Comparison of Anterior Chamber Depth Measurement Between Orbscan IIz and Ultrasound Biomicroscopy

Jong Yun Lee, MD; Jun-Heon Kim, MD; Hyo-Myung Kim, MD; Jong-Suk Song, MD

ABSTRACT

PURPOSE: To compare the measurement of anterior chamber depth exclusive of corneal thickness using Orbscan IIz and ultrasound biomicroscopy (UBM) and evaluate the repeatability of each method.

METHODS: Three consecutive measurements of anterior chamber depth were prospectively performed using Orbscan IIz and Paradigm 50-MHz UBM in 40 eyes in 20 individuals. Mean values were compared using the paired *t* test. For 12 eyes in 6 individuals, anterior chamber depth measurements were performed 5 times to estimate the repeatability of each method by a coefficient of variation. Refractive errors were measured to correlate with anterior chamber depth.

RESULTS: The mean anterior chamber depth was 2.82±0.46 mm with the Orbscan IIz and 2.91±0.43 mm in UBM. This difference was statistically significant ($P<.001$), but not clinically meaningful. The coefficient of variation was 1.15% and 1.10% in Orbscan IIz and UBM, respectively. A negative correlation between anterior chamber depth and spherical equivalent refraction was noted within the range of −5.50 to +3.00 diopters.

CONCLUSIONS: The mean anterior chamber depth of Orbscan IIz was 0.087 mm less than that of UBM. Both methods were precise. Orbscan IIz seems to be a useful and more convenient method to measure anterior chamber depth for phakic intraocular lens implantation. [*J Refract Surg.* 2007;23:487-491.]

Phakic intraocular lens (IOL) implantation has gained popularity for correction of refractive errors of high myopic and hyperopic patients. The advantages of implanting a phakic IOL are that the IOL is removable and success does not depend on the vagaries of corneal wound healing. In addition, it does not sacrifice the crystalline lens and its accommodative ability.[1] However, phakic IOLs have a risk of postoperative cataract formation and progressive endothelial loss.[2-4] Phakic IOLs are classified into three categories: anterior chamber angle-supported, anterior chamber iris-fixated, and posterior chamber sulcus-supported. The manufacturers of these inform their users of appropriate surgical guidelines, one of which is the minimal depth of the anterior chamber required to allow for implantation of phakic IOLs.

Several methods can be used to measure anterior chamber depth. They generally are classified into two categories: ultrasonic and optical. Ultrasonic methods are divided into contact and immersion. Optical methods include scanning slit beam topography (Orbscan; Bausch & Lomb, Rochester, NY), slit-lamp or Scheimpflug camera-associated devices, and partial coherence interferometry. The most popular methods to clinically measure anterior chamber depth seem to be contact type A-scan and Orbscan. However, significant differences between measurements recorded by these two methods have recently been reported.[5] Mean contact A-scan measurements were 0.40 mm less than those obtained using Orbscan. Therefore, it is possible that one patient's eyes could be judged as adequate or inadequate for phakic IOLs, depending on which

From the Department of Ophthalmology, Korea University College of Medicine, Seoul, Republic of Korea.

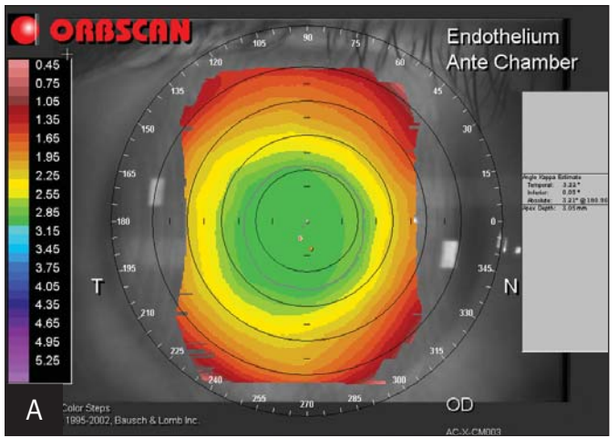
The authors have no financial or proprietary interest in the materials presented herein.

Correspondence: Jong-Suk Song, MD, Dept of Ophthalmology, Guro Hospital, Korea University College of Medicine, 80 Guro-dong, Guro-gu, Seoul, 152-703, Republic of Korea. Tel: 82 2 818 6746; Fax: 82 2 857 8580; E-mail: crisim@korea.ac.kr

Received: May 23, 2006

Accepted: October 10, 2006

Posted online: March 30, 2007



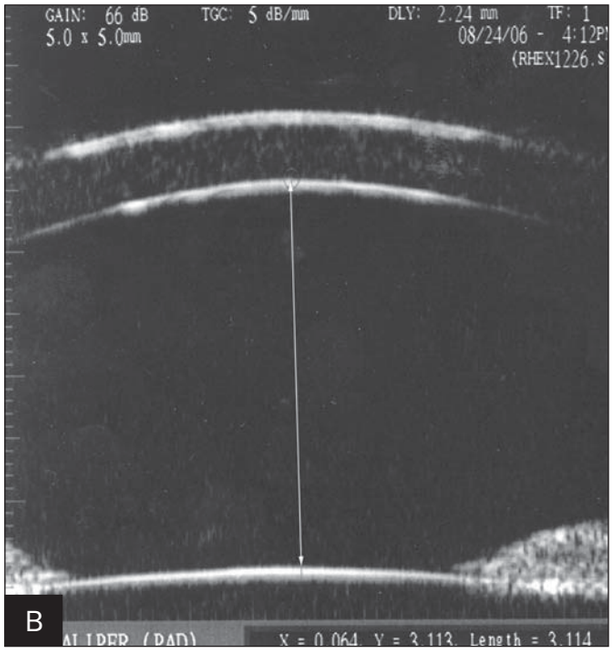


Figure 1. Measurements of central anterior chamber depth of corneal endothelium to anterior lens capsule in two different eyes. **A)** Orbscan Apex anterior chamber depth: 3.05 mm and **B)** UBM anterior chamber depth: 3.114 mm.

method is used. This situation may be confusing to surgeons as well as patients.

This difference could be due to corneal indentation when measured using a contact A-scan method. Therefore, we used a high frequency ultrasound biomicroscope (UBM) equipped with a 50-MHz transducer (Paradigm UBM plus, Model p45; Paradigm Medical Industries, Salt Lake City, Utah), which requires ocular immersion, and compared this measurement with that obtained using Orbscan. To eliminate possible errors caused by corneal thickness, anterior chamber depth exclusive of corneal thickness was used with both methods. We also evaluated the repeatability of each method and analyzed the correlation between anterior chamber depth and refractive status.

PATIENTS AND METHODS

Forty eyes in 20 healthy volunteers (12 men and 8 women) were included in this prospective study. Mean age was 44.25 years (range: 24 to 76 years). No patient had current ophthalmic disease, except for cataract, or history of ocular surgery. The measurement of anterior chamber depth was performed by a scanning slit topography Orbscan IIz (Bausch & Lomb-Orbtek Inc, Salt Lake City, Utah) and a high frequency UBM equipped with a 50-MHz transducer. The anterior chamber depth was first measured by Orbscan IIz, followed by UBM, because the ocular immersion necessary for UBM may change the ocular surface and thereby influence Orbscan measurements. Saline solution (0.9% NaCL) was used for ocular immersion and the individual was asked to fixate on a ceiling target with the fellow eye maintaining accommodation and fixation.

Three consecutive measurements were performed using each method, and the mean values were compared. One experienced technician measured all eyes. The anterior chamber depth exclusive of corneal thickness was measured using both methods (Fig 1). For 12 eyes in 6 individuals, anterior chamber depth measurements were performed 5 times to estimate the repeatability of each method using a coefficient of variation. Refractive errors were measured using a table-mounted autorefractor prior to measuring the anterior chamber depth so as to correlate refractive errors with anterior chamber depth.

The paired *t* test was used to analyze differences between the two methods for anterior chamber depth measurement. The correlation between Orbscan and UBM measurements was assessed using Pearson's correlation analysis. To evaluate the correlation between anterior chamber depth and the spherical equivalent of refractive error, Pearson's correlation analysis was performed. *P* values $<.05$ were considered statistically significant.

RESULTS

The anterior chamber depth measured ranged from 1.937 to 3.446 mm using UBM and from 1.830 to 3.447 mm using Orbscan IIz. Measurements using the two methods correlated significantly with each other; the correlation coefficient was 0.982 ($P<.001$) (Fig 2).

The mean anterior chamber depth was 2.82 ± 0.46 mm

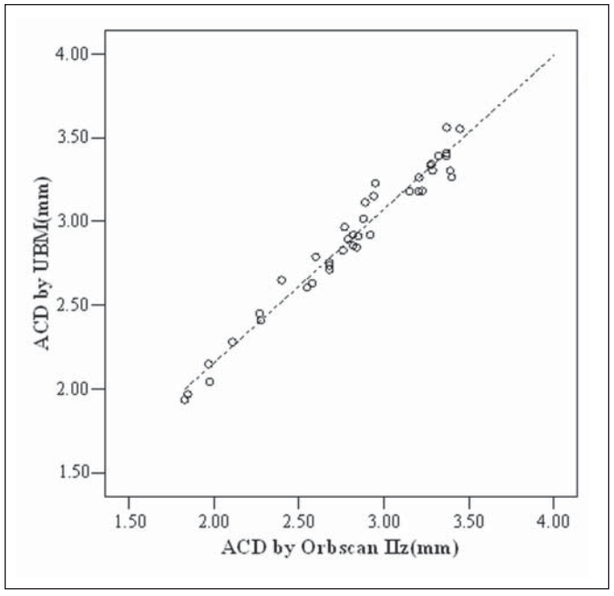


Figure 2. Correlation plot of anterior chamber depth measured by Orbscan IIz and UBM in 40 eyes

with Orbscan IIz and 2.91±0.43 mm using UBM; the difference was statistically significant ($P<.001$). However, the mean difference was 0.087±0.09 mm, which is minimal. The coefficient of variation was calculated to determine repeatability. The coefficient of variation was 1.15% for Orbscan IIz and 1.10% for UBM. Thus, both methods were highly reliable.

The spherical equivalent refraction of study participants ranged from −5.50 to +3.00 diopters (D), and the correlation coefficients between anterior chamber depth and spherical equivalent refraction were −0.544 ($P<.01$) and −0.577 ($P<.01$) in Orbscan IIz and UBM, respectively (Fig 3). A negative correlation between anterior chamber depth and spherical equivalent refraction was noted within this range of refractive errors.

DISCUSSION

Implantation of phakic IOLs is an emerging technology for the treatment of high ametropia. The procedure avoids the unpredictability of keratorefractive surgery and the accommodation loss that is associated with clear lens extraction. Several studies have reported favorable surgical results and a low rate of short-term complications following phakic IOL implantation.[3,6-9] However, long-term safety of phakic IOLs remains controversial,[10-12] and apparent progressive loss of corneal endothelial cells occurring 3 years after surgery has been reported in anterior chamber iris-fixated IOLs.[11] Therefore, longer follow-up is necessary, as younger patients usually undergo phakic IOL implantation to preserve accommodation.

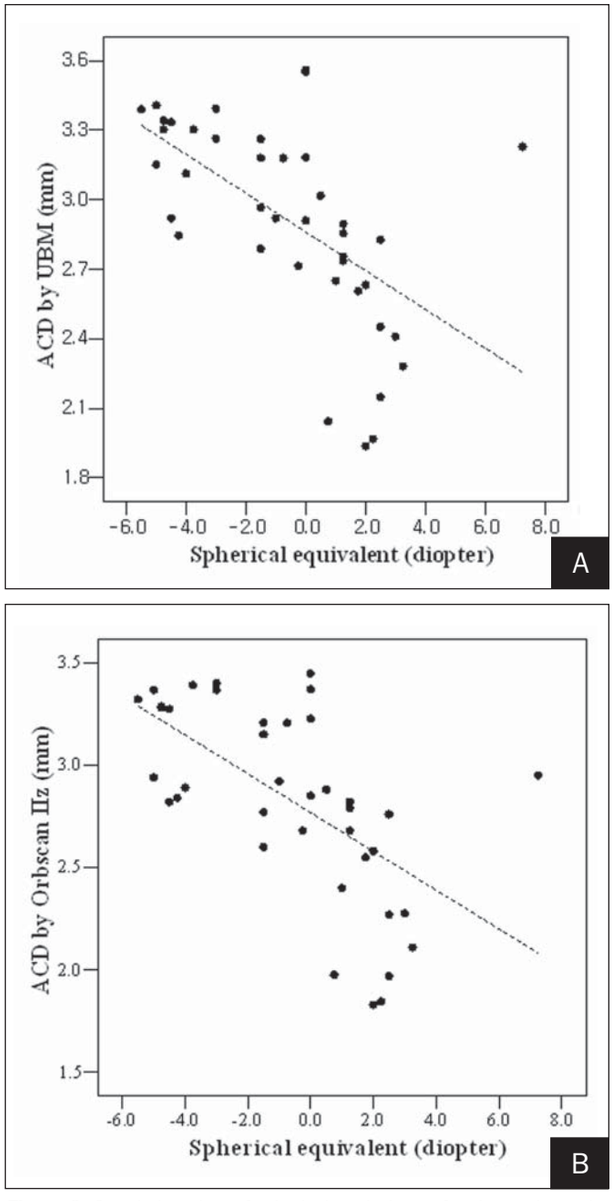


Figure 3. Correlation plots of spherical equivalent refraction and anterior chamber depth measured by **A)** UBM and **B)** Orbscan IIz in 40 eyes.

Phakic IOL power is calculated by several independent variables, which include keratometric power, spherical equivalent refraction, and central anterior chamber depth, and phakic IOL length is determined based on the patient's horizontal corneal diameter (white-to-white distance). Anterior chamber depth is a major factor for determining operability because if the anterior chamber depth is not enough for implantation, corneal endothelial cells could be damaged postoperatively. The most popular method for measuring the an-

terior chamber depth seems to be with the contact type A-scan.[13] However, it can be influenced by various factors, including the experience and technique of the examiner, probe handling, and fixation status.[14] If the cornea were to be depressed by the ultrasound probe, the anterior chamber depth would appear to be less than the actual depth. The Orbscan topography system initially was invented to determine corneal topography. However, it can also create true three-dimensional maps of the anterior segment and can measure the anterior chamber depth using the Scheimpflug principle.[15] Orbscan is a noncontact method, which eliminates the risk of infection, and it is easier to repeat than the contact method. Therefore, the Orbscan system is a convenient tool to evaluate anterior chamber depth in the clinical setting.

Reddy et al[5] reported that the mean anterior chamber depth measured by contact ultrasound was 0.40 mm and 0.43 mm less than when measured by Orbscan II and IOLMaster (Carl Zeiss Meditec, Jena, Germany), respectively. The contact ultrasound biometry might seem to be the safest way to measure, as it provided the smallest measurement among the three methods. However, these small anterior chamber depth measurements might exclude many patients desiring phakic IOL implantation. Therefore, it is important to investigate the reasons for differences between the methods and to identify the optimal method for measuring the anterior chamber depth—which is the most accurate, the easiest to determine, and which has the highest repeatability.

Two factors may be responsible for the differences of measurement between the contact A-scan and Orbscan. The first is that Orbscan is a noncontact method, unlike the contact A-scan. Giers and Epple[16] reported that contact ultrasound gave 0.3-mm smaller measurements of the anterior chamber depth when compared with immersion ultrasound biometry. Koranyi et al[17] suggested that this difference was due to applanation when the ultrasound probe touched the cornea. The second is that if the anterior chamber depth inclusive of corneal thickness were used, possible errors due to corneal thickness might influence the anterior chamber depth measurements. Significant differences in corneal thickness measurements between ultrasound and Orbscan have already been reported.[18,19] Therefore, the anterior chamber depth exclusive of corneal thickness seems to be an appropriate way to compare these two methods.

To minimize the above possibilities, we used UBM, an immersion ultrasound biometry, to compare with Orbscan. The anterior chamber depth exclusive of corneal thickness was used with both methods. Our study shows that the mean anterior chamber depth of Orbscan is 0.087 mm less than that of UBM, opposite from a previous report.[5] Auffarth et al[20] reported that the anterior chamber depth of Orbscan was on average 0.04 mm less than the immersion A-scan values. Although statistical significance was not mentioned in this study, the result is similar to ours. The anterior chamber depth measurement using Orbscan is closer to immersion ultrasound values than those of contact ultrasound. Thus, the major cause of the discrepancy between the Orbscan and contact ultrasound values may be due to mechanical applanation effects.

In our study, Orbscan and UBM had high repeatability, and the mean differences in anterior chamber depth were minimal. Although it is difficult to know which is the more precise method, Orbscan is easier to perform and is less affected by the experience of the examiner. Its measurement is slightly less than that of UBM. Therefore, we believe Orbscan is useful and more convenient for determining the indication of phakic IOL implantation in the clinical setting.

This study shows a significant relationship between anterior chamber depth and refractive status, within the range of moderate refractive error. The correlation coefficients between anterior chamber depth and spherical equivalent refraction were −0.544 and −0.577 in Orbscan and UBM, respectively. Rabsilber et al[15] reported a similar result, finding that the regression coefficient was approximately −0.6 between the anterior chamber depth and spherical equivalent refraction. Although the anterior chamber depth of high hyperopic eyes often is less than that of emmetropic eyes,[21,22] it has been reported that no direct correlation exists between anterior chamber depth and refraction status in highly myopic eyes, as refractive errors in high myopic eyes depend mostly on vitreous chamber elongation.[23,24]

Orbscan IIz and UBM had high repeatability, and the anterior chamber depth measured by Orbscan IIz was 0.087 mm less than that of UBM. Therefore, Orbscan IIz seems to be a useful and more convenient method to measure the anterior chamber depth for phakic IOL implantation.

REFERENCES

1. Pesando PM, Ghiringhello MP, Tagliavacche P. Posterior chamber collamer phakic intraocular lens for myopia and hyperopia. *J Refract Surg.* 1999;15:415-423.
2. Lackner B, Pieh S, Schmidinger G, Simader C, Franz C, Dejaco-Ruhswurm I, Skorpik C. Long-term results of implantation of phakic posterior chamber intraocular lenses. *J Cataract Refract Surg.* 2004;30:2269-2276.
3. Sanders DR, Doney K, Poco M; ICL in Treatment of Myopia Study Group. United States Food and Drug Administration clinical trial of the Implantable Collamer Lens (ICL) for moderate to high myopia: three-year follow-up. *Ophthalmology.* 2004;111:1683-1692.

4. Benedetti S, Casamenti V, Marcaccio L, Brogioni C, Assetto V. Correction of myopia of 7 to 24 diopters with the Artisan phakic intraocular lens: two-year follow-up. *J Refract Surg.* 2005;21:116-126.
5. Reddy AR, Pande MV, Finn P, El-Gogary H. Comparative estimation of anterior chamber depth by ultrasonography, Orbscan II, and IOL master. *J Cataract Refract Surg.* 2004;30:1268-1271.
6. Alexander L, John M, Cobb L, Noblitt R, Barowsky RT. U.S. clinical investigation of the Artisan myopia lens for the correction of high myopia in phakic eyes. Report of the results of phases 1 and 2, and interim phase 3. *Optometry.* 2000;71:630-642.
7. Allemann N, Chamon W, Tanaka HM, Mori ES, Campos M, Schor P, Baikoff G. Myopic angle-supported intraocular lenses: two-year follow-up. *Ophthalmology.* 2000;107:1549-1554.
8. De Souza RF, Forseto A, Nose R, Belfort R Jr, Nose W. Anterior chamber intraocular lens for high myopia: five year results. *J Cataract Refract Surg.* 2001;27:1248-1253.
9. Werblin TP. Phakic anterior chamber lenses for the correction of myopia. *Ophthalmology.* 1999;106:2041-2043.
10. Lovisolo CF, Reinstein DZ. Phakic intraocular lenses. *Surv Ophthalmol.* 2005;50:549-587.
11. Landesz M, Worst JG, van Rij G. Long-term results of correction of high myopia with an iris claw phakic intraocular lens. *J Refract Surg.* 2000;16:310-316.
12. Dejaco-Ruhswurm I, Scholz U, Pieh S, Hanselmayer G, Lackner B, Italon C, Ploner M, Skorpik C. Long-term endothelial changes in phakic eyes with posterior chamber intraocular lenses. *J Cataract Refract Surg.* 2002;28:1589-1593.
13. Leaming DV. Practice styles and preferences of ASCRS members-2000 survey. *J Cataract Refract Surg.* 2001;27:948-955.
14. Vertrugno M, Cardascia M, Cardia L. Anterior chamber depth measured by two methods in myopic and hyperopic phakic IOL implant. *Br J Ophthalmol.* 2000;84:1113-1116.
15. Rabsilber TM, Becker KA, Frisch IB, Auffarth GU. Anterior chamber depth in relation to refractive status measured with the Orbscan II topography system. *J Cataract Refract Surg.* 2003;29:2115-2121.
16. Giers U, Epple C. Comparison of A-scan device accuracy. *J Cataract Refract Surg.* 1990;16:235-242.
17. Koranyi G, Lydahl E, Norrby S, Taube M. Anterior chamber depth measurement: A-scan versus optical methods. *J Cataract Refract Surg.* 2002;28:243-247.
18. Yaylali V, Kaufman SC, Thompson HW. Corneal thickness measurements with the Orbscan topography system and ultrasonic pachymetry. *J Cataract Refract Surg.* 1997;23:1345-1350.
19. Marsich MW, Bullimore MA. The repeatability of corneal thickness measures. *Cornea.* 2000;19:792-795.
20. Auffarth GU, Tetz MR, Biazid Y, Volcker HE. Measuring anterior chamber depth with the Orbscan Topography System. *J Cataract Refract Surg.* 1997;23:1351-1355.
21. Greene PR. Optical constants and dimensions for the myopic, hyperopic and normal rhesus eye. *Exp Eye Res.* 1990;51:351-359.
22. Pitts JF, Jay JL. The association of Fuchs's corneal endothelial dystrophy with axial hypermetropia, shallow anterior chamber, and angle closure glaucoma. *Br J Ophthalmol.* 1990;74:601-604.
23. McBrien NA, Adams DW. A longitudinal investigation of adult-onset and adult-progression of myopia in an occupational group. Refractive and biometric findings. *Invest Ophthalmol Vis Sci.* 1997;38:321-333.
24. Goss DA, Van Veen HG, Rainey BB, Feng B. Ocular components measured by keratometry, phakometry, and ultrasonography in emmetropic and myopic optometry students. *Optom Vis Sci.* 1997;74:489-495.