ORIGINAL ARTICLE

Intra and Inter-Observer Variability in the Measurement of Anterior Chamber Depth Diameter Using B-Mode Ultrasonography

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ABSTRACT

Introduction: B-mode ultrasonography, a non-invasive imaging modality, plays a pivotal role in evaluating ocular structures such as anterior chamber depth. Its measurement is crucial for ocular health assessment and managing conditions like glaucoma cataract and refractive surgery planning. However, ultrasonography's operator-dependent nature impacts diagnostic sensitivity and specificity. **Aims:** This study investigates intra-observer and inter-observer variability in ultrasonographic ACD measurements and its implications. **Methods**: A prospective observational study was conducted at Nepalgunj Medical College and Teaching Hospital in September 2023. Healthy volunteers over 17 years of age were enrolled, with ethical approval and informed consent. Ultraso nography was performed using a 7.5 MHz linear transducer, involving a radiologist with over 5 years of experience and a radiology trainee. Reproducibility was assessed using intraclass correlation coefficients (ICC). **Results**: The study included 150 participants (83 males, 67 females) with a mean age of 25.7 years. ACD demonstrated a linear correlation with age. The mean right ACD was 2.824 mm (range: 2.175 mm - 4.175 mm) and the mean left ACD was 2.826 mm (range: 2.20 mm - 4.175 mm). Age had a significant linear correlation with ACD (p <0.001). Intra-observer variability for both observers showed statistically significant linear correlations (p <0.001), with high Pearson correlation coefficients. Inter-observer variability in mean ACD also exhibited a significant correlation (p<0.01) with excellent agreement. **Conclusion:** This study highlights the importance of assessing intra and inter-observer variability in ACD measurements by ultrasonography. The findings provide valuable insights for ocular health management, particularly in patients with elevated intraocular pressure. Standardizing measurement techniques can improve diagnostic accuracy and patient care.

Keywords: Anterior chamber, Glaucoma, Inter-observer variability, Ultrasonography

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INTRODUCTION

B-mode ultrasonography is a non-invasive imaging modality and has its varied clinical applications. It is also frequently employed for assessing various ocular structures, including the measurement of anterior chamber depth (ACD), optic nerve sheath diameter, extraocular muscles as well as ocular length. ACD, defined as the distance between the cornea and the anterior lens surface, is an important parameter in the evaluation of ocular health and the management of ocular conditions such as glaucoma, cataract, refractive surgery planning as well as monitoring of diseases.[1] Unlike other cross-sectional imaging, ultrasound is however operator dependent which significantly impacts the sensitivity and-specificity in diagnosis of various conditions. In this study, we aimed to study the intra-observer and inter-observer variability in the ultrasonographic measurement of the anterior chamber length diameter which has an impact on the overall management of patients with raised intraocular pressure (IOP).

METHODS

This was a prospective observational study undertaken at Nepalgunj Medical College and Teaching Hospital, Banke, Nepal from September 1st to September 30th 2023. Inclusion criteria was healthy volunteers of greater than 17 years of age, willing to participate. The study was approved by the institutional review committee and informed consent was obtained from all individuals prior to the enrollment to the study. Exclusion criteria were history of head injury, hypertension, endocrine abnormalities, ophthalmic and neurological problems.Ultrasound was performed on Logiq P6 ultrasound machine (GE Healthcare, Waukesha, Washington) with a 7.5 MHz linear transducer for the assessment of the ACD by a radiologist with greater than 5 years of experience and a radiology trainee. Interobserver variability was noted for measurements or observations made by the two observers as well as intraobserver variability for the same observer. Volunteers were examined on supine position and were instructed to have a neutral gaze and the close the eyes. The transducer was then placed over the closed upper eye lid of the right eye after application of moderate amount of gel (figure 1). Measurement was taken in the axial plane from the mid-point of the outer edge of the cornea to the midpoint of the anterior surface of the lens by two observers blinded to each other with two measurements for both eyes. For all statistical analyses, SPSS Statistics Version 21.0 (IBM Corp., USA) was used. Intra-observer and interobserver reproducibility were calculated for each of the two observers on the basis of two serial measurements. Reproducibility was evaluated by means of the intraclass correlation coefficient (ICC).

RESULTS

A total of 150 patients who fulfilled all the inclusion and exclusion criteria were enrolled in the study which included 83 males (55%) and 67 females (45%). The age of the patient ranged from 17 years to 41.0 years with a mean age of 25.7 +/- 6.79 years. Mean age was not significantly different depending on gender (p=0.87). There was a linear correlation of age with ACD 0.634 correlation coefficient (95% CI) Pearson correlation 0.634. The minimum and maximum diameter of right ACD was 4.175 mm and 2.175 mm with a mean diameter of 2.824 mm with standard deviation of 0.518 mm. The minimum and maximum diameter of right ACD was 4.175 mm and 2.175 mm with a mean diameter of 2.824 mm with standard deviation of 0.518 mm. The minimum and maximum diameter of right ACD was 4.175 mm and 2.175 mm with a mean diameter of 2.824 mm with standard deviation of 0.518 mm. The minimum and maximum diameter of left ACD was 4.175 mm and 2.20 mm with a mean diameter of 2.826 mm with standard deviation of 0.518 mm. There was a statistically significant linear correlation between age and both right and left anterior chamber depth (p <0.001) for the Pearson correlation coefficient 0.633 and 0.634 at 95%CI.

Intraobserver variability for first observer for right eye ACD statistically significant linear correlation (p <0.001). The Pearson correlation coefficient correlation coefficient (95% CI) of 0.998 (figure 2a, 2b). For the left eye ACD, intra observer variability for the first observer was - statistically significant linear correlation (p <0.001) with the Pearson correlation coefficient t (95% CI) of 0.996 (figure 3a, 3b).

Intraobserver variability for second observer for right eye ACD -statistically significant linear correlation (p <0.001) with a Pearson correlation coefficient (95% CI) of 0.999. For the left eye ACD, intraobserver variability for the second observer was statistically significant linear correlation (p <0.001) with Pearson correlation coefficient (95% CI) of 0.997.

There is a statistically significant correlation of right as well as left mean ACD interobserver variability (p<0.01) with the Spearman correlation coefficient of 0.994 and 0.998 respectively and excellent agreement Kappa Static of 0.841 and 0.776 (figure 4a, 4b).

DISCUSSION

Anterior chamber depth of the eye is an important paramter assessment prior to ophthalmic surgery. It is the distance between the corneal epithelium and the anterior surface of the crystalline lens. Studies have shown ACD to be directly proportional with axial length, corneal power, and anterior chamber angle, and an inverse relationship with the age. A deep ACD is often seen in large myopic eyes. A shallow anterior chamber can be seen in physiologically normal but small eyes with short axial lengths as well as even smaller nanophthalmic eyes.[2] ACD is also important in several eye conditions, including inflammatory eye processes, keratoconus, endothelial cell density loss, oxidative stress in endothelial cells, glaucoma surgical interventions, phacoemulsification surgery, anterior chamber dimensions, intraocular lens formula calculations, and surgical post refractive errors. Few studies have demonstrated that the anterior chamber depth has a geographic as well as racial variation.[3, 4] In our study, there was not any statistical difference of ACD with gender which is concordant to previous studies.[5] Study on an Iranian population showed mean ACD of 2.62 mm with value ranging from 2.57 mm and 3.41 mm.[6, 7] Few studies have shown ACD to be lower in Asians and higher in Latinos.[8] Our study showed a mean ACD of 2.824 and 2.826 mm in the right and left eye which was similar to few Asian studies.[4, 9, 10] Studies have shown anterior chamber scan had low inter-observer and intraobserver variability in the quantitative evaluation that was not affected with the angle status or to the experience of an operator in optical coherence tomography.[11] In our study, there was also low inter-observer and intraobserver variability reflecting high reproducible measurements.

Limited studies have been done evaluating ACD with B-mode ultrasound. B-mode ultrasound is widely available and in dearth of ophthalmologist and other diagnostic modalities in remote regions, use in diagnosing acute ophthalmologic emergencies is paramount. The minimal intra and inter observer variability in ACD measurement has significant clinical implications as is precise ACD values crucial in ophthalmic surgery planning and management of conditions like glaucoma. Few studies comparing B-mode ultrasound with optical biometer have found good reliability and variability in measuring ACD and ocular length suggesting its importance in assessment and follow up of wide range of ophthalmic diseases.[12] High reliability of ultrasound-derived ACD values supports its utility when other imaging modalities are unavailable especially in remote regions.

CONCLUSION

Measuring ACD diameter using B-mode ultrasonography is a reproducible method, with minimal intra and inter-observer variability. Our findings support the use of this technique in clinical settings where precise measurements are crucial in resource limited setting. Nonetheless, it is important to consider the potential sources of variability and implement strategies to minimize them, such as regular training and calibration of observers, and utilizing advanced technology with improved resolution and accuracy. Future studies should focus on evaluating the impact of these factors on the reliability of ACD diameter measurements.

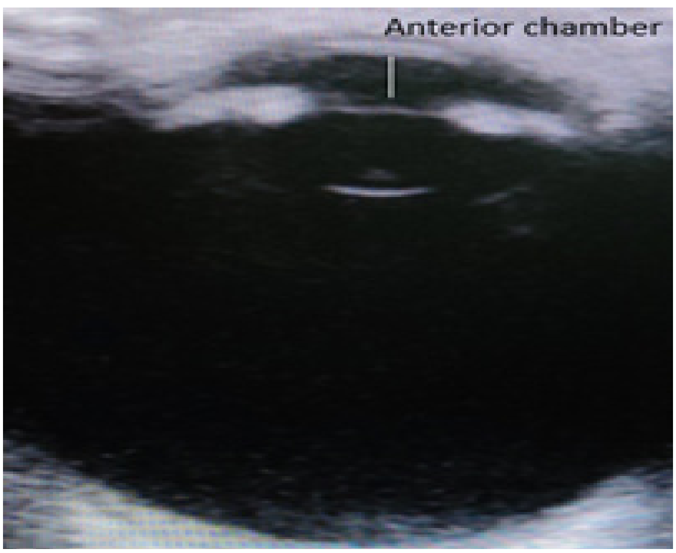
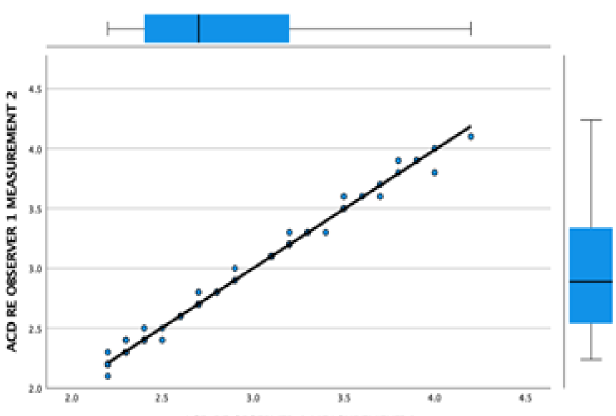


Figure 1: B-mode ultrasonography of the orbit



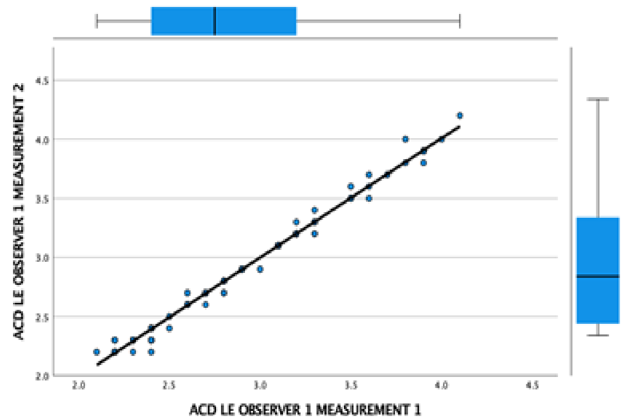
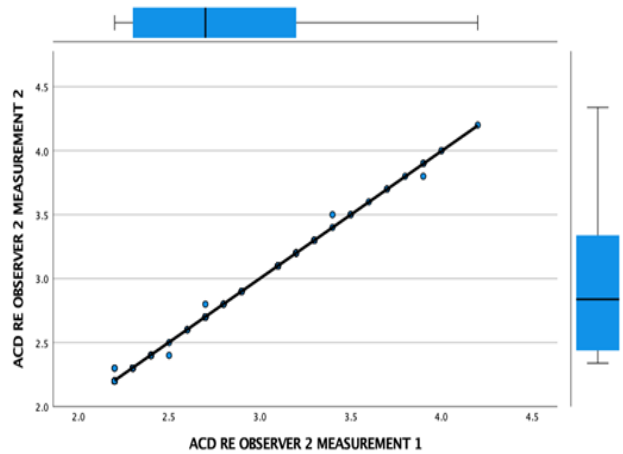


Figure 2 a and b: Right and left eye ACD -Intraobserver variability for Observer 1



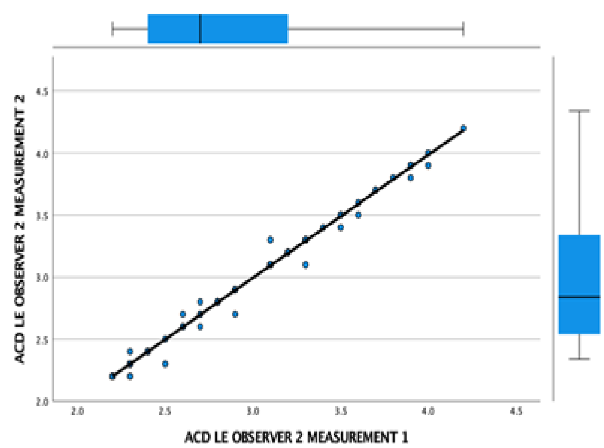


Figure 3a and b: Right and left eye ACD -Intraobserver variability for Observer 2

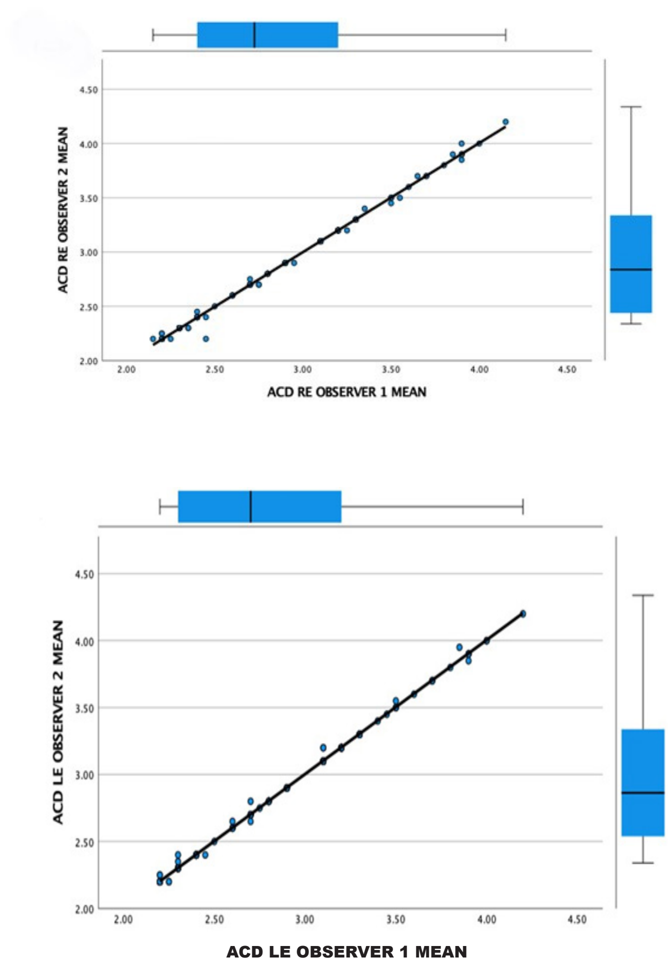


Figure 4a and b: Interobserver variability for Right and left eye ACD for observer 1 and 2

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