affect clinical decisions and outcomes in refractive surgery. In LASIK, overestimated ACD may lead to inappropriate eligibility assessment and increase the risk of post-operative ectasia. In implantable Collamer lens and its Toric version (ICL/TICL) implantation, inaccurate ACD causes incorrect lens sizing. Oversized lenses may induce angle closure and increased IOP, while undersized lenses can contact the crystalline lens, which results in cataract or rotational instability. Thus, even a 0.01mm variation can be clinically significant.⁶ The recommended ACD for ICL surgery is 2.80mm in Europe or 3.00mm in the USA since implanting an ICL (STAAR Surgical, Nidau, Switzerland) may result in a shallower anterior chamber.⁷

Imaging of the anterior segment of the eye has increasingly advanced over the past 15 years. A-scan ultrasonography was invented first, followed by scanning-slit topography examination with a Scheimpflug camera and anterior segment optical coherence tomography (AS-OCT). The Pentacam AXL Wave is a relatively new device that analyses the anterior section of the eye accurately. It combines the measurement of axial length with anterior segment tomography. The quality specification feature (QS) of the Pentacam AXL Wave evaluates the scan quality and shows an appropriate image with a “OK” result (OCULUS).^{8,9}

The MS-39 (Costruzione Strumenti Oftalmici, Florence, Italy; software version 4.0) is an anterior segment–optical coherence tomography (AS-OCT) device that integrates high-resolution spectral-domain OCT (SD-OCT) with Placido disk corneal topography. By merging tomographic and topographic

measurements, the MS-39 provides a comprehensive evaluation of the corneal structure and anterior segment.¹⁰

Precise measurement of CCT and ACD is essential for proper diagnosis, surgical planning, and optimal outcomes in refractive and cataract procedures. Even though the Pentacam and MS-39 are often used in clinical ophthalmology, there is still a dearth of comprehensive information about their measurement agreement, especially in Asian populations.

Most earlier studies have small sample sizes and insufficient statistical power to yield conclusive and widely applicable results. This study fills a major gap in research by conducting a comprehensive agreement analysis of Pentacam and MS-39 measurements on a larger and more representative sample. The validity and reliability of the results are enhanced by more precise statistical analysis, which is only possible with a larger population size. There will be significant clinical ramifications if systematic variances or a high degree of agreement between the two devices are discovered. It will help ophthalmologists to make preoperative decisions by choosing the device, leading to a safer and more accurate results.

This study was conducted to assess the agreement between CCT and ACD measurements using Pentacam and MS-39.

METHODS

This cross-sectional study was conducted at Amanat Eye Hospital to evaluate the agreement between two anterior segment imaging devices, the Oculus Pentacam and MS-39 for measuring CCT and ACD. Institutional Review Board (IRB# 26/03-001) approved the study. Every procedure followed the Helsinki Declaration. Each participant provided written informed consent before being included in the study. The data was collected from July to October 2025. A total of 263 patients meeting the inclusion criteria were included through consecutive sampling. Patients aged 18 years or above having clear corneas, no active ocular surface disease and no history of ocular surgery or corneal refractive procedures were included in this study. Patients with corneal scars or opacities, keratoconus, active ocular inflammation, contact lens use (soft lenses within 24–48 h, rigid lenses within 2–4 weeks) or scans failing manufacturers quality criteria were excluded from this study. Written informed consent was obtained from all

the participants prior to imaging. To prevent statistical bias from inter-eye association, just one eye was chosen for the primary analysis, even though both eyes of each subject were evaluated. If only one eye satisfied the inclusion requirements, that eye was selected.

Standardization of the imaging process was done to guarantee accuracy and consistency. A controlled lighting environment was used for all scans. Patients were told to maintain appropriate fixation and to blink regularly prior to each acquisition. For each eye two scans were acquired on each device, and the scan with highest quality index was selected for analysis. CCT (μm) was measured at the corneal apex and internal ACD (mm) was measured from the endothelium to the anterior lens surface. To prevent statistical bias from inter-eye correlation, only one eye was chosen for the primary analysis. If both eyes met the criteria, one eye was chosen randomly. Additionally, demographic data was collected including sex and age. Two unbiased observers cross checked the data once it was entered into a structured proforma to ensure its accuracy. The coded, anonymized and securely kept data was only accessible to the study investigators.

R software (version R 4.5.0) was used to conduct all statistical analyses. All the continuous variables were expressed as mean $\pm$ Standard deviation (SD). Measurements from both devices were compared using paired t-tests. Bland-Altman plots were used to evaluate agreement between the two devices (bias and 95% limits of agreement). Calculations of intraclass correlation coefficient (ICC) were used to evaluate device dependability. A p-value of less than 0.05 was regarded as statistically significant.

RESULTS

This study included a total of 263 participants with a mean age of 28.09 ± 7.39 years. Among them 128 (48.7%) were male and 136 (51.3) were female. In terms of occupation majority of the participants were students ($n=140$, 53.2%), followed by employed individuals ($n=85$, 32.2%) and unemployed individuals ($n=38$, 14.5%).

The normality of the discrepancies between MS-39 and Pentacam readings were evaluated using the Shapiro-Wilk test. Given that the p-value was higher than 0.05, the findings demonstrated that the CCT differences were normally distributed ($W = 0.99292$, $p = 0.2437$). A similar normal distribution was seen for ACD discrepancies ($W = 0.99625$, $p = 0.7850$). The paired t-test and Bland-Altman analysis were two parametric statistical techniques that were used in further assessments because these results validate that the assumption of normality was satisfied.

The CCT and ACD values from the Pentacam and MS-39 devices were compared using the paired t-test (Table 1). The differences between the MS-39 and Pentacam measurements were not statistically significant ($p > 0.05$). Mean values for ACD and CCT are given in Table 2.

The intraclass correlation coefficient (ICC) was used to assess the agreement between Pentacam and MS-39 measurements (Table 3). The results demonstrated that Pentacam and MS-39 have very consistent CCT measurements and reasonably consistent ACD values, supporting their interchangeable use in clinical practice for these parameters.

Table 1: Paired t-test comparing Pentacam with MS-39 measurements.

Variable	t-value	Df	p-value	Mean Diff	95% CI Lower	95% CI Upper
ACD (mm)	-1.2525	263.0000	0.2115	-0.0154	-0.0397	0.0088
CCT (μm)	-0.8097	263.0000	0.4189	-0.5114	-1.7549	0.7323

Table 2: Mean values of ACD and CCT.

Parameter	Pentacam Mean	MS-39 Mean	Difference (Pentacam - MS-39)
ACD (mm)	3.1822	3.1976	-0.0154
CCT (μm)	537.0568	536.5455	0.5113

Table 3: Agreement of Pentacam and MS-39 measurements using Interclass Correlation Coefficient (ICC).

Variable	ICC(A,1)	95% CI	F-Test	df1	df2	p-value
CCT (μm)	0.956	0.945-0.966	44.8	263	264	3.39×10^{-143}
ACD (mm)	0.813	0.768-0.851	9.74	263	264	2.21×10^{-64}

The agreement between MS-39 and Pentacam was evaluated using Bland-Altman analysis. The 95% limits of agreement for CCT ranged from about $-20\mu\text{m}$ to $+20\mu\text{m}$. And the mean bias was negligible. The 95% limits of agreement for ACD ranged from -0.4mm to $+0.4\text{mm}$, and the mean bias was near to zero. These results demonstrate that MS-39 and Pentacam offer comparable readings for CCT and ACD in clinical evaluation, indicating good agreement between the two devices (Figure 1 and 2).

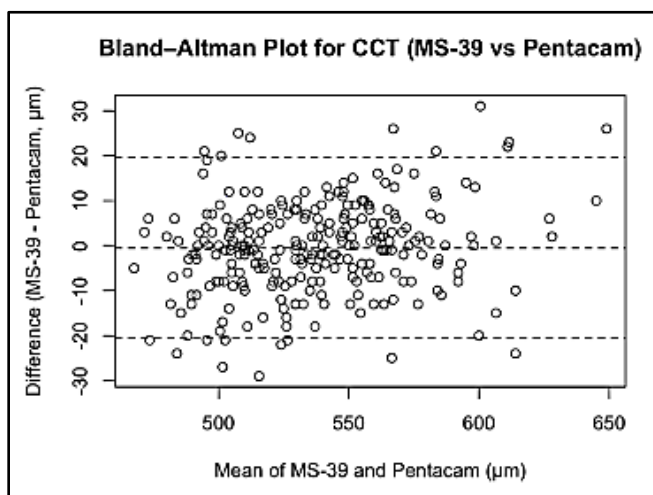


Figure 1: Bland-Altman plot exhibit agreement between MS-39 and Pentacam for CCT measurements.

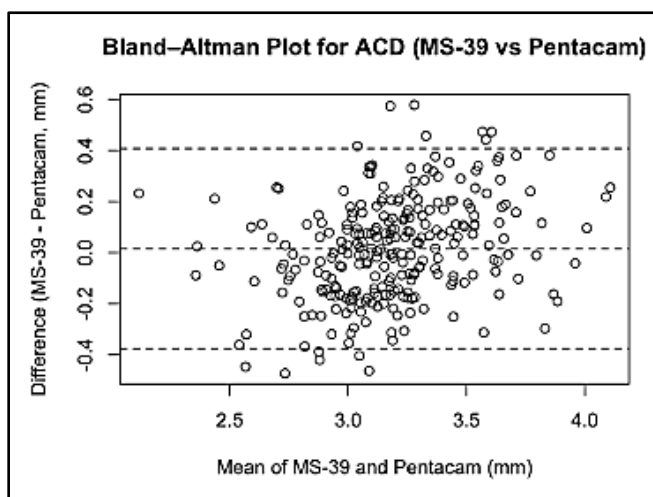


Figure 2: Bland-Altman plot exhibit agreement between MS-39 and Pentacam for ACD measurements.

DISCUSSION

This study showed that there are no statistically significant differences between the MS-39 and

Pentacam, which offer accurate and consistent measurements of CCT and ACD, with excellent agreement.

The Pentacam (Oculus, Wetzlar, Germany) uses a rotating Scheimpflug blue LED (475 nm) to capture 50 images of the anterior corneal surface within about two seconds, covering $0-180^\circ$. Pentacam offers comprehensive corneal health data by producing four important maps pachymetry, anterior and posterior elevation, and sagittal curvature that are utilized for clinical assessment and diagnosis.¹¹ The MS-39 combines an anterior segment spectral domain OCT (SD-OCT) with a Placido disc corneal topographer.

Precise assessment of ACD and CCT is essential for numerous clinical and surgical uses, such as intraocular lens power calculation, keratoconus identification, and refractive surgery planning.¹² The MS-39 and Pentacam systems showed good agreement in this investigation for both ACD and CCT measurements, with high intraclass correlation coefficients (ICC) and no statistically significant discrepancies. These results support the device's interchangeable use in clinical and research settings by showing that they both offer accurate and repeatable anterior segment characteristics.

Our results are in line with several earlier studies evaluating the agreement of contemporary anterior segment imaging systems. Anwar et al, showed no significant variations in ACD and excellent agreement for CCT and keratometric parameters ($\text{ICC} > 0.95$) when comparing Pentacam, Sirius, Anterior, and MS-39.¹³ The dependability of optical imaging modalities was further supported by Humayun S et al, who reported a strong correlation between a Scheimpflug system (Allegro Oculyzer II) and a PCI device (Wavelight OB 820) for both CCT ($r = 0.958$) and ACD ($r = 0.965$).¹⁴ Li, Xuepei, et al, compared Pentacam with CASIA2 swept-source OCT, finding high agreement on Bland-Altman analysis and no discernible discrepancies in regional corneal thickness or ACD.² A study conducted by Doors M et al, showed high reproducibility for both CCT and ACD measurements while comparing Scheimpflug and AS-OCT based devices, but there were notable inter-device variations, especially for ACD.¹⁵ While ACD measurements differ consistently, CCT exhibited much higher agreement. This suggests that despite strong reliability, CCT and especially ACD should not be used interchangeably between Pentacam and OCT.

Despite statistically significant inter-device discrepancies, previous research comparing Pentacam with Galeli and Lenstar found high correlation for both CCT and ACD measurements. While data are reliable, CCT and ACD are not completely interchangeable across different imaging systems and should be interpreted cautiously in clinical practice.¹⁶ Song H et al, showed strong correlations in ACD values while comparing Pentacam with anterior segment imaging devices such as IOL Master and Sirius.¹⁷ Despite strong association, ACD measures are not interchangeable across various technologies, and device-specific variations should be taken into account during clinical practice. These results, along with our own, provide credence to the clinical reliability and consistency of contemporary optical systems, such as Scheimpflug, hybrid, and swept-source OCT technologies.

However, systematic differences may appear when comparing several optical devices, or optical and ultrasonic systems. For both CCT and ACD, minor but statistically significant changes between Sirius and ultrasound pachymetry/biometry were noted by Jorge J et al.¹⁸ Comparing Galilei, Pentacam, and Lenstar, statistically significant differences in both ACD and CCT were found in addition to highly significant correlations ($r > 0.9$, $p < 0.001$).¹⁹ ACD and CCT have 95% limits of agreement between 0.28mm and 0.46 mm and 31.95 and 46.57 μ m, respectively, suggesting that although the measurements track closely, they are not exactly identical.¹⁹ These results highlight how, even among optical systems, measurement techniques, reference locations, and imaging principles can result in small yet persistent biases.

Since this study was conducted on healthy eyes. The results of this investigation might not be applied to pathological corneas like keratoconus, post-refractive surgery ectasia, or corneal oedema, where device agreement can differ more significantly. Future research should examine how well the device performs in corneal diseases, assess agreement in bigger and more varied populations, and consider incorporating automated correction factors or calibration procedures to increase consistency between devices.

CONCLUSION

There are no statistically significant differences between the MS-39 and Pentacam, which offer accurate and consistent measurements of CCT and

ACD, with excellent agreement. However, there may be minor but statistically significant discrepancies when comparing different technologies or measurement algorithms. This should be considered in high-precision clinical applications like the planning of cataract and refractive surgery. Good agreement between Pentacam and MS-39 supports their regular usage in research and clinical practice, which helps to standardize and increase the flexibility of anterior segment assessment.

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Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board (IRB#26/03-001)

REFERENCES

1. **Chong YJ, Azzopardi M, Hussain G, Recchioni A, Gandhewar J, Loizou C, et al.** Clinical Applications of Anterior Segment Optical Coherence Tomography: An Updated Review. *Diagnostics* (Basel). 2024;**14**(2):122. Doi: 10.3390/diagnostics14020122.
2. **Li X, Zhou Y, Young CA, Chen A, Jin G, Zheng D.** Comparison of a new anterior segment optical coherence tomography and Oculus Pentacam for measurement of anterior chamber depth and corneal thickness. *Ann Transl Med.* 2020;**8**(14):857. Doi: 10.21037/atm-20-187.
3. **Agbato D, Rickford K, Laroche D.** Central Corneal Thickness and Glaucoma Risk: The Importance of Corneal Pachymetry in Screening Adults Over 50 and Glaucoma Suspects. *Clin Ophthalmol.* 2025;**19**:563-570. Doi: 10.2147/OPTH.S498422.
4. **Qian Z, Xie X, Yang J, Ye H, Wang Z, Chen J, et al.** Detection of shallow anterior chamber depth from two-dimensional anterior segment photographs using deep learning. *BMC Ophthalmol.* 2021;**21**(1):341. Doi: 10.1186/s12886-021-02104-0.
5. **Alotaibi WM.** Central Corneal Thickness and Anterior Chamber Depth Measurements among Young Healthy Saudi Sub-jects. *EC Ophthalmology.* 2025;**16**:01-8.
6. **Grzebieluch-Reichert K, Marek J, Misiuk-Hojło M.** Safety assessment of using collamer phakic implants in the correction of refractive errors. *Polim Med.* 2018;**48**(1):47-51. Polish. Doi: 10.17219/pim/102975.

7. **Lim DH, Lee MG, Chung ES, Chung TY.** Clinical results of posterior chamber phakic intraocular lens implantation in eyes with low anterior chamber depth. *Am J Ophthalmol.* 2014;**158**(3):447-454.e1. Doi: 10.1016/j.ajo.2014.06.005.
8. **Wang H, Zhu LS, Pang CJ, Fan Q.** Repeatability assessment of anterior segment measurements in myopic patients using an anterior segment OCT with placido corneal topography and agreement with a swept-source OCT. *BMC Ophthalmol.* 2024;**24**(1):182. Doi: 10.1186/s12886-024-03448-z.
9. **Alotaibi WM, Challa N, Alrasheed SH, Abanmi RN.** Measurements of white-to-white corneal diameter and anterior chamber parameters using the Pentacam AXL wave and their correlations in the adult Saudi population. *Peer J.* 2025;**13**:e19227. Doi: 10.7717/peerj.19227.
10. **Gupta N, Maharjan S, Sapkota S.** Comparability of Measurement of Astigmatism between URK-800F Auto Refractometer and MS-39 Anterior Segment Optical Coherence Tomography in Patients with Refractive Error. *Nepal J Ophthalmol.* 2023;**15**(30):47-54. Doi:10.3126/nepjoph.v15i2.57044.
11. **Ahmed SM, See OH, Weng LY, Al-Sharify NT, Nser HY, Al-Sharify ZT, Ghaeb NH.** Corneal elevation topographic maps assessing different diseases detection: a review. *Ain Shams Engineering Journal.* 2024 Jan 1;**15**(1):102292. Doi: 10.1016/j.asej.2023.102292
12. **Fukuda S, Ueno Y, Fujita A, Mori H, Tasaki K, Murakami T, et al.** Comparison of anterior segment and lens biometric measurements in patients with cataract. *Graefes Arch Clin Exp Ophthalmol.* 2020;**258**(1):137-146. Doi: 10.1007/s00417-019-04482-0.
13. **Anwar M, Bühren J, Kook D, Prahs P, Herrmann WA.** Comparison of Anterior, MS-39, Pentacam, and Sirius in Corneal Assessment Prior to Refractive Surgery. *Clin Ophthalmol.* 2025;**19**:3487-3495. Doi: 10.2147/OPTH.S537050.
14. **Humayun S, Noor M, Naqvi SAH, Tarar MS, Ishaq M, Yasmeen H.** Correlation Between Corneal Keratometry, Central Corneal Thickness and Anterior Chamber Depth as Measured by Wave light OB 820 Biometer and Wavelight Oculyzer II in Preoperative Cataract Surgery Patients. *J Coll Physicians Surg Pak.* 2023;**33**(8):890-894. Doi: 10.29271/jcpsp.2023.08.890.
15. **Doors M, Cruysberg LP, Berendschot TT, de Brabander J, Verbakel F, Webers CA, et al.** Comparison of central corneal thickness and anterior chamber depth measurements using three imaging technologies in normal eyes and after phakic intraocular lens implantation. *Graefes Arch Clin Exp Ophthalmol.* 2009;**247**(8):1139-1146. Doi: 10.1007/s00417-009-1086-6.
16. **Shajari M, Lehmann UC, Kohnen T.** Comparison of Corneal Diameter and Anterior Chamber Depth Measurements Using 4 Different Devices. *Cornea.* 2016;**35**(6):838-842. Doi: 10.1097/ICO.0000000000000840.
17. **Song H, Yang W, Yang C, Sun Q.** Comparison of anterior chamber depth measured by three different anterior segment analysis systems. *Photodiagnosis Photodyn Ther.* 2025;**51**:104471. Doi: 10.1016/j.pdpdt.2025.104471.
18. **Jorge J, Rosado J, Díaz-Rey J, González-Méijome J.** Central corneal thickness and anterior chamber depth measurement by Sirius® Scheimpflug tomography and ultrasound. *Clin Ophthalmol.* 2013;**7**:417-422. Doi: 10.2147/OPTH.S35121
19. **Han SH, Hwang HS, Shin MC, Han KE.** Comparison of Central Corneal Thickness and Anterior Chamber Depth Measured Using Three Different Devices. *J Korean Ophthalmol Soc.* 2015;**56**(5):694-701. Doi: 10.7469/JKOS.2015.56.05.694

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Maria Akhtar; Optometrist: *Concepts, Manuscript Review.*

Waqas Ali; Optometrist: *Data Analysis, Statistical Analysis.*

Muhammad Affan; Optometrist: *Manuscript Review.*

