

Comparative Study between Pentacam and IOL Master in Measuring Anterior Segment Parameters in Eyes of Egyptian Individuals

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Abstract

Background: Accurate values of anterior segment parameters are important for diagnosing variety of diseases and for cataract surgery, glaucoma, refractive surgery and post-operative follow-up. The true values of Anterior Chamber Depth (ACD), corneal power (K-readings) and White-to-White (WTW) are essential in calculating the Intraocular Lens power (IOL). The measurement of the ACD and WTW is essential for the success of phakic IOL implantation in patients asking for refractive surgery. This is now possible because of the development of new, accurate diagnostic and surgical tools.

Aim of Study: To compare values of anterior segment parameters (ACD, K-reading, WTW) obtained by Pentacam and IOL master to know if there are significant differences in measurement results between both devices or only minimal differences which can be neglected.

Patients and Methods: This comparative cross sectional study included 40 eyes of 22 Egyptian individuals. Evaluation included best corrected visual acuity, slit-lamp evaluation and autorefractometer reading. Imaging by investigative method in the form of IOL master 500 and Pentacam Oculus. All investigations and examinations were done at Kobri El-Kobba military Hospital, Cairo. From January 2018 to August 2018.

Results: IOL master gives statistically significant higher value of K-readings (43.56 ± 1.72 & 45.03 ± 1.59 for K1 & K2 respectively) than Pentacam (43.28 ± 1.73 & 44.72 ± 1.58 for K1 & K2 respectively). Low significant difference between both devices in values of ACD (mean difference \pm SD -0.03 ± 0.10). Pentacam measures longer WTW value (mean 12.10 ± 0.45) than IOL master (mean 12.00 ± 0.41).

Conclusion: IOL master gives slightly higher K-reading than Pentacam. Both devices measure ACD accurately and give nearly similar results. IOL master gives reliable WTW estimation but pentacam measurement of WTW by inserting calipers on scheimpflug image may give different values than IOL master.

Key Words: Anterior chamber depth – White-to-White – K-readings – IOL master – Pentacam.

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Introduction

MEASURING parameters of anterior segment of the eye accurately is important for diagnosing variety of diseases and for cataract surgeries, glaucoma, refractive surgeries and post-operative follow-up. The true values of Anterior Chamber Depth (ACD), corneal power (K-readings), corneal astigmatism and White-to-White (WTW) are essential in calculating the Intraocular Lens (IOL) power, specially with the newer generations of biometric formulas [1]. The measurement of the ACD and WTW is essential for the success of phakic IOL implantation in high refractive error patients asking for refractive surgery. Errors in evaluating these parameters before surgery may result in postoperative unwanted errors of refraction [2].

Different technologies are used in measurement of the structures of the anterior segment. In recent years, technologies used for anterior segment imaging have developed rapidly. New devices based on Scheimpflug imaging, such as the Pentacam and Galilei Dual Scheimpflug Analyzer (GD SA), or high speed anterior segment optical coherence tomography, or partial coherence interferometry based devices as Zeiss IOL Master, or very high frequency ultrasound. These devices provide qualitative and quantitative information about the anterior segment including corneal parameters, ACD, anterior chamber angle and WTW, and they are now being routinely used in ophthalmological practice. They also have the advantage of being noncontact devices and easy to use [3].

Also, accurate anterior segment parameters values are mostly indicated in preoperative evaluation of cataract surgeries. Modern cataract surgery can be considered a form of refractive surgery,

aiming to improve visual clarity and to provide excellent vision in refractive terms. This is now possible because of the development of new, accurate diagnostic and surgical tools [3].

The cornea is responsible for 2/3 of the total optical power of the eye and hence the accurate assessment of corneal curvature is very important in ophthalmic practice [4]. Different keratometry systems are available for use. Manual keratometer used to measure pre-operative corneal astigmatism but accurate measurement by it requires a learning curve and measured values can differ according to the operator. Automated devices can be used such as autorefractor keratometer, IOL master, three Placido disk based corneal topographers, Scheimpflug camera devices as Pentacam and Sirius [5].

Depth of Anterior Chamber (ACD) is the distance between the anterior surface of the crystalline lens and posterior surface of cornea. The ACD can be measured clinically using different methods. The oldest method is the manual optical pachymeter. IOL Master device then was introduced, which uses a non-laser optical slit method to determine the ACD. Scheimpflug imaging cameras were introduced later, allowing for a photographic scan and analysis of the ACD including the Pentacam and the Galilei [6].

The White-to-White (WTW) corneal diameter is defined by the horizontal distance between the borders of the corneal limbus [7]. Available techniques for the measurement of WTW distance including manual techniques, as surgical calipers, corneal gauges. Also, automated techniques, as ultrasound biomicroscopy, IOL master, anterior segment OCT and Pentacam. Automated measurements provide more precise results than manual techniques [8].

The aim of this study was to compare values of anterior segment parameters (ACD, K-reading, WTW) obtained by Pentacam and IOL master to know if there are significant differences in measurement results between both devices or only minimal differences which can be neglected.

Patients and Methods

This study was performed on 40 eyes of 22 Egyptian individuals. Subjects included in this study were aged between twenty and forty years, presenting for glass prescription, asking for refractive surgery or coming for just check up. All investigations and examinations were done at Kobri El-Kobba Hospital, Cairo during the period of the

study from January 2018 to August 2018. The patients signed written consent after they were informed about the nature of the study. Subjects with previous ocular or refractive surgery, ocular trauma, keratoconus patients, uveitis patients or individuals with history of recent contact lens wear, all were excluded from the study. All participants past ocular history and general medical history were checked. All of them were examined for unaided and best corrected visual acuity using Landolt's chart and autorefractometer reading was taken. Slit lamp examination for anterior segment of the eye was done prior to the imaging. All enrolled individuals were imaged by investigative techniques in the form of IOL master 500 and Pentacam oculus HR in the same session and by the same operator.

IOL master 500: Optical biometry by the Zeiss IOL Master was introduced in the United Kingdom in 1999. Its technology is based on laser interferometry with partial coherent light, termed as Partial Coherence Interferometry (PCI) [9]. The device uses the principle of PCI to measure the axial length of the eye. While uses a slit-beam photographic technique for ACD measurements [10]. For keratometry measurement, six light spots are projected hexagonally on the cornea [1]. The device records the reflection of these images measuring the separation of the opposite pairs of light spots and calculating the corneal radii and toroidal surface curvature. The mean of the taken measurements is considered the corneal power [11]. The displayed K1 and K2 represent the average keratometry values at two major perpendicular meridians [12]. For ACD measurement, the IOL Master directs a slit beam of light 0.7mm wide through the anterior segment at an angle of 38° to the visual axis. The internal software measures the distance between anterior pole of the cornea and the anterior surface of the lens to calculate the ACD [13]. The device takes five ACD measurements in rapid succession; the mean of these readings are taken as the ACD value [14]. For WTW measurement, a digital grey-scale photograph of the anterior surface of the eye is taken after focusing on the iris. The limbus is then detected automatically and the WTW distance is measured [15].

Pentacam oculus: The Pentacam obtains images of the anterior segment by a rotating Scheimpflug blue Light Emitting Diode (LED) with a wavelength of 475nm. It acquires 50 images in a duration of approximately two seconds. It extracts about 2,760 true elevation points from the obtained images which in turn generates 1 38,000 true elevation points for the both front and back corneal surfaces

and from limbus to limbus, including the central part of the cornea [16]. There for, it calculates k-readings of the cornea. The Pentacam HR calculates ACD from the corneal endothelial layer along a line from the apex of the cornea to the anterior surface of the lens [17]. Horizontal WTW was measured in this study by manual placement of callipers on the Scheimpflug image of the horizontal plane of the examined eye; callipers are placed on the corneo-scleral junction then a line is automatically drawn between the two points Fig. (1). The length of this line represents the WTW value [18].

OCULUS - PENTACAM Overview

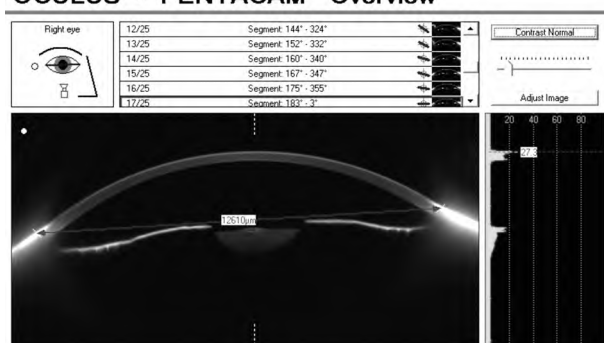


Fig. (1): Manual placing of callipers on the limbus for WTW measurement.

Statistical analysis:

The collected data from both pentacam & IOL master were revised, coded, tabulated in Microsoft Excel sheet including age, sex, K1-K2 readings, ACD, WTW values. The collected data were arranged for use in SPSS package. Data were expressed as mean \pm Standard Deviation (SD). Throughout the statistical analysis, the results were considered statistically significant when the significance level or p -value ≤ 0.05 .

Results

This is a cross sectional comparative study carried out on 40 eyes of 22 Egyptian individuals underwent phacoemulsification and IOL implantation surgery. There were 4 males and 18 females shared in the study. Their age was ranging from 21 years to 38 years with an average of 28.80 ± 5.92 years. Table (1) shows the K1 values obtained by pentacam ranged from 38.8 to 46.36D with mean 43.28 ± 1.73 D. While by IOL master, K1 ranged from 39.29 to 46.36D with mean 43.56 ± 1.72 D. The K2 values obtained by pentacam ranged from 41.3 to 47.5D with mean 44.72 ± 1.58 D. While by IOL master, K2 ranged from 41.46 to 47.74D with mean 45.03 ± 1.59 D. From (Table 1) there is high statistically significant difference between pentacam

and IOL master in both K1 & K2 with p -value < 0.01 .

Table (1): Comparison between K-reading values obtained by pentacam and IOL master.

| K-reading | Pentacam HR | IOL master | Mean difference ± SD | Paired <i>t</i> -test | | |
|-------------|----------------|---------------|----------------------------|-----------------------|---------------------|-----|
| | | | | <i>t</i> | <i>p</i> - value | Sig |
| <i>K1:</i> | | | | | | |
| • Mean ± SD | 43.28±1.73 | 43.56±1.72 | 0.28±0.13 | -14.053 | 0.000 | HS |
| • Range | 38.8-46.1 | 39.29-46.36 | | | | |
| <i>K2:</i> | | | | | | |
| • Mean ± SD | 44.72±1.58 | 45.03±1.59 | 0.31±0.19 | -10.154 | 0.000 | HS |
| • Range | 41.3-47.5 | 41.46-47.74 | | | | |

p -value > 0.05 : Non significant.

p -value < 0.05 : Significant.

p -value < 0.01 : Highly significant.

Table (2) shows that ACD value by Pentacam ranged from 3.00 to 4.06mm with mean 3.53 ± 0.25 mm. While by IOL master, ACD ranged from 2.97 to 4.11mm with mean 3.50 ± 0.25 mm. There is no significant difference between pentacam and IOL master in ACD value with p -value > 0.05 . IOL master measures higher K-reading value than Pentacam.

Table (2): Comparison between ACD by Pentacam & IOL master.

| ACD | Pentacam | IOL master | Mean difference \pm SD | Paired t -test | | |
|---------------|-----------------|-----------------|--------------------------|------------------|------------|------|
| | | | | t | p -value | Sig. |
| Mean \pm SD | 3.53 \pm 0.25 | 3.50 \pm 0.25 | -0.03 \pm 0.10 | 1.814 | 0.077 | NS |
| Range | 3-4.06 | 2.97 \pm 4.11 | | | | |

p -value > 0.05 : Non significant.

p -value < 0.05 : Significant.

p -value < 0.01 : Highly significant.

Table (3) shows that By pentacam, WTW ranged from 11.2-13.09mm with mean 12.10 ± 0.45 mm. While by IOL master, WTW ranged from 11.3-12.9mm with mean 12.00 ± 0.41 mm. Pentacam gives significant different WTW value than IOL master with p -value < 0.05 .

Table (3): Comparison between WTW by Pentacam & IOL master.

| WTW | Pentacam | IOL master | Mean difference \pm SD | Paired t -test | | |
|---------------|------------------|------------------|--------------------------|------------------|------------|------|
| | | | | t | p -value | Sig. |
| Mean \pm SD | 12.10 \pm 0.45 | 12.00 \pm 0.41 | -0.10 \pm 0.27 | 2.349 | 0.024 | S |
| Range | 11.2 \pm 13.09 | 11.3 \pm 12.9 | | | | |

p -value > 0.05 : Non significant.

p -value < 0.05 : Significant.

p -value < 0.01 : Highly significant.

Discussion

Accurate assessment and measuring parameters of the anterior segment of the eye is very important in ophthalmology practice. New imaging techniques were introduced within last years and more accurate technologies were added to already present devices to improve their accuracy and performance. IOL master is used in recent years for assessment of eyes specially for preoperative IOL power calculation formulas. Pentacam scheimpflug imaging then was introduced for more detailed images of anterior segment of the eye and a full map of corneal topography. This study was done to compare between the values of anterior segment parameters (K-readings, ACD, WTW) obtained by Pentacam and IOL master. A total of 40 eyes of 22 Egyptian individuals included in this study and they were examined by both Pentacam and IOL master.

In our study, the mean K-readings by Pentacam, K1 & K2 are 43.28 ± 1.73 & 44.72 ± 1.58 respectively. The mean K-readings by IOL master 500, K1 & K2 are 43.56 ± 1.72 & 45.03 ± 1.59 respectively. Our study shows statistically significant difference between mean K-reading by Pentacam and IOL master 500 ($p < 0.01$). This results agreed with Dong et al., [19] in 2015 which found significant difference between both devices in flat K1 and steep K2 values. His study was done on Chinese group. Also, Woodmass et al., [20] in 2009 and Elbaz et al., [21] in 2007 studies found that Pentacam mean K value is lower than that of IOL master. On the reverse Laursen et al., [22] in 2016 study compared keratometry by different 5 devices. Minimal differences was found between pentacam & IOL master in mean K-reading which in general was not significant. The study was done on higher age group (39 to 88 years). This study agreed with our study that IOL master gives relatively higher K-reading than other methods including Pentacam oculus.

Our study shows that mean ACD by Pentacam is 3.53 ± 0.25 mm. While mean ACD by IOL master is 3.50 ± 0.25 mm. Mean difference between both devices is -0.03 ± 0.10 . The study shows minimal insignificant difference between both devices ($p > 0.05$). This result agreed with results of Shajari et al., [23] in 2016, the study found that no statistically significant difference between Pentacam HR and IOL master in ACD value in healthy unoperated eyes. Also Domínguez-vicent et al., [15] in 2015 and Muzyka-Wozniak et al., in 2018 [24] studies agreed that there is minimal insignificant difference between both devices in ACD value. Fernandez-

Vigo et al., [25] in 2016 study done on 1006 eyes of Caucasian individuals, showed excellent agreement between Pentacam and IOL master in ACD measurements. On the reverse, Utine et al., [26] in 2009 found that IOL master ACD values were 0.11mm less than Pentacam ACD values. The mean difference between IOL master and Pentacam measurements was 3.16% of the mean ACD calculated across all measurements but this difference is too small to create significant difference in refractive outcome.

Our study results mean WTW value by pentacam was 12.10 ± 0.45 mm while that of IOL master was 12.00 ± 0.41 mm. Significant difference was found in WTW by both devices (p -value 0.024). The Pentacam gives longer WTW than IOL master (mean difference -0.10 ± 0.27 mm). Shajari et al., [23] in 2016 found higher value of WTW by IOL master (mean 12.0 ± 0.3 mm) than that of Pentacam (mean 11.8 ± 0.4 mm). The study done using Pentacam HR (Oculus, Germany), the version which include iris camera that can measure WTW automatically so, it's operator independent measure of WTW on the contrary to our study in which WTW was measured subjectively by manual insertion of a scale on the general scheimpflug image of horizontal view. Domínguez-Vicent et al., [15] in 2015 found low significant difference in WTW by Pentacam HR and IOL master (mean difference 0.07 ± 0.10 mm). The study said that both devices can be used interchangeably to each other to measure WTW as IOLs are produced to the nearest 0.50mm. Elkateb, Swelem [18] study in 2016 done in Egypt compared WTW by pentacam and IOL master and found that mean WTW by pentacam (mean 11.93 ± 0.43 mm) is higher than WTW by IOL master (mean 11.66 ± 0.27 mm). It was done by the same method used in our study for WTW by pentacam which is manual placing of two calipers on the scheimpflug image of the pentacam. The study said that there is significant difference between both devices so, they can't be used interchangeable to each other for WTW measurement.

Conclusion:

We concluded from this study that both Pentacam oculus and IOL master 500 are excellent noncontact devices for assessment and accurate measurement of anterior segment parameters of the eye. IOL master gives slightly higher K-reading than Pentacam. This difference may be statistically significant but we needs to know by further studies if it's practically significant or not. Both devices measure ACD accurately and give nearly similar results so, both of them can be used interchangeable to each other to measure ACD taking into account

to be from corneal epithelium to anterior lens capsule. IOL master gives reliable WTW estimation but pentacam manual measurement of WTW by inserting calipers on scheimpflug image may give different results as its subjective operator dependant to some extent.

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دراسة مقارنة بين جهاز تخطيط القرنية وجهاز تحديد مقاس عدسة العين في قياسات الجزء الأمامي للعين في الأفراد المصريين

القياس الدقيق لقيم الجزء الأمامي للعين هام جداً لتشخيص العديد من أمراض العين والتخطيط للعمليات الجراحية والمتابعة بعد الجراحة. القيم الحقيقية لعمق الخزانة الأمامية، قوة القرنية، الإنكسار والعرض الأفقي للقرنية تعد ضرورية في ممارسة طب العيون. ومن أكثر الأجهزة المستخدمة لقياس قيم الجزء الأمامي، جهاز التصوير بالكاميرا الخماسية الذي يقوم بتصوير الجزء الأمامي بواسطة كاميرا شمبفلج الدوارة، وجهاز تحديد مقاس عدسة العين الذي يعتمد على تكنولوجيا التداخل الجزئي لأشعة الليزر.

في هذه الدراسة، قمنا بالمقارنة بين قيم القطع الأمامي (قوة القرنية، العرض الأفقي، عمق الخزانة الأمامية) التي حصلنا عليها باستخدام جهاز التصوير بالكاميرا الخماسية وجهاز تحديد مقاس عدسة العين. وقد شملت هذه الدراسة أربعين عيناً من ٢٢ فرداً مصرياً. حيث تم فحصهم بجهاز التصوير بالكاميرا الخماسية وجهاز تحديد مقاس عدسة العين في نفس الجلسة. وبمقارنة النتائج طبقاً لقواعد الإحصاء، وجدنا أن جهاز تحديد مقاس عدسة العين يعطي قيمة قراءة أكبر لقوة القرنية من جهاز الكاميرا الخماسية. ووجدت الدراسة أيضاً عدم وجود فرق ذي دلالة إحصائية تقريباً بين الجهازين في قياس عمق الخزانة الأمامية للعين مما يعني أنه يمكن استخدام كلا الجهازين للتبادل مع بعضهما البعض. أظهرت الدراسة إختلافاً ذو دلالة إحصائية بين الجهازين في قياس قيمة العرض الأفقي. حيث أن قيم العرض الأفقي التي حصلنا عليها بجهاز الكاميرا الخماسية أعلى من القيمة التي حصلنا عليها بجهاز تحديد مقاس عدسة العين إذا استخدمنا طريقة وضع الفرجار يدوياً على صورة شمبفلج للعين المكونة بواسطة جهاز الكاميرا الخماسية.