International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 44 No. 2 May 2024, pp. 138-145

Values of White-to-White Corneal Diameter and Anterior Chamber Depth in Healthy Libyan Eyes Obtained with Pentacam Scheimpflug Imaging

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Abstract

Background: Accurate measurements of the depth of the anterior chamber and horizontal white-to-white (WTW) corneal diameter are essential for numerous clinical applications.
Aim: to determine the normative values of white-to-white corneal diameter and anterior chamber depth in a healthy Libyan population using Pentacam HR.
Methods: An observational cross-sectional study was carried out in Benghazi Teaching Eye Hospitals between December 2023 and February 2024, it involved100 individuals (200 eyes), with a mean age of 32.84±13.04 years (range17-74 years), the white-to-white corneal diameter and anterior chamber depth were measured using the Pentacam® HR.
Results:
The mean WTW distance was 11.71± 0.57mm (range=10.25 - 12.80mm), and the mean anterior chamber depth was 3.53± 0.43mm (range= 2.67 - 4.42mm). There was no statistical difference between genders regarding WTW distance and anterior chamber depth (p<.05)
The WTW corneal diameter and ACD were significantly inversely proportion correlatedwith age, there was a decrease in WTW diameter and AC depthwith increasing age, [F (2,97) =27.01, P=<.001, F (2,97) =13.20, P=<.001] respectively. The increase in WTW distance was associated with an increase in AC depth which was a highly positive statistically significant correlation (r=.741, p<.001).
Conclusion:
The Libyan's mean WTW corneal diameter was lower, and the anterior chamber depth was deeper than other populations. A positive correlation between the WTW and ACD was found.

Keywords – Anterior chamber depth, Cornea, White-to-White, Libya, Pentacam HR.

I. INTRODUCTION

The anterior segment of the eye plays a crucial role in vision and ocular health.[1] The white-to-white (WTW) corneal diameter is an important anatomical measurement, representing the horizontal width of the cornea, it is a key factor in determining the appropriate intraocular lens (IOL) size influencing the postoperative refractive error, [2] the anterior chamber depth (ACD) is the distance between the corneal endothelium and the anterior surface of the lens, it aids in preoperative planning for cataract surgery, IOL power calculation, and the detection of angle-closure risk. [3]

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Precise measurements of WTW distance and ACD depth, are essential for numerous clinical applications. Inter-individual and ethnic variations in corneal diameter exist, necessitating population-specific norms for accurate assessments. [4-7]

The choice of measurement technique can impact accuracy. Newer technologies may offer advantages over traditional methods like Scheimpflug imaging which provides accurate and reproducible results. [8,9]

OCULUS Pentacam® HR is a non-invasive/ non-contact Scheimpflug imaging tomography that creates a three-dimensional image of the anterior segment of the eye and automatically calculates the horizontal WTW diameter and ACD. [10]

The present study aimed to determine the normative values of white-to-white corneal diameter and anterior chamber depth in a healthy Libyan population using Pentacam HR.

II. Subjects and Methods

An observational cross-sectional study was carried out in Benghazi Teaching Eye Hospital from December 2023 to February 2024 on healthy emmetropic volunteers of both genders with an age range of 17-74 years.

A complete Ophthalmological examination was done, subjects suffering from corneal disease, uveitis, previous trauma or ocular surgery, and patients with dry eyes or having a history of glaucoma were excluded from the study.

The white-to-white corneal diameter and anterior chamber depth were measured using the Pentacam® HR (Oculus, Wetzlar, Germany), Three measurements were made for each individual. The statistical median of these three measurements was used to compute the subsequent measurement result.

The study was done following the Helsinki Declaration and informed consent was obtained from participants.

Statistical analysis was performed using the Statistical Package for the Social Science (SPSS) version 23. Data were presented as mean± standard deviations (SD), Student's *t*-test was used to assess differences across genders, the analysis of variance (ANOVA) was used to assess differences between age groups, and Pearson correlation to find if there is a correlation between WTW distance and AC depth. A P value < 0.05 was considered statistically significant.

III. Results

This study involved 100 individuals (200 eyes), of whom 51 (51%) were females and 49 (49%) were males, the mean age was 32.84±13.04 years (females: 32.37±11.12 y and males: 33.33±14.88y). The age range was 17-74 years (females: 20-66y and males: 17-74 y).

The mean WTW distance was 11.71± 0.57mm (minimum 10.25 mm and maximum 12.80mm). The mean WTW distance was 11.65±0.49 mm in females and 11.77±0.65 mm in males.

The mean anterior chamber depth was 3.53±0.43mm (minimum 2.67 and maximum 4.42mm). The mean anterior chamber depth was 3.55±0.39 mm in females and 3.52±0.47 mm in males

There was no statistical difference between genders by Student's *t*-test regarding WTW distance and anterior chamber depth ($p<.05$), see Table 1.

Table 1: WTW corneal diameter measurements and Anterior chamber depth in both genders by laterality

Parameter	Females (n=51)	Males (n=49)	*p*- value [a]
Right eye WTW (mm), (Mean± SD)	11.63±.50	11.75±.64	.32
Left eye WTW (mm), (Mean± SD)	11.67±.49	11.79±.67	.30
Right eye AC depth (mm), (Mean± SD)	3.52±.40	3.49±.47	.75
Left eye AC depth (mm), (Mean± SD)	3.57±.45	3.54±.49	.73

Abbreviations: mm, millimeter; n, number of participants; SD, standard deviation; WTW, white to white; AC, anterior chamber.

[a] Differences between genders using the Student's *t*-test

The WTW corneal diameter was significantly affected by age, there was a decrease in diameter with increasing age, F (2,97) = 27.01, P=<.001. (Table 2).

Table 2: WTW corneal diameter measurements in the total study population by age groups and laterality

Age group	N. of eyes	Right eye WTW (mm), (Mean± SD)	N. of eyes	Left eye WTW (mm), (Mean± SD)	*p*- value [a]
< 30	54	11.99± .37	54	12.04±.39	<.001
30-40	22	11.49±.67	22	11.51±.65	<.001
> 40	24	11.18±.43	24	11.23±.44	<.001
All	100	11.69±.58	100	11.73±.58	<.001

Abbreviations: mm, millimeter; n, number of participants; SD, standard deviation; WTW, white to white.

[a] Differences between age groups using the analysis of variance (ANOVA)

As seen in Table 3, the AC depth also was significantly affected by age, there was a decrease in AC depth with increasing age F (2,97) = 13.20, P=<.001

Pearson correlation of WTW distance and AC depth was found to be highly positive and statistically significant (r=.741, p<.001), this means that an increase in WTW distance was associated with an increase in AC depth.

Table 3: AC depth in the total study population by age groups and laterality

Age group	N. of eyes	Right eye AC depth (mm), (Mean± SD)	N. of eyes	Left eye AC depth (mm), (Mean± SD)	*p*- value [a]
< 30	54	3.72±.29	54	3.75±.41	<.001
30-40	22	3.37±.39	22	3.39±.43	<.001
> 40	24	3.16±.48	24	3.26±.43	<.001
All	100	3.51±.43	100	3.56±.47	<.001

Abbreviations: mm, millimeter; n, number of participants; SD, standard deviation; AC, anterior chamber.

[a] Differences between age groups using the analysis of variance (ANOVA)

IV. Discussion

In parallel with technical advances in cataract and refractive surgery, reliable measurements of anterior segment parameters like ACD and WTW distance have become more important. Physicians' technical demands for more reliability and less dependence on the practitioner were met with non-contact anterior segment analyzers that have been used in recent years like Pentacam-Scheimpflug. [11]

Reliable detection of WTW distance and ACD is very important for phakic intraocular lens (IOL) implantation, especially for optimal biometrics, surgical planning, and follow-up, the ACD has been also used in screening programs to detect occludable angles in primary angle closure glaucoma. [12,13]

The present study aimed to determine the normative values of white-to-white corneal diameter and anterior chamber depth in healthy Libyan participants using Pentacam HR.

The study involved 100 individuals (200 eyes), with a mean age of 32.84±13.04 years (range 17-74 years).

White-to-white corneal diameter

In the present study, the mean WTW corneal diameter was 11.71± 0.57mm (range=10.25 - 12.80mm), which is lower than what was reported by studies from Western India,[1]Iran,[14] Saudi,[15] South Korea,[16] and Spain[17] (Table 4), although most of these studies were done with different instruments, but the study on the Spanish population [20] was by the same imaging technique as ours (Pentacam HR) which indicate that the WTW distance islower in Libyans than other populations.

Table 4. WTW corneal diameter measurements in previous studies compared to the present study

Author	Place	Mean age (year)	Age range (year)	Measurement technique	WTW (mm)
Singh et al. [1]	Western India	36.79	13-82	IOL master	11.79
Hashemi et al. [14]	Iran	50.7	40-64	LENSTAR/BioGraph	11.80
Alotaibi et al [15]	Saudi	28.7	20-60	Pentacam AXL	11.95
Kim et al. [16]	South Korea	NR	NR	Pentacam	11.86
Domínguez-Vicent et al. [17]	Spain	30.36	20-40	Pentacam HR	11.90
Present study=106	**Libya**	**32.84**	**17-74**	**Pentacam HR**	**11.71**

Abbreviations: mm, millimeter; WTW, white to white; NR, not reported.

Regarding gender, in the present study, the WTW was higher in males, which was statistically not significant. Similarly, other studies found no effect of gender on WTW corneal diameter. [1,4, 14,18]

In contrast, Fu et al. in their study, found that females have larger corneas than males, [19] while Chen and Osher found that males have larger corneal diameters than females. [20]

The current study showed that the WTW corneal diameter was significantly affected by age. A negative relationship was found, with aging, the white-to-white distance decreased [F (2,97) = 27.01, P=<.001. In the same line, Rufer et al.[18] and Fu et al. [19] reported a significant correlation between aging and a decrease in the corneal diameter. On the other hand, Hashemi H et al., [4] Singh et al.,[1] and Chen and Osher [20] found no significant correlation between age and corneal diameter.

The anterior chamber depth

In the current study, the mean anterior chamber depth was found to be 3.53±0.43mm (range 2.67 - 4.42mm). This measurement is deeper than what has been reported in other populations studied [15, 17, 21- 24] (Table 5). While some studies have compared the different measuring instruments; the comparison between Pentacam HR single-camera and Galilei G2 showed good Repeatability and reproducibility, [23,25] Additionally, when measuring ACD with Pentacam HR and with IOL Master, the two instruments showed a high correlation and similar values. [26] However, when researchers compared the Pentacam HR with Orbscan[23] or compared 35-MHz ultrasound biomicroscopy (UBM), Visante optical coherence tomography (OCT) with Pentacam [16] and Pentacam HR with A-scan ultrasonography, they found that these devices should not be used interchangeably for ACD measurements. [27]

Table 5. Anterior chamber depth in previous studies compared to the present study

Author	Place	Mean age (year)	Age range (year)	Measurement technique	ACD (mm)
Mashige and Oduntan. [21]	South Africa	28.15	10-66	A-scan ultrasonography	3.21
Mallen et al. [22]	Jordan	NR	17-40	A-scan ultrasonography	3.19
Salouti et al. [23]	Iran	27.4	NR	Pentacam HR Galilei	3.25 3.22
Bukhatwa and Suliman[24]	Libya	35.36	17-75	Alladdin optical biometer	2.96
Domínguez-Vicent et al.[17]	Spain	30.36	20-40	Pentacam HR	3.19
Alotaibi et al [15]	Saudi	28.7	20-60	Pentacam AXL	2.97
Present study	**Libya**	**32.84**	**17-74**	**Pentacam HR**	**3.53**

Abbreviations: mm, millimeter; ACD, anterior chamber depth; NR, not reported.

Bukhatwa and Suliman [24] in their study on the Libyan population of the same age range as the present study found that the ACD was 2.96 mm, which is shallower than the present study (3.53 mm), It is possible that this difference can be attributed to the use of different measuring techniques since Bukhatwa and Suliman used Alladdin optical biometer which is different than the measuring technique in the present study. However, we were unable to find any literature that compares these two instruments.

Although the ACD was deeper in females than males (3.55±0.39 mm vs 3.52±0.47 mm), this difference was statistically not significant (p=<0.05), this result is comparable to other studies, [24, 28] but different from others that found that the ACD was deeper in males than in females. [1,29]

The current study showed that the AC depth has an inverse proportion relationship with age F(2,97) = 13.20, P=<.001, there was a decrease in AC depth with increasing age which could be explained by the increase in the crystalline lens thickness by aging, [30] This was similar to other studies. [24, 30]

There was a highly positive correlation between the WTW corneal diameter and AC depth (r=.741, p<.001), a result that is similar to Alotaibi et al. [15] and Hashemi et al [4] who also showed a positive correlation between the WTW corneal diameter and ACD depth. Others found no correlation between the WTW corneal diameter and AC depth. [1]

Using the WTW corneal diameter and anterior chamber parameters as a reference helps ophthalmologists diagnose angle closure glaucoma and corneal illnesses related to corneal diameter. These parameters help surgeons determine the size of the IOL for cataract and refractive procedures. [1]

The study was limited by the fact that all participants had good vision, and therefore no data on refractive error was collected. In the future, it would be beneficial to investigate the relationship between WTW corneal diameter, ACD, and refraction.

In summary, this study aimed to determine the average and normal range of WTW corneal diameter and ACD in the Libyan population, measured using the Pentacam HR. The results showed a statistically significant inverse correlation between age and both WTW corneal diameter and ACD, as well as a positive correlation between the two measurements.

LIST OF ABBREVIATIONS

(ACD)Anterior chamber depth

(ANOVA)Analysis of variance

(IOL)Intraocular lens

(mm) millimeter

(NR) not reported.

(SD) standard deviation;

(WTW) white-to-white

REFERENCES

[1]. Singh K, Gupta S, Moulick PS, Bhargava N, Sati A, Kaur G. Study of distribution of white-to-white corneal diameter and anterior chamber depth in study population obtained with optical biometry using intraocular lens (IOL) master. *Med J Armed Forces India*. 2019;75(4):400-405. doi:10.1016/j.mjafi.2018.06.001

[2]. Piñero DP, Plaza Puche AB, Alió JL. Corneal diameter measurements by corneal topography and angle-to-angle measurements by optical coherence tomography: evaluation of equivalence. J Cataract Refract Surg. 2008;34(1):126-131. doi:10.1016/j.jcrs.2007.10.010

[3]. Vetrugno M, Cardascia N, Cardia L. Anterior chamber depth measured by two methods in myopic and hyperopic phakic IOL implant. Br J Ophthalmol. 2000;84(10):1113-1116. doi:10.1136/bjo.84.10.1113

[4]. Hashemi H, KhabazKhoob M, Yazdani K, Mehravaran S, Mohammad K, Fotouhi A. White-to-white corneal diameter in the Tehran Eye Study. Cornea. 2010;29(1):9-12. doi:10.1097/ICO.0b013e3181a9d0a9

[5]. Wei L, He W, Meng J, Qian D, Lu Y, Zhu X. Evaluation of the White-to-White Distance in 39,986 Chinese Cataractous Eyes. Invest Ophthalmol Vis Sci. 2021;62(1):7. doi:10.1167/iovs.62.1.7

[6]. Hashemi H, KhabazKhoob M, Mehravaran S, Yazdani K, Mohammad K, Fotouhi A. The distribution of anterior chamber depth in a Tehran population: the Tehran eye study. Ophthalmic Physiol Opt. 2009;29(4):436-442. doi:10.1111/j.1475-1313.2009.00647.x

[7]. He M, Huang W, Zheng Y, Alsbirk PH, Foster PJ. Anterior chamber depth in elderly Chinese: the Liwan eye study. Ophthalmology. 2008;115(8):1286-1290.e12902. doi:10.1016/j.ophtha.2007.12.003

[8]. Bandlitz S, Nakhoul M, Kotliar K. Daily Variations of Corneal White-to-White Diameter Measured with Different Methods. Clin Optom (Auckl). 2022;14:173-181. Published 2022 Sep 20. doi:10.2147/OPTO.S360651

[9]. Wang Q, Ding X, Savini G, et al. Anterior chamber depth measurements usingScheimpflug imaging and optical coherence tomography: repeatability, reproducibility, and agreement. J Cataract Refract Surg. 2015;41:178–85

[10]. https://www.pentacam.com/fileadmin/user_upload/pentacam.de/downloads/interpretations-leitfaden/interpretation_guideline_3rd_edition_0915.pdf

[11]. Konstantopoulos A, Hossain P, Anderson DF. Recent advances in ophthalmic anterior segment imaging: a new era for ophthalmic diagnosis?. Br J Ophthalmol. 2007;91(4):551-557. doi:10.1136/bjo.2006.103408

[12]. Rabsilber TM, Khoramnia R, Auffarth GU. Anterior chamber measurements using Pentacam rotating Scheimpflug camera. J Cataract Refract Surg. 2006;32(3):456-459. doi:10.1016/j.jcrs.2005.12.103

[13]. Vega Y, Gershoni A, Achiron A, et al. High Agreement between Barrett Universal II Calculations with and without Utilization of Optional Biometry Parameters. J Clin Med. 2021;10(3):542. Published 2021 Feb 2. doi:10.3390/jcm10030542

[14]. Hashemi H, Khabazkhoob M, Emamian MH, Shariati M, Yekta A, Fotouhi A. White-to-white corneal diameter distribution in an adult population. Journal of current ophthalmology. 2015 Mar 1;27(1-2):21-4.

[15]. Alotaibi WM, Challa N, Alrasheed SH, Abanmi RN. Measurements of White-to-White Corneal Diameter and Anterior Chamber Parameters using the Pentacam AXL Wave and their correlations in the Adult Saudi population.2024. doi.org/10.21203/rs.3.rs-4016989/v1

[16]. Kim SK, Kim HM, Song JS. Comparison of internal anterior chamber diameter imaging modalities: 35-MHz ultrasound biomicroscopy, Visante optical coherence tomography, and Pentacam. J Refract Surg. 2010;26(2):120-6.

[17]. Domínguez-Vicent A, Monsálvez-Romín D, Aguila-Carrasco AJ, García-Lázaro S, Montés-Micó R. Measurements of anterior chamber depth, white-to-white distance, anterior chamber angle, and pupil diameter using two Scheimpflug imaging devices. *Arq Bras Oftalmol*. 2014;77(4):233-237. doi:10.5935/0004-2749.20140060

[18]. Rufer F, Schroder A, Erb C. White-to-white corneal diameter: normal values in healthy humans obtained with the Orbscan II topography system. Cornea 2005;24:259–261.

[19]. Fu T, Song YW, Chen ZQ, He JW, Qiao K, et al. (2015) Ocular biometry in the adult population in rural central China: a population based study. Int J Ophthalmol 8: 812-817.

[20]. Chen TH, Osher RH. Horizontal corneal white to white diameter measurements using calipers and IOLMaster. J Eye Cataract Surg. 2015;1(3):15-46.

[21]. Mashige KP, Oduntan OA. Axial length, anterior chamber depth and lens thickness: Their intercorrelations in black South Africans. Afr Vision Eye Health. 2017;76(1), a362.

[22]. Mallen EA, Gammoh Y, Al-Bdour M, Sayegh FN. Refractive error and ocular biometry in Jordanian adults. Ophthalmic Physiol Opt. 2005;25(4):302-309. doi:10.1111/j.1475-1313.2005.00306.x

[23]. Salouti R, Nowroozzadeh MH, Zamani M, Ghoreyshi M, Salouti R. Comparison of anterior chamber depth measurements using Galilei, HR Pentacam, and Orbscan II. Optometry. 2010;81(1):35-9.

[24]. Bukhatwa SA, Suliman M. Axial length, anterior chamber depth, and lens thickness in normal Libyan eyes; measured by the Aladdin ocular biometer. Libyan Int Med Univ J 2022;7:17–21.

[25]. Aramberri J, Araiz L, García A, Illrramendi I, Olmos J, Oyanarte I, et al. Dual versus single Scheimpflug camera for anterior segment analysis: Precisions and agreement. J Cataract Refract Surg. 2012;38(11):1934-49.

[26]. Németh G, Hassan Z, Módis L Jr, Szalai E, Katona K, Berta A. Comparison of anterior chamber depth measurements conducted with Pentacam HR® and IOLMaster®. Ophthalmic Surg Lasers Imaging. 2011;42(2):144-147. doi:10.3928/15428877-20110210-03

[27]. Szalai E, Berta A, Németh G, Hassan Z, Módis L Jr. Anterior chamber depth measurements obtained with Pentacam HR® imaging system and conventional A-scan ultrasound. Ophthalmic Surg Lasers Imaging. 2011;42(3):248-253. doi:10.3928/15428877-20110210-04

[28]. Hsu WC, Shen EP, Hsieh YT. Is being female a risk factor for shallow anterior chamber? The associations between anterior chamber depth and age, sex, and body height. Indian J Ophthalmol. 2014;62(4):446-449. doi:10.4103/0301-4738.119344

[29]. Shufelt C, Fraser-Bell S, Ying-Lai M, Torres M, Varma R; Los Angeles Latino Eye Study Group. Refractive error, ocular biometry, and lens opalescence in an adult population: the Los Angeles Latino Eye Study. Invest Ophthalmol Vis Sci. 2005;46(12):4450-4460. doi:10.1167/iovs.05-0435

[30]. Oduntan OA, Mashige KP. Axial length, anterior chamber depth and lens thickness: Their intercorrelations in black South Africans. African Vision and Eye Health. 2017 Feb 21;76(1):1-7.