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Introducing an appropriate coefficient for slit length to estimate the depth of the anterior chamber measured by the Pentacam

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HIGHLIGHTS

This study indicates that correction factors of 1.22 and 1.4 in the slit length technique respectively underestimate and overestimate anterior chamber depth (ACD) measured by the Pentacam. Only the 1.31 correction factor ensures accurate ACD assessment with the Pentacam.

ABSTRACT

Purpose: To introduce an appropriate coefficient for Smith slit length technique to estimate the anterior chamber depth using slit lamp biomicroscopy

Methods: This cross-sectional study was conducted in 40 subjects (80 eyes) aged 18–25 years in 2019. The inclusion criteria were a negative history of active inflammatory eye diseases, cataract, glaucoma and ocular surgery. First, the ACD was measured in all subjects using slit lamp biomicroscopy and then both eyes underwent Pentacam imaging.

Results: The mean ACD was 3.45 (±0.35), 3.22 (±0.33), and 3.00 (±0.31) mm using the Smith method and 1.4, 1.31, and 1.22 correction factors respectively and 3.20 (±0.25) mm using the Pentacam. There was a significant difference between the results of the Pentacam and Smith method with 1.4 and 1.22 correction factors (P <0.0001) while no significant difference was found between the results of the Pentacam and Smith method using the 1.31 correction factor. The mean difference between the Pentacam and Smith method (using the 1.31 correction factor) was 0.02 mm and their 95% LOA was between +0.30 and -0.34 mm. The intarclass correlation coefficient (ICC) between the results of the Pentacam and Smith method (using the 1.31 correction factor) was 0.919, which was higher than the ICCs of 1.22 and 1.4 factors.

Conclusion: According to this study, applying the correction factors of 1.22 and 1.4 in the slit length technique causes underestimation and overestimation of the ACD obtained from the Pentacam and only the 1.31 correction factor is suitable for ACD estimation using the Pentacam.

Key words: anterior chamber depth, estimation, pentacam, slit lamp, slit length

INTRODUCTION

Anterior chamber depth (ACD) refers to the distance between the posterior corneal surface and the anterior crystalline lens surface [1]. This distance is of great importance in diagnosis and treatment of many diseases and plays a major role in glaucoma diagnosis, probability of angle closure following pupil dilation, evaluation of peripheral iridotomy indications, IOL implantation, and fitting of scleral contact lenses [2]. The anterior chamber depth and angle can be measured using paraclinical devices like the Pentacam, Orbscan, and Galilei as well slit-lamp biomicroscopy [3, 4]. Two common methods for estimating the anterior chamber depth angle and depth in the clinical setting include the techniques proposed by Smith and van Herick [4, 5]. In the Smith's method, which was introduced in 1979 [4], a horizontal slit beam is projected to the eye such that the angle between the slit lamp and the microscope is set at 60˚. A horizontal light beam is focused on the cornea and an out-of-focus light beam is formed on the lens and iris. The slit is now lengthened until the edge of the slit image on the cornea is coincident with the edge of the slit image at lens/iris. The slit length should be multiplied by a factor of 1.4 to obtain the anterior chamber depth [4].

A number of subsequent studies reported different correction factors. In 1996, Barrett et al. reviewed the ACD estimates provided by the Smith's method and proposed a correction factor of 1.31 instead of 1.4 [6]. Moreover, Eperjesi and Holden compared three methods used for ACD measurement, including the van Herick, Smith, and Orbscan, and reported a correction factor of 1.22 for ACD estimation using the Smith's method based on the Orbscan results [7]. One of the anterior segment imaging methods that is widely used is Scheimpflug imaging. The Pentacam uses a rotating Scheimpflug camera for imaging all anterior segment structures [8]. This device is of undoubted significance in quantitative assessment of anterior chamber parameters in ophthalmic examinations. Therefore, considering the differences and controversies of the previous studies regarding the Smith's correction factor, it seems necessary to conduct a study to adjust the Smith correction factor according to the Pentacam results. The aim of the present study was to determine the Smith's correction factor for ACD estimation according to the results of Pentacam imaging.

METHODS

This cross-sectional study was conducted in 40 subjects (80 eyes) aged 18–25 years in 2019. The inclusion criteria were a negative history of active inflammatory eye diseases, cataract, glaucoma and ocular surgery.

The study followed the tenets of the Helsinki Declaration and informed consent was obtained from all subjects prior to the study. A through ophthalmic history was taken from all participants; then, they underwent slit-lamp biomicroscopy to evaluate the inclusion criteria. Subjects that met all inclusion criteria were included in the study.

ACD estimation

The slit-length method, also known as the Smith's method, was used to estimate the ACD in this study [4, 6]. For this test, the subject was seated at the slit lamp and the chin rest and forehead strap were adjusted. The angle between the slit lamp and the microscope was set at 60˚. A slit beam at a width of about 2 mm was adjusted on the patient's cornea. The height of the slit light was set at 1 mm in the beginning. The beam was adjusted to the central pupil on the cornea such a slit light was projected on the cornea and another slit light was projected on the lens/iris. The light was focused on the cornea while the light on the lens/iris was out of focus. Then, the slit light height was increased until 2 slit lights coincided. The height of the slit light was considered as the slit length [4]. The test was done in triplicate and averaged.

ACD measurement using the Pentacam

Pentacam imaging was done after slit lamp examination. The patients were seated at the Pentacam and the chin rest and forehead strap were adjusted. Next, they were instructed to fixate on an internal fixation target and keep their eyes still. Then, imaging was done and the ACD value was extracted from the results.

Statistical analysis

Descriptive statistics were calculated for all parameters and the mean values obtained from 3 factors (1.4 as the main correction factor, 1.31 as the correction factor modified by Barrett, and 1.22 as the Orbscan factor) were compared with the Pentacam results. The Bland–Altman method was applied to determine the agreement between the Smith method and Pentacam results and the 95% limit of agreement was estimated. The interclass correlation coefficient was also calculated. Finally, the equation between the Smith method and Pentacam was calculated using regression analysis and the correction factor was determined using slit-length results.

RESULTS

The data of 40 subjects (80 eyes) aged 18–25 years, including 26 male participants, were analyzed.

The mean and standard deviation of the ACD measured by the Pentacam and estimated by the Smith method using 3 correction factors as well as the P-values of the comparison between the Pentacam and Smith method results and their agreement and difference are presented in table 1.

TABLE 1

Comparison between the Pentacam and Smith method results and their agreement and difference.

	Mean (±SD)	Mean difference with Pentacam	ICC (agreement with Pentacam)	LOA (agreement with Pentacam)	p-value (comparison with Pentacam)
Pentacam	3.21 (±0.26)				
Smith.1.22 (mm)	3.00 (±0.31)	0.20 (±0.15)	0.815	0.09–0.49	<0.001
Smith.1.40 (mm)	3.45 (±0.35)	-0.24 (±0.18)	0.781	-0.59–0.11	<0.001
Smith 1.31 (mm)	3.22 (±0.33)	-0.02 (±0.16)	0.919	-0.34–0.30	0.307

ICC – intarclass correlation coefficient; LOA – limits of agreement; SD – standard deviation.

The smallest and largest difference between the Pentacam and Smith method results was related to the 1.4 and 1.31 correction factors, respectively. There was no significant difference between the results of the Pentacam and Smith method using the 1.31 correction factor. The highest and lowest ICC was also related to the comparison between the results of the Pentacam and Smith method using 1.4 and 1.31 correction factors, respectively. The LOA and Bland–Altman plot are presented in figure 1.

Calculation of Pentacam estimation coefficient

A regression analysis was applied to determine the Pentacam estimation coefficient using the Smith method. The regression results were as follows:

Pentacam ACD = 0.9911 + 0.8988 × slit length

Pentacam ACD = 0.9889 + 0.7383 × (Smith 1.22)

Pentacam ACD = 1.0106 + 0.6370 × (Smith 1.40)

Pentacam ACD = 0.9913 + 0.6868 × (Smith 1.31)

FIGURE 1

The Bland–Altman showing the agreement of Pentacam and Smith 1.22.

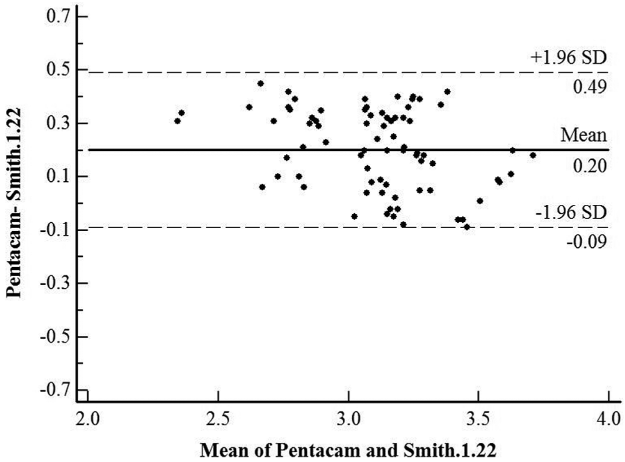


FIGURE 2

The Bland–Altman showing the agreement of Pentacam and smith 1.40.

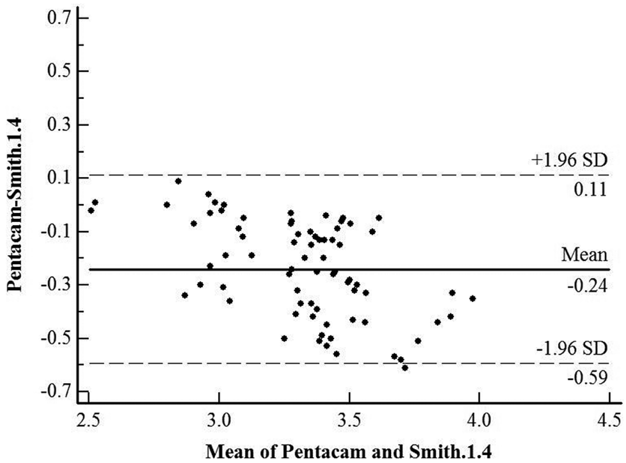
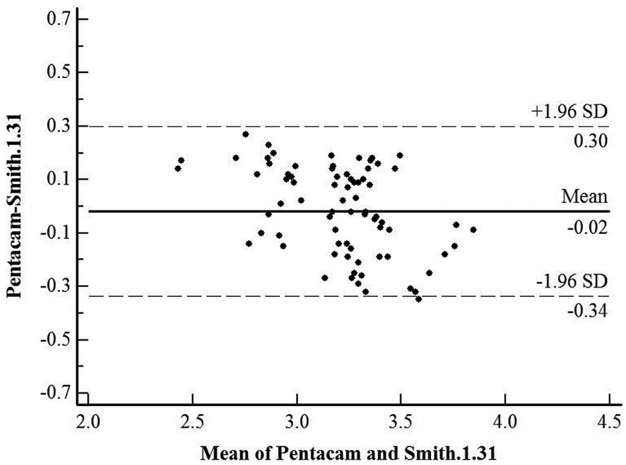


FIGURE 3

The Bland–Altman showing the agreement of Pentacam and smith 1.31.



DISCUSSION

This was the first study of the best correction factor for ACD estimation using the Smith method based on the Pentacam results. Since the Pentacam is widely used for anterior segment imaging and assessment of anterior chamber parameters, modification of the Smith correction factor based on the Pentacam results can increase the accuracy of this method.

Although the difference between the mean values of the Smith method using the 1.2 correction factor and Pentacam results was statistically significant, it could be of clinical significance as well. According to the results, applying this correction factor resulted in the ACD value overestimation compared to the Pentacam. Barrett et al. studied the Smith method in 1996 [6] and introduced the 1.31 correction factor instead of 1.4. This study found no significant difference between the results of the Pentacam and Smith method using the 1.31 correction factor. In 2011, Eperjesi and Holdren introduced a correction factor of 1.22 for the Smith method [7] based on the Orbscan results and reported that using previous correction factors (1.4 and 1.31) resulted in overestimation of the ACD value compared to the Orbscan results. Comparison of the results of the Pentacam and Smith method using the 1.22 correction factor showed significant statistical and clinical differences and underestimation of the ACD value compared to the Pentacam results.

The reason for underestimation of the ACD estimates using the 1.22 correction factor compared to the Pentacam results could be measurement method differences between the Orbscan and Pentacam. Previous studies suggest that the Orbscan underestimates the ACD value compared to the Pentacam [9–11]. This underestimation was found to be 0.13, 0.05, and 0.15 mm in studies conducted by Dinc et al., Utine et al., and Yazici et al., respectively [9–11]. Therefore, the 0.2 mm difference between the Pentacam results and Smith method using the 1.22 correction factor in this study could be largely due to the differences between the Orbscan and Pentacam.

As mentioned earlier, the only correction factor whose results were not significantly different from the Pentacam was the 1.33 correction factor. The Bland–Altman plot was used to evaluate the agreement between the Pentacam and Smith method. According to the plot, the mean difference between these two methods was 0.02 mm, which could be considered zero practically. On the other hand, the 95% limits of agreement of these two methods had a narrow range within ±0.3, which is clinically acceptable. In addition, the ICC between the Pentacam and Smith method using the 1.31 correction factor was higher than other ICCs, indicating the Smith method with this correction factor has the highest prediction power for Pentacam results.

According to the results of this study, using the 1.4 correction factor causes ACD overestimation by 0.2 mm and applying the 1.22 correction factor causes ACD underestimation by 0.2 mm compared to the Pentacam results, while the 1.31 correction factor produces results that are not significantly different from the Pentacam. Therefore, it is suggested that the 1.31 correction factor be used for ACD estimation using the slit length technique based on the Pentacam results.

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Conflict of interest:

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Ethics:

The content presented in the article complies with the principles of the Helsinki Declaration, EU directives and harmonized requirements for biomedical journals. This study was approved by the Ethics Committee of Iran University of Medical Science (IR IUMS.REC.1399.146).