



Assessment of Anterior Chamber Angle and Angle to Angle Among Healthy Saudi Individuals by using Pentacam

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Abstract

Purpose: To assess the repeatability and reproducibility of Pentacam in measuring the Anterior Chamber Angle (ACA) and Angle-to-Angle (ATA). Also, to evaluate the normative values in young, healthy Saudi individuals as well as comparing it between genders.

Method: In this cross-sectional study, we measured ACA and ATA in 60 healthy Saudi individuals aged between 18 to 29 by using Pentacam HR (Oculus, Wetzlar, Germany). All individuals underwent ocular examinations before talking the measurement to exclude any ocular abnormalities. Two examiners took two readings of ACA and ATA of one eye (right eye) to assess the repeatability and reproducibility of Pentacam HR.

Results: The mean ACA and ATA was 38.11° and 12.20 mm respectively, with females having statically significant smaller ACA with P-value 0.049, but ATA was not statically significant between genders. The Intra-class correlation coefficient (ICC) of repeatability of ACA and ATA were 0.925 and 0.787 respectively. While ICC for the reproducibility of ACA and ATA were 0.938 and 0.656 respectively.

Conclusion: We established the normative values of ACA and ATA, in addition we found that there was significant difference between genders in ACA with females having smaller angles. While ATA was not significant between genders. Moreover, the Pentacam HR showed excellent repeatability and reproducibility of ACA, on the other hand ATA showed good repeatability and moderate reproducibility.

Keywords: Anterior chamber angle; Angle-to-Angle; Pentacam HR; Repeatability; Reproducibility

Abbreviations: Anterior Chamber Angle (ACA); Angle-to-Angle (ATA); Intra-class correlation coefficient (ICC); Primary angle-closure glaucoma (PACG); Primary open-angle glaucoma (POAG); Intra ocular lens (IOL)

Introduction

The measurement of Anterior Chamber Angle (ACA) is very essential in diagnosing a glaucoma patient; specially it allows us to differentiate between primary angle-closure glaucoma (PACG) and primary open-angle glaucoma (POAG), in addition it helps in further management [1] Also, ACA is important in the placement of intraocular lens in phakic patients [2]. The normal range for ACA is between 30.2° and 41.6° [3]. Moreover, Angle to Angle (ATA) helps to provide an accurate estimation of the optimum intra ocular lens

(IOL) placement and length since the internal distance is preferable more than the external distance (white to white). Having the ability to measure perfect IOL size is crucial to avoid unwanted events such as lens decentration, rotation or inadequate vaulting. If the IOL size selected is small; it may result in raised IOP or corneal endothelial cell damage. The normal range varies between 11.4- and 12-mm [4,5]. ACA and ATA measurement have been noted to be affected by multiple factors including age, gender, race/ethnicity,

corneal curvature, and refractive error [6]. There are multiple devices can assess ACA and ATA, but only few studies have assessed the accuracy and the repeatability of ACA and ATA. Pentacam HR (Oculus, Wetzlar, Germany) is a non-contact rotating Scheimpflug technology that has been shown to be repeatable and reproducible for ACA and ATA measurements [2,7]. There is no study yet done to investigate the repeatability and reproducibility of Pentacam among Saudi population, therefore the purpose of this study is to evaluate the normative values of Saudi individuals, repeatability and reproducibility of ACA and ATA by using Pentacam, as well as, to compare the difference of these values between genders. The results of this study may help in explaining why higher prevalence of angle closure rates are in females.

Materials and Methods

In this prospective cross-sectional study sixty healthy Saudi individuals aged between 18 to 30 were included in this study, 30 males and 30 females. Screening tests were performed for each subject using slit lamp to exclude any ocular abnormalities and autorefraction was taken from each subject. Healthy subjects without ocular or systemic diseases were included. Participants who use contact lenses had stopped it three days prior taking the examination. Any ocular abnormalities or history of ocular surgery, spherical equivalent of more than $\pm 4.00D$, ocular pathology as glaucoma, keratoconus, pregnancy, and smoking. Participants who are taking any systemic or ocular medications were excluded. This study was performed at King Saud University, College of Applied Medicine clinics. It was conducted in accordance with the

tenets of the Declaration of Helsinki regarding research involving human subjects. Each subject signed an informed consent form to participate in the study and after receiving information on the objectives of the research. One examiner assessed the repeatability of Pentacam HR by taking the mean of two readings of the ACA as well as ATA from one eye (right eye). Then two examiners assessed the reproducibility by taking, the mean of two readings of each parameter. Before taking each measurement, the patient is asked to place his/her chin on the chin rest and the forehead against the forehead strap. The patient was asked to keep both eyes open and stare at the fixation target. Only the image of good quality was taken and selected. The data were calculated using Excel 2017, it presented as Mean \pm SD. Paired t-test was used to calculate the difference between genders in terms of ACA and ATA. The bland-Altman of agreements was used to calculate the repeatability of one examiner and the reproducibility between two examiners.

Results

Demographic Data and Normal Values of ACA and ATA

Data collected from sixty individuals showed that the overall age (Mean \pm SD) for all participants was 21.7 ± 3.1 years. In addition to that, the (Mean \pm SD) of the spherical equivalent was -0.67 ± 1.19 D, where males had lower spherical equivalent equal to -0.57 D. Furthermore, the (Mean \pm SD) of ACA was $38.11 \pm 5.16^\circ$, where females had smaller ACA of 37.18° . Moreover, the (Mean \pm SD) of ATA was 12.20 ± 1.12 mm, with females having shorter ATA with a mean of 12.18 mm (Table 1). The parameters of ACA and ATA were tested by the normality test, and they were normally distributed.

Table 1: Shows Demographic Data and Normative Values of ACA and ATA.

	N	Age (Years)	Spherical Equivalent of Refractive Error (D)	Normal values of ACA ($^\circ$)	Normal values of ATA (mm)
		Range Mean \pm SD	Range Mean \pm SD	Range Mean \pm SD	Range Mean \pm SD
Male	30	(18-29 Years)	(-3.25 - +1.00 D)	(28.55 - 48.35 $^\circ$)	(10.23 - 14.14 mm)
		22.9 \pm 3.7	-0.57 \pm 1.09 D	39.04 \pm 5.08 $^\circ$	12.21 \pm 1.04 mm
Female	30	(18-23 Years)	(-3.50 - +1.25 D)	(26.55 - 46.56 $^\circ$)	(8.29 - 13.63 mm)
		20.4 \pm 1.5	-0.78 \pm 1.29 D	37.18 \pm 5.12 $^\circ$	12.18 \pm 1.21 mm
Total Participant	60	(18-29 Years)	(-3.50 - +1.25 D)	(26.55 - 48.35 $^\circ$)	(8.29 - 14.14 mm)
		21.7 \pm 3.1	-0.67 \pm 1.19 D	38.11 \pm 5.16 $^\circ$	12.20 \pm 1.12mm

Note: Anterior Chamber Angle (ACA), Angle-to-Angle (ATA), Diopter (D), Standard of Deviation (SD), Millimeters (mm), Degree ($^\circ$), and Number of participant (n).

Comparison of ACA and ATA between genders

The result showed that there was significant difference between males and females in ACA with P-value of 0.049, on the other hand

there was no significant difference between males and females in ATA with P-value of 0.867. Despite that the results showed that there were no significant differences in ATA, the mean values of females had a slightly lower ATA compared to males (Table 2).

Table 2: Shows comparison of ACA and ATA between genders.

Measurements	(Mean ± SD)	P-value
ACA		
Males (n = 30)	39.04 ± 5.08°	0.049
Females (n=30) 30)	37.18 ± 5.12°	
ATA		
Males (n = 30)	12.21 ± 1.04 mm	0.867
Females (n=30) 3030)	12.18 ± 1.21 mm	

Note: Anterior Chamber Angle (ACA), Angle-to-Angle (ATA), Standard of Deviation (SD), Millimeters (mm), Degree (°), and Number of participant (n).

Repeatability of Pentacam HR in measuring ACA and ATA by one Examiner.

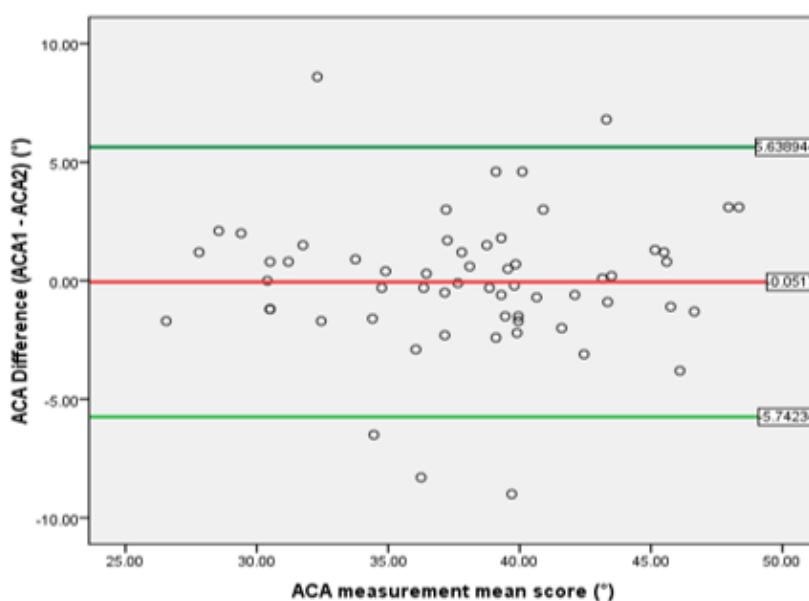
Intra-class correlation coefficient (ICC) and the corresponding 95% confidence interval (CI) calculated for evaluating the repeatability of Pentacam HR in measuring ACA and ATA by one examiner. The ICC value for ACA measurement is 0.861 such result indicates a good level of repeatability, while the ICC value for ATA measurement is 0.649 which indicates a moderate level

of repeatability (Table 3). There were no significant differences between the two measurements of ACA and ATA by one examiner with P-value= 0.891, P-value= 0.614 respectively. The Bland-Altman plot showing the agreement of ACA measurements by one examiner where the line shows the mean difference, and the lower and upper 95% confidence levels (-5.74234, 5.638944) respectively (Figure 1). On the other hand, ATA measurements shows the lower and upper 95% confidence levels (-1.95563, 2.090632) respectively (Figure 2).

Table 3: Intra-class Correlation Coefficient (ICC) for ACA and ATA Measurements – Examiner1.

Measurement	Intraclass Correlation	95% Confidence Interval	
		Lower Bound	Upper Bound
ACA			
Single Measures	0.861	0.777	0.915
Average Measures	0.925	0.875	0.955
ATA			
Single Measures	0.649	0.474	0.774
Average Measures	0.787	0.643	0.873

Note: Anterior Chamber Angle (ACA), Angle-to-Angle (ATA).

**Figure 1:** Bland-Altman Level of Agreement Plot for ACA Measurements -Examiner1.

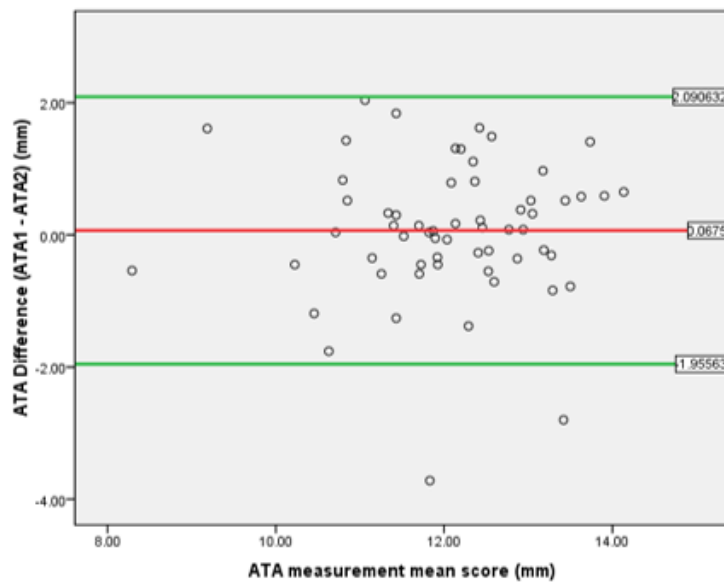


Figure 2: Bland-Altman Level of Agreement Plot for ATA Measurements -Examiner1.

Reproducibility of Pentacam HR in measuring ACA and ATA by two Examiners.

The ICC value for ACA measurement is 0.883 that indicates a good level of reproducibility. In addition, the ICC value for ATA measurement is 0.488 which indicates a poor level of reproducibility. But the average measures result for ATA indicate a moderate level

of reproducibility (Table 4). There were no significant differences between the two measurements in case of ACA and ATA by two examiners with P-value= 0.137, P-value = 0.979 respectively. The Bland-Altman plot showing the agreement of ACA measurements by two examiners which shows the lower and upper 95% confidence levels (-5.35837, 4.659972) respectively (Figure 3). While ATA measurements show (-2.59724, 2.59084) respectively (Figure 4).

Table 4: Intra-class Correlation Coefficient (ICC) for ACA and ATA Measurements – Examiner1&2.

Measurement	Intraclass Correlation	95% Confidence Interval	
		Lower Bound	Upper Bound
ACA			
Single Measures	0.883	0.837	0.917
Average Measures	0.938	0.911	0.957
ATA			
Single Measures	0.488	0.338	0.613
Average Measures	0.656	0.505	0.760

Note: Anterior Chamber Angle (ACA), Angle-to-Angle (ATA).

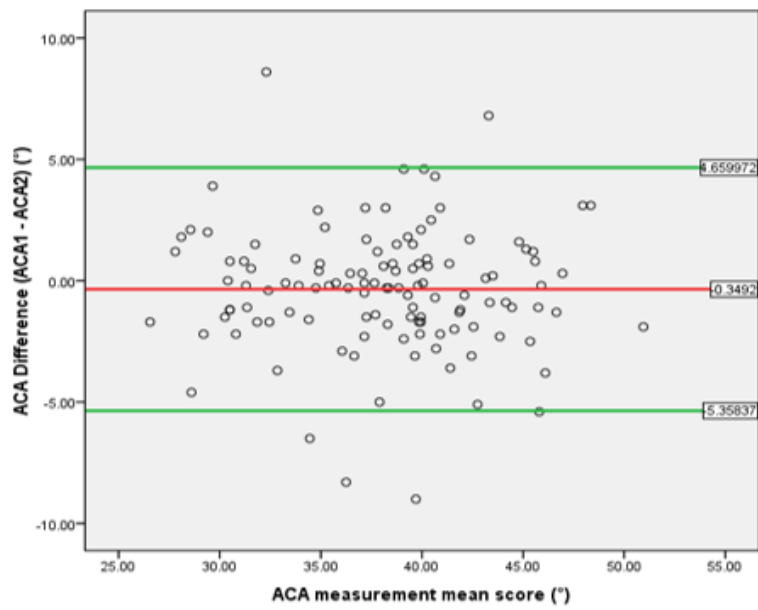


Figure 3: Bland-Altman Level of Agreement Plot for ACA Measurements -Examiners 1&2.

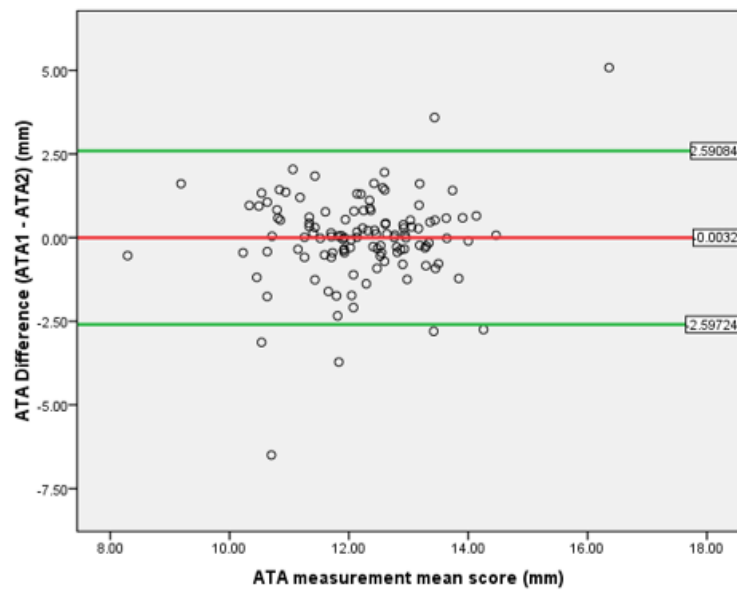


Figure 4: Bland-Altman Level of Agreement Plot for ATA Measurements -Examiners 1&2.

Table 5: Anterior segment parameters measured among different populations.

Author	RE	N	Race	Age	Instrument	ACA (°)	ATA (mm)
Current Study (2022)	Low Myopia	60	Saudi	18 to 29	Pentacam HR	38.11±5.1°	12.20 ± 1.12mm
Mu Li [9] 2018	Myopia	32	Chinese	age ≥18	AS-OCT	35.96 ± 11.35°	N/A
Hassan Hashemi [2] (2016)	N/A	4,688	Iranian	40 to 64	Pentacam	34.3° (34.1–34.5)	N/A
Aya Saito [5] (2019)	Myopia	26	Japanese	N/A	Pentacam HR	N/A	11.32 ± 0.45 mm
Isabel Pinilla Lozano [8] (2017)	Myopia & Hyperopia	52	Spanish	20 to 43	Spectralis AS-OCT	N/A	12.10 ± 0.43 mm

Note: Anterior Chamber Angle (ACA), Angle-to-Angle (ATA), Refractive Error (RE), Millimeters (mm), Degree (°), Number of participant (n), and Not Applicable (N/A).

Discussion

ACA plays an important role in the diagnosis and treatment of glaucoma on the other hand ATA is an important measurement in IOL implantation after cataract surgery or in phakic patient. In this prospective cross-sectional study, by using Pentacam HR, the normative values of ACA and ATA for young Saudi population with a mean refractive error of -0.67 D was 38.11° and 12.20 mm respectively (Table 5). shows the differences in anterior segment parameters measured in different studies conducted on different populations. The differences in the mean of ACA and ATA between the present study and previous studies could be due to ethnicity, genetic, environmental, methodology and design of the study, sample size or other factors. We demonstrated that females had smaller ACA and shorter ATA compared to male, with mean value of 37.18° and 12.18 mm respectively, so the difference between females and males in ACA was statically significant ($P=0.049$), and the difference of ATA between females and males was not statically significant ($P= 0.876$). Similarly, ACA was found to be significant

between males and females among Iranian [2] with females having smaller ACA which agrees with our results. Moreover, [8] found that ATA was statically significant between gender, which was longer in males, therefore it was the opposite of our result. The explanation of the differences between our study and [8] is maybe due to the manual method when ATA measurement was captured in Pentacam HR since it was the only option in our study (Table 6). shows the differences of ACA and ATA among genders. The present study is compatible with [9] where it showed that Pentacam had excellent reproducibility in measuring ACA. Also, [10] showed similar results as ours since ATA had good repeatability. While [5] stated that ATA wasn't highly repeatable and reproducible by using Pentacam HR. Our study was limited by some conditions mainly due to COVID-19. One of the unavoidable limitations was the manual method in taking ATA since the automatized option wasn't available in this version, it would have shown a better repeatability and reproducibility. On the good side, it is the first study of ACA and ATA that have been done in Saudi Arabia and its beneficial since those measurement differs among ethnicities.

Table 6: Shows the differences of ACA and ATA between genders among different studies.

Author	N	Race	Age	Instrument	Results
Current Study (2022)	60	Saudi	18 to 29	Pentacam HR	ACA significant between genders M (39.04°) > F (37.18°)
					ATA not significant between genders M (12.21 mm) > F (12.18 mm)
Hassan Hashemi [2] (2016)	4,688	Iranian	40 to 64	Pentacam	ACA significant between genders M (34.8°) > F (33.8°)
Isabel Pinilla Lozano [8] (2017)	52	Spanish	20 to 43	Spectralis AS-OCT	ATA significant between genders M (12.26 mm) > F (12.00 mm)

Note: Anterior Chamber Angle (ACA), Angle-to-Angle (ATA), Refractive Error (RE), Millimeters (mm), Degree (°), Males(M), Females(F) and Number of participant (n).

Conclusion

In this study we established the normative values of ACA and ATA among young healthy Saudi individuals, as well as we found that there was significant difference between genders in ACA measurement. But ATA measurements were not significant between genders. Moreover, Pentacam HR showed excellent repeatability and reproducibility in measuring ACA while it showed good repeatability and moderate reproducibility in measuring ATA. The anterior parameters that we have studied are valuable

measurements in glaucoma management as well as intraocular lens implantation. We recommend further research with wider age group and larger sample size.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

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