

A comparative study of the discrepancy in the horizontal white-to-white measurement using Calipers vs Pentacam

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ABSTRACT

Background: The accurate measurement of the horizontal corneal white-to-white (WTW) diameter is essential and has multiple applications in the field of ophthalmology whether medical or surgical. There are many means of measuring the horizontal white-to-white, which includes the Pentacam, the IOL Master and Manual Calipers. Both the Pentacam and Manual Calipers measure the external white-to-white diameter, whereas the IOL Master measures the internal white-to-white diameter.

Objective: The aim of this study is to measure the accuracy of the Pentacam white-to-white camera in measuring the horizontal corneal WTW diameter in comparison to the Manual Calipers, which is considered to be the basic standard.

Patients and Methods: The study was a cross sectional one, conducted at Maghrabi Eye Hospital, Cairo, Egypt. It was conducted in accordance with the ethical standards stated by the Ethical Committee of Ain Shams University. Informed consent was obtained from each participant following the explanation of the academic nature of the study.

Results: Our study compared the accuracy of the Pentacam HR to the Manual Calipers and found a strong correlation between both methods regarding all parameters. A difference of 0.44 ± 0.17 mm was found between the manual calipers and the Pentacam (HVID Automated) measurements and a lesser difference of 0.24 ± 0.27 mm when comparing the manual calipers with the Pentacam manual digital calipers. On the other hand, the difference between the 2 methods of the Pentacam measurement used was 0.19 ± 0.13 mm. All of which, showed a highly significant correlation.

Conclusion: The Pentacam gives larger WTW measurements than the manual calipers as it relies on the gray scale analysis of the HVID in the iris image display.

Keywords: White to White - Manual Calipers - Pentacam

INTRODUCTION

The horizontal corneal white-to-white (WTW) diameter measurement is an essential value and has multiple applications in the field of ophthalmology. It is defined as the distance between the two corneal limbal areas horizontally⁽¹⁾.

There are many means of measuring the horizontal WTW, which includes the Pentacam, the IOL Master and Manual Calipers. Both the Pentacam and Manual Calipers measure the external white-to-white diameter, whereas the IOL Master measures the internal white-to-white diameter.

The current accepted standards of normal horizontal WTW diameter, is greater than 11.0 mm and less than 13.0 mm⁽¹⁾.

The Pentacam HR (OCULUS, Germany) is a device that combines a rotating Scheimpflug camera with a static camera to acquire multiple photographs of the anterior eye segment. The Scheimpflug camera rotates along with a monochromatic slit light source around the optical axis to obtain the slit images. This rotating system performs a corneal scan from zero to 180 degrees and each of the photographs is an image of the cornea at a specific angle. It also has a WTW camera, to automatically measure the horizontal WTW diameter of the cornea⁽²⁾.

The IOL Master is considered to be the gold standard in optical biometry. It uses the principle of partial coherence interferometry (PCI) to obtain the axial length of the eye with high precision and hence calculating the intraocular lens (IOL) power. The IOL Master also automatically measures the horizontal white-to-white diameter of the cornea⁽³⁾.

As for the manual calipers, we used the Bausch and Lomb Storz Ophthalmics E-2404 Castroviejo Caliper, which measures from 0 to 20 mm in 0.5 mm increments, with a scale reading on both sides. The measurement will be performed under the slit lamp biomicroscope.

There are many clinical uses of the horizontal WTW measurement, including identification of: microphthalmia, relative anterior microphthalmia, microcornea, macrophthalmia, megalocornea, and congenital glaucoma⁽¹⁾.

As from the surgical point of view, surgeons have relied on the horizontal WTW measurement for sizing of some types of intraocular lenses like implantable collamer lenses (ICL) and angle supported phakic IOLs⁽¹⁾.

AIM OF THE WORK

The aim of this study was to measure the accuracy of the Pentacam white-to-white camera in

measuring the horizontal corneal WTW diameter in comparison to the manual calipers, which is considered to be the basic standard.

PATIENTS AND METHODS

A comparative single cohort study was conducted comprising of 46 healthy eyes from 23 patients seeking refractive surgery (7 males and 16 females), whose ages ranged from 18 to 37 years (Mean ± Standard Deviation: 27.04 ± 5.46 years).

The study was a cross sectional one, conducted at Maghrabi Eye Hospital, Cairo, Egypt. The study was approved by the Ethics Board of Ain Shams University.

It was conducted in accordance with the ethical standards stated by the Ethical Committee of Ain Shams University. Informed consent was obtained from each participant following the explanation of the academic nature of the study.

All patients were subjected to the following workup: History taking including name, age, previous ocular trauma or surgery whether major or minor and contact lens use. Ophthalmological examination using slit lamp biomicroscopy for assessment of the anterior segment.

Patients with ocular disease or history of ocular surgery or trauma were excluded from the study.

Both eyes of each patient were examined and the horizontal corneal WTW diameter was measured using a manual caliper under the slit lamp biomicroscope, by placing each tip on the limbus just beyond the clear corneal margins. After which, the patients were scanned with the Pentacam HR (OCULUS, Germany).

Patients were seated and positioned comfortably with a chin-rest and a headrest and asked to fixate on an internal target within the Pentacam. Fine adjustments were made to the chinrest to make sure that the lateral canthi of the eyes were in line with the side markers on the holding bars of the headrest.

Patients were then asked to perform a rapid, complete blink just before measurements were taken to ensure a smooth tear film over the cornea.

Scans that were substandard due to blinking or eye movement, were discarded and a second scan was performed.

The following parameters were obtained: the horizontal corneal WTW distance measured by manual caliper, the horizontal visible iris diameter

(HVID) measured automatically by the Pentacam, as well as a manual digital measurement of the HVID using the iris image display of the Pentacam.

Statistical methods:

The data were collected, revised, coded and entered into the Statistical Package for Social Sciences (IBM SPSS) version 20. Data were presented as mean, standard deviations and ranges.

The comparison between two paired groups was done with using paired t-test. Spearman's correlation coefficients were used to assess the correlation between two quantitative parameters in the same group.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. Hence, the p-value was considered significant as follows: P ≥ 0.05: Non-significant. P < 0.05: Significant. P < 0.01: Highly significant.

RESULTS

Table (1): The horizontal corneal WTW diameter measurements using manual caliper and the Pentacam (both HVID automated and digital manual).

WTW by Manual Caliper	Mean±SD	11.28 ± 0.29
	Range	11 – 12
WTW by Pentacam (HVID Automated)	Mean±SD	11.72 ± 0.26
	Range	11.3 – 12.3
WTW by Pentacam (Digital Manual)	Mean±SD	11.52 ± 0.27
	Range	11.02 – 12.22

Table (2): Shows the difference between the mean WTW of the Manual Caliper and the Pentacam (HVID Automated)

WTW	Manual Caliper	Pentacam (HVID Automated)	Difference	t	P-value
Mean±SD	11.28 ± 0.29	11.72 ± 0.26	0.44±0.17	17.257	<0.001
Range	11 – 12	11.3 – 12.3			

Table (3): Shows the difference between the mean WTW of the Manual Caliper and the Pentacam (Digital Manual)

WTW	Manual Caliper	Pentacam (Digital Manual)	Difference	t	p-value
Mean±SD	11.28 ± 0.29	11.52 ± 0.27	0.24±0.19	8.598	<0.001
Range	11 – 12	11.02 – 12.22			

Table (4): Shows the difference between the mean WTW of the Pentacam (HVID Automated) and the Pentacam (Digital Manual)

WTW	Pentacam (HVID Automated)	Pentacam (Digital Manual)	Difference	t	p-value
Mean±SD	11.72 ± 0.26	11.52 ± 0.27	0.19 ± 0.13	10.512	<0.001
Range	11.3 – 12.3	11.02 – 12.22			

Table (5): Illustrates the Correlation Coefficient *r* between the age and each of the WTW methods of measurement used in the study.

	Age	
	r	p-value
WTW by Manual Caliper	0.204	0.351
WTW by Pentacam (HVID Automated)	0.055	0.803
WTW by Pentacam (Digital Manual)	0.177	0.420

DISCUSSION

The standard definition of the WTW diameter is vague and inconsistent. However, the current accepted gold standard measurement of normal horizontal WTW between >11.0 mm and <13.0 mm has not been established by evidence-based studies ⁽¹⁾.

The accurate measurement of the horizontal WTW diameter of the cornea is an important landmark on which surgeons have relied on for the sizing of some types of intraocular lenses like the implantable collamer lenses (ICL) as well as its use in sizing capsular tension ring (CTR) and phakic anterior chamber IOLs. Moreover, it is used in many clinical settings as microphthalmia, relative anterior microphthalmia, microcornea, macrophthalmia, megalocornea, and congenital glaucoma ⁽¹⁾.

The exact relationship between the white-to-white (WTW), angle-to-angle (ATA) and the sulcus-to-sulcus (STS) is still being evaluated. Many surgeons add 0.50-1.0 mm to the external corneal WTW measurement to determine the overall diameter for a posterior chamber phakic lens ^(4,5).

However, the relationship between the external WTW and the ATA diameter was not consistently determined ⁽¹⁾.

In this study, we compared the horizontal WTW diameter measurement using the commonly used manual caliper with the Pentacam HR (Oculus, Germany); both in its automated horizontal visible iris diameter (Automated HVID) form as well as its digital manual form, in which we measure the WTW diameter manually on the Oculus software using the iris image display. To our knowledge, this is the first study to compare these modalities together.

By definition, the normal range (mean \pm 2 SD) should include approximately 95% of all values, and approximately 2.5% of values should fall 2-3 standard deviations above and below the mean. Using manual caliper, the horizontal WTW diameter ranged from 11 – 12 mm, with the mean

being 11.28 mm \pm 0.29 SD. The other two measurements were done using the Pentacam (horizontal visible iris diameter automated measurement and manual digital measurement). The WTW diameter using the HVID automated method showed the results ranging from 11.3 – 12.3 mm, with the mean at 11.72 mm \pm 0.26 mm. Whereas, the digital manual method using the Pentacam ranged from 11.02 – 12.22 mm, with a mean of 11.52 \pm 0.27 mm.

This shows a difference of 0.44 \pm 0.17 mm between the manual caliper and the Pentacam (HVID Automated) measurements and a lesser difference of 0.24 \pm 0.27 mm when comparing the manual caliper to the Pentacam (manual digital). On the other hand, the difference between the 2 methods of the Pentacam measurement used was 0.19 \pm 0.13 mm.

This difference in measurements may be attributed to the fact that the Pentacam takes measurements in 0.1 mm increments, while the manual calipers use 0.5 mm increments. So, when using the calipers, if the WTW was for example 11 or 11.5 mm, we documented it as such. However, if it lied in between these 2 marks, we always approximated it to the closest one. Hence, any WTW measurement falling between 11 and 11.25 mm would be approximated to 11 mm. Moreover, if we were in doubt whether it was closer to 11 or 11.5 mm, we always approximated to the lesser mark, as this is an important factor in ICL sizing to prevent excessive vaulting due to oversizing.

As per the difference in the WTW measurements when using the Pentacam (HVID automated) and the Pentacam (Digital Manual) methods, this is explained by the fact that the Pentacam uses a grey scale to determine the edges of the HVID. When we did the same using our personal visual judgement of the grey scale iris image, we obtained different results, which were actually closer to the manual calipers' measurement.

This is in contrast to a study done by **Chen and Osher** ⁽¹⁾ comparing the difference in measurements of the horizontal WTW using manual calipers and IOL Master, which showed that IOL Master WTW measurements that were slightly but significantly smaller than manual calipers WTW measurements ⁽¹⁾.

There are several limitations to our study, the most important being the sample size. Moreover, the

results of our study are only applicable to healthy adult eyes, and this may be a potential design limitation. The results might not be applicable to pediatric patients, patients with anterior segment eye disease, such as keratoconus or cataract, eyes with previous surgery, such as refractive procedures, corneal crosslinking, and corneal transplantation.

Thus, we recommend further studies to be conducted with a larger sample size to address these considerations and to increase the power of the study.

CONCLUSION

Both the Pentacam and the manual calipers are reliable methods for WTW measurement in normal patients. The Pentacam gives larger WTW measurements than the manual calipers as it relies on the gray scale analysis of the HVID in the iris image display. Using the manual digital calipers of the Pentacam reduces the differences between the 2 methods. This must be taken into consideration when determining the size of the posterior chamber phakic IOLs and in all surgical procedures depending on the WTW measurements.

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