Comparison of Anterior Chamber Depth in Healthy Myopic Thai Eye Using Orbscan and Ultrasound

Winai Chaidaroon, MD*,
Atchareeya Jengjalern, MD*

** Department of Ophthalmology, Faculty of Medicine, Chiang Mai University, Chiang Mai*

Objectives: *To compare the anterior chamber depth (ACD) using ultrasonic and optical measurements.*
Material and Method: *In this prospective study, ultrasound and optical (Orbscan) devices were employed to measure ACD in 42 eyes of 21 myopic volunteers. ACD values were compared using the paired-sample Student t test. The correlation of ACD values obtained from two groups was assessed by linear regression analysis.*
Results: *The difference of mean ACD values between the ultrasound (3.02 $\pm$ 0.37 mm) and Orbscan (3.56 $\pm$ 0.42 mm) method was statistically significant difference ($p < 0.0001$).*
Conclusion: *The optical measurement of ACD in healthy myopic Thai eyes is, on average, 0.54 mm greater than ultrasonic measurement; however, both methods posses a significant linear correlation.*

Keywords: *Anterior chamber depth, Orbscan, Ultrasound*

J Med Assoc Thai 2005; 88 (10): 1362-6
Full text. e-Journal: *http://www.medassocthai.org/journal*

In order to correct severe refractive errors, intraocular lenses (IOL) are being placed in phakic eyes as an alternative to keratorefractive surgery to eliminate contact lenses or thick spectacles[1]. The result of phakic IOL demonstrates a high predictive outcome and reduction of aberrations[2]. Anterior chamber depth (ACD) evaluation is necessary to prevent damage to the anterior chamber structures during phacorefractive surgery[3]. Moreover, when referring to the mostly used nomogram, an exact IOL power depends on the accuracy of ACD measurement[1]. Nowadays, the clinical measurement of ACD, in which indirectly technique, is primarily by ultrasonography or optical methods. Although ultrasound has been used in a clinical setting for over 30 years[4,5], the values of measurement may be affected by various factors, such as the differences of probe handling, and the operator's technique and experience[3]. The optical system has become more widely used in refractive surgery[6]. It provides not only accurate topographical evaluation, but also ACD information without direct corneal contact.

Correspondence to : Chaidaroon W, Department of Ophthalmology, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand. Phone: 0-5394-5512, Fax: 0-5394-6121, E-mail: wchaidar@mail.med.cmu.ac.th

The purpose of the present study was to compare ACD measurements between the ultrasonic and optical (Orbscan) method in healthy myopic eyes.

Material and Method

This prospective study was performed in 21 healthy myopic subjects who visited the refractive unit for refractive error evaluation at the Department of Ophthalmology, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand between November 2002 and August 2003.

Approval from the research ethical committee was obtained and all subjects provided written informed consent. All cases of the present study met the inclusion criteria that comprised age of at least 20 years, the best corrected visual acuity of 20/20 or better, manifest refraction spherical equivalent error of at least -5.00 diopters (D), refractive astigmatism of less than 1.00 D, no contact lens worn for at least 3 (soft contact lens) or 7 days (hard or semi-hard contact lens), and healthy eyes after slit-lamp biomicroscopic and indirect ophthalmoscopic examinations. The exclusion criteria consisted of patients who had a history of ocular surgery, topical ocular medication, and ocular disease.

The Orbscan corneal topography system (Orbscan II®, Bausch & Lomb Surgical, Salt Lake City, UT, USA) is an optical topography that consists of a three dimensional scanning slit beam system for analyzing corneal surfaces as well as ACD. One Orbscan operator performed ACD measurements in all eyes first in order to avoid corneal surface irregularities that might occur during contact ultrasonic measurements. The subjects were instructed to sit and place their chin on the chin rest of the instrument. When the Orbscan system was ready, they were asked to open both eyes widely and look at a fixation target. After having 3-time measurements of Orbscan, the cornea was anesthetized with topical benoxinate hydrochloride 0.4 percent and the ACD was measured by A/B-5500 ultrasound (Sonomed, Inc., Lake Success, NY, USA). Patients were asked to observe the fixation target during measurement to ensure optimal alignment and centration of the ultrasonic probe. The probe was sterilized and applied as perpendicularly as possible to the cornea, and 10 programmed consecutive measurements of ACD were achieved.

The study was powered to detect a difference in the Orbscan versus ultrasonic mesurement of ACD of 0.17 mm[3], with an assumed standard deviation of 0.12 mm (a power of 80 percent and a two-sided alpha level of 0.05), given the enrollment of 4 eyes. According to this small number of eyes and many patients who volunteered to participate, we recruited 42 eyes for this study. The outcomes were analyzed using linear regression analysis and the paired-sample Student *t* test. A p value less of than 0.05 was considered statistically significant.

Results

The mean age of the subjects (9 men and 12 women) was 27.9 years $\pm$ 8.8 (SD). The mean manifest refraction spherical equivalent error was -8.49 D $\pm$ 4.0 (SD).

Table 1 shows ACD of all patient eyes which were measured by ultrasound and Orbscan. The mean ACD using the ultrasonic measurement of 42 eyes was 3.02 $\pm$ 0.37 mm and by Orbscan measurement, 3.56 $\pm$ 0.42 mm. There was a statistically significant difference between the ACD values of the two methods ($p < 0.0001$).

The regression analysis was performed on the ACD values of Orbscan and ultrasound. The regression coefficient was 0.6 ($p < 0.0001$), which demonstrated that the two methods had a significant linear correlation (Fig. 1).

Table 1. ACD of all patient eyes measured by ultrasound and Orbscan methods

Eye No.	ACD (mm) measured by	
	Ultrasound	Orbscan
1	3.24	3.73
2	3.22	3.76
3	3.29	3.94
4	3.37	4.00
5	2.79	3.47
6	2.84	3.39
7	3.31	3.74
8	3.29	3.57
9	3.26	3.75
10	3.13	3.72
11	3.49	4.15
12	3.47	4.01
13	3.08	3.65
14	3.11	3.59
15	2.39	3.05
16	2.42	3.18
17	3.00	3.15
18	3.01	3.19
19	3.68	4.23
20	3.61	4.21
21	3.06	3.28
22	2.99	3.12
23	2.24	4.41
24	2.30	3.90
25	2.29	2.16
26	2.37	2.68
27	3.11	3.51
28	3.08	3.49
29	3.28	3.69
30	3.31	3.69
31	3.10	3.32
32	3.18	3.53
33	2.79	3.31
34	2.84	3.39
35	3.35	3.87
36	3.31	4.00
37	3.29	3.89
38	3.28	3.84
39	2.75	3.45
40	2.85	3.21
41	2.62	3.28
42	2.61	3.26

ACD = anterior chamber depth

Discussion

ACD measurement has provided useful information in many studies, including cataract surgery (biometric formulas)[7-10], glaucoma screening in epidemiological studies[11,12], and glaucoma surgery[13]. Recently,

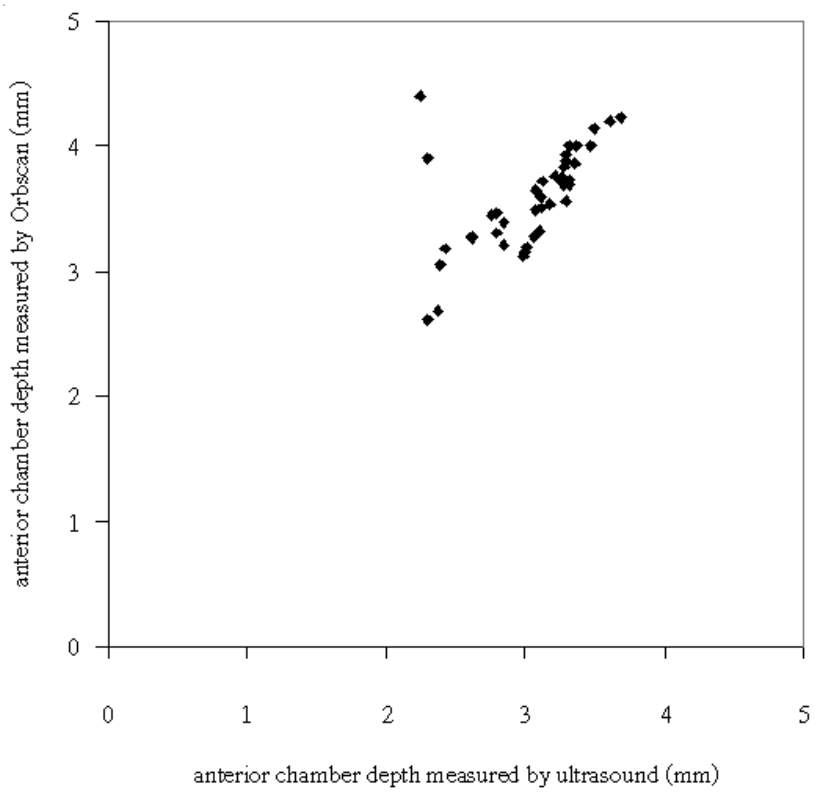

Fig. 1 Linear regression of the myopic eyes

the relevance of phakic IOL implant in either the anterior or posterior chamber is increasing because of higher predictability outcome and ability to correct a large refractive error if compared with keratorefractive surgery[14-16]. With modern surgical techniques and instruments, patients expect a perfect result from their refractive surgery. ACD is an important factor that determines the achievement of implanting lens power calculation. Furthermore, ACD evaluation before phacorefractive surgery is necessary in order to prevent IOL-corneal endothelium contact.

Two methods commonly used to evaluate ACD are ultrasound and optical analysis. A prospective study of ACD measurements was performed using the ultrasound and optical (Orbscan) system. The authors' conclusions demonstrated that different methods of measuring ACD gave results that differed considerably. The mean ACD values were significantly larger with the Orbscan ($p < 0.0001$) than with ultrasound. These outcomes were different to the values in normal cataract affected eyes obtained by Auffarth[17]. Such a difference between the two measurement systems may be caused by age. The mean age in Auffarth's[17] study was 70.4 years, while it was 27.9 years in the present study. The depth and volume of the anterior chamber diminishes with age, which may result from a thickening and forward displacement of the lens[18]. In the present study, the reason why the values of ACD measured using ultrasound is less than these by the optical method may be explained by the excessive indentation of the cornea, which occurs during ultrasonic measurement. The immersion ultrasound method will obviate such an error. Unfortunately, this instrument is not available in this hospital. However, Giers and Epple found that ACD values measured using the immersion ultrasound technique were larger by 0.3 mm compare to those measured by contact ultrasound[19].

There is a significant linear correlation of ACD measurements between ultrasound and optical method. This result is comparable to other studies[3,17]. The present study also showed that the ACD measured by the Orbscan was 17.8 per cent higher than that using the ultrasonic method.

With increasing refractive surgery numbers, an Orbscan is an optical instrument useful for pre-

operative corneal topographic analysis, and it also provides ACD values because the measurement is based on a Scheimpflug type slitlamp scanning system[17]. The advantages of this method are the ease in which it is used and its noncontact performance property. Moreover, no anesthesia is needed and there is no risk of infection. However, the ACD measured by ultrasound is considered a gold standard[3]. It has also become the most commonly used routine method[20].

In summary, the present study demonstrated that the Orbscan measurements of ACD in normal myopic eyes were, on average, 0.54 mm greater than ultrasonic measurements. These two methods had a significant linear correlation. The Orbscan is becoming a popular instrument, the higher value of ACD measured by this method may guide the surgeons that ACD is deeper than actual depth. Therefore, the Orbscan should be used in conjunction with ultrasonic measurement, particularly when the measurement of ACD is critical, as in phacorefractive surgery.

Acknowledgements

The authors wish to thank Miss Kittika Kanjanaratanakorn, MSc. (Statistics) for assisting in the statistical analysis.

References

1. Holladay JT. Refractive power calculations for intraocular lenses in the phakic eye. Am J Ophthalmol 1993; 116: 63-6.
2. Applegate RA, Howland HC. Refractive surgery, optical aberrations, and visual performance. J Refract Surg 1997; 13: 295-9.
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: 1113-6.
4. Murphy GE, Murphy CG. Comparison of efficacy of longest, average, and shortest axial length measurements with a solid-tip ultrasound probe in predicting intraocular lens power. J Cataract Refract Surg 1993; 19: 644-5.
5. Laroche D, Ishikawa H, Greenfield D, Liebmann JM, Ritch R. Ultrasound biomicroscopic localization and evaluation of intraocular foreign bodies. Acta Ophthalmol Scan 1998; 76: 491-5.
6. Chakrabarti HS, Craig JP, Brahma A, Malik TY, McGhee CNJ. Comparison of corneal thickness measurements using ultrasound and Orbscan slit-scanning topography in normal and post-LASIK eyes. J Cataract Refract Surg 2001; 27: 1823-8.
7. Arai M, Ohzuno I, Zako M. Anterior chamber depth after posterior chamber intraocular lens implantation. Acta Ophthalmol 1994; 72: 694-7.
8. Olsen T, Corydon L, Gimbel H. Intraocular lens power calculation with an improved anterior chamber depth prediction algorithm. J Cataract Refract Surg 1995; 21: 313-9.
9. Fenzl RE, Gills JP, Cherchio M. Refractive and visual outcome of hyperopic cataract cases operated on before and after implementation of the Holladay II formula. Ophthalmology 1998; 105: 1759-64.
10. Holladay JT, Gills JP, Leidlein J, Cherchio M. Achieving emmetropia in extremely short eyes with two piggyback posterior chamber intraocular lenses. Ophthalmology 1996; 103: 1118-23.
11. Congdon NG, Quigley HA, Hung PT, Wang TH, Ho TC. Screening techniques for angle closure glaucoma in rural Taiwan. Acta Ophthalmol Scand 1996; 74: 113-9.
12. Garner LF, Yap MK, Kinnear RF, Frith MJ. Ocular dimensions and refraction in Tibetan children. Optom Vis Sci 1995; 72: 266-71.
13. Caronia RM, Liebmann JM, Stegman Z, Sokol J, Ritch R. Increase in iris-lens contact after laser iridotomy for pupillary block angle closure. Am J Ophthalmol 1996; 112: 53-7.
14. O'Brien TP, Awwad ST. Phakic intraocular lenses and refractory lensectomy for myopia. Curr Opin Ophthalmol 2002; 13:264-70.
15. Baikoff G, Collin J. Intraocular lenses in phakic patients. Ophthalmol Clin North Am 1992; 5: 789-95.
16. Perez-Santonja JJ, Alio JL, Jimenez-Alfato I, Zato MA. Surgical correction of severe myopia with an angle-supported intraocular lens. J Cataract Refract Surg 2000; 26: 1288-302.
17. Auffarth GU, Tetz MR, Biazid Y, Volcker HE. Measuring anterior chamber depth with the Orbscan topography system. J Cataract Refract Surg 1997; 23: 1351-5.
18. Shields MB. Textbook of glaucoma. 4th ed. Baltimore: Williams & Wilkins; 1997: 179.
19. Giers U, Epple C. Comparison of A-scan device accuracy. J Cataract Refract Surg 1990; 16: 235-42.
20. Koranyi G, Lydahl E, Norrby S, Taube M. Anterior chamber depth measurement: A-scan versus optical methods. J Cataract Refract Surg 2002; 28: 243-7.

การเปรียบเทียบการวัดความลึกของช่องตาด้านหน้าในคนไทยสายตาสั้นที่ปกติโดยใช้วิธีออปสแกนและอัลตราซาวด์

วินัย ชัยดรุณ, อัจฉรียา เจ็งเจริญ

วัตถุประสงค์: เพื่อศึกษาเปรียบเทียบค่าความลึกของช่องตาด้านหน้าจากการวัดด้วยวิธีอัลตราซาวด์และวิธีออปติคัล

วัสดุและวิธีการ: เป็นการศึกษาไปข้างหน้าโดยการวัดความลึกของช่องตาด้านหน้าของอาสาสมัครที่สายตาสั้นทั้งหมด 21 คนใน 42 ตาด้วยวิธีอัลตราซาวด์ และวิธีออปติคัล (Orbscan) และเปรียบเทียบค่าเฉลี่ย รวมทั้งความสัมพันธ์ของค่าความลึกของช่องตาด้านหน้าทั้งสองวิธีด้วยวิธีทางสถิติ paired-sample Student t test และ linear regression analysis ตามลำดับ

ผลการศึกษา: มีความแตกต่างของค่าเฉลี่ยของความลึกของช่องตาด้านหน้าอย่างมีนัยสำคัญจากการวัดทั้งสองวิธี โดยค่าเฉลี่ยของความลึกของช่องตาด้านหน้าที่วัดด้วยวิธีอัลตราซาวด์เท่ากับ 3.02 $\pm$ 0.37 มิลลิเมตร และวัดด้วย Orbscan เท่ากับ 3.56 $\pm$ 0.42 มิลลิเมตร ($p < 0.0001$)

สรุป: ความลึกของช่องตาด้านหน้าในคนไทยที่สายตาสั้นจากการวัดด้วยวิธีออปติคัลจะมากกว่า 0.54 มิลลิเมตร โดยเฉลี่ย เมื่อเทียบกับการวัดด้วยวิธีอัลตราซาวด์ และทั้งสองวิธีมีความสัมพันธ์ในแนวตรงอย่างมีนัยสำคัญ