Agreement and Reproducibility of Contact and Immersion Techniques for Axial Length Measurement and Intraocular Lens Power Calculation

Kitthisak Kitthaweesin MD*,
Warataporn Mungsing MD*

** Department of Ophthalmology, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand*

Objective: *To investigate the agreement and reproducibility of contact and immersion ultrasound biometry in an axial length measurement and intraocular lens power calculation.*
Study design: *Prospective cross-sectional study*
Material and Method: *Axial length was measured in 198 cataract patients using both contact and immersion techniques, randomly assigned to two measurers, one with more experience than the other. Both techniques were repeated by each measurer. The mean difference of both techniques was calculated for the difference of the intraocular lens power.*
Results: *The respective mean differences of both techniques for the first and the second measurers were 0.03 and 0.07 mm. The repeatability coefficient was two-fold for the contact but was similar for the immersion technique. The respective difference of the intraocular lens power of both measurers was 1.15 and 1.65 diopters (D). A statistically significant agreement was noted between both techniques. The reproducibility of both techniques was similar when performed by an experienced measurer however, the less experienced measurer had greater reproducibility with the immersion technique.*
Conclusion: *The difference in the intraocular lens power from both techniques may have clinical significance; hence, the immersion technique should be considered, particularly for less-experienced measurer.*

Keywords: *A-scan biometry, Axial length, Contact technique, Immersion technique, Intraocular lens power*

J Med Assoc Thai 2009; 92 (8): 1046-9
Full text. e-Journal: *http://www.mat.or.th/journal*

A-scan ultrasound biometry, using contact or immersion techniques, is used for axial length measurement worldwide. Accurate measurement is necessary for the correct power of the intraocular lens as erroneous axial length measurement is the most common cause of incorrect intraocular lens power(1). While most investigators usually found axial length measured with the contact technique less than that measured using the immersion method(2-8), some found a longer axial length using the contact technique(9).

In this prospective, randomized study, the authors compared the agreement and reproducibility of contact and immersion ultrasound biometry to check for any significant difference in axial length and intraocular lens power.

Material and Method

After excluding any patients with irregular cornea, retinal detachment, previous ocular trauma or surgery, aphakia, and pseudophakia, 198 patients; 11 with monocular and 187 with binocular cataracts, were recruited. All of the patients provided written informed consent after the present study was approved by the institutional ethics committee.

All of the patients were randomized to be measured first with contact or immersion, then with other techniques, by either measurer 1 or 2. Afterwards, they were measured with both techniques by the other measurer. The measurers were not apprised of each

Correspondence to: Kitthaweesin K, Department of Ophthalmology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand. Phone & Fax: 043-348-383, E-mail: Kitthisak@hotmail.com

other's results. Measurer 1 had more experience than measurer 2, however, both were right-handed.

Axial length measurement was performed using an Alcon Ocuscan (Alcon Thailand) with a 10 MHz A-scan biometry probe, for both contact and immersion techniques, and ultrasound velocities of 1,532 and 1,641 milliseconds for the anterior chamber and the lens, respectively.

For the immersion technique, tetracaine 1% was used as a topical anesthetic and a scleral immersion shell (Alcon Thailand) placed in the palpebral fissure to support the probe with sterile normal saline solution as the coupling medium. Patients were asked to fixate on the light of the probe. Ten measurements were taken and unreliable results discarded in order to obtain the average value with a SD of less than 0.1 mm.

For the contact technique, patients were asked to keep their eyes in the primary position by focusing on their thumbs after instillation of tetracaine 1%. The average of 10 reliable readings was accepted only if the Standard deviation (SD) was less than 0.1 mm.

The agreement of both techniques by each measurer and the reproducibility of the measurements by each technique were analyzed using the Bland-Altman technique[10,11] in which the difference in axial length is plotted against the mean value for each eye. The 95% confidence interval of the difference was also shown on the plot.

Results

The authors examined 385 eyes (193 right and 192 left) from the 198 patients (93 males and 105 females) ranging between 35 and 90 years of age (average, 66). The respective mean axial length measured by measurer 1 vs. measurer 2 using the contact and immersion techniques was 23.31 $\pm$ 1.25 (20.88-30.17) and 23.34 $\pm$ 1.32 (20.94-30.35) mm vs. 23.28 $\pm$ 1.31 (20.46-30.49) and 23.35 $\pm$ 1.37 (21.03-30.86) mm.

The intra-observer standard deviation for measurer 1 was 0.15 mm, while it was 0.21 mm for measurer 2. For measurer 1, the respective repeatability coefficient of the contact and immersion technique was 0.24 mm and 0.21 mm vs. 0.43, and 0.22 mm for measurer 2 (Table 1).

The mean difference between both techniques measured by measurer 1 was -0.03 mm (-0.01,-0.06; 95% CI), vs. -0.07 mm (-0.04, -0.10; 95% CI) by measurer 2 (Table 2). The agreement plot showing the difference between both techniques by each measurer (Y axis) and the mean axial length (X axis) indicated a broader 95% limit of agreement for measurer 2; however, overlapping of the upper and the lower limits was also demonstrated (Fig. 1).

According to the SRK formula, the intra-occular lens power change from the mean respective difference of the axial length measured by measurer 1 and measurer 2 was 1.15 and 1.65 D.

Discussion

Due to the effect of corneal indentation, contact ultrasound biometry in most studies yields shorter axial lengths, ranging from 0.14-0.47 mm[2-8]. However, Hennessy reported 0.03 mm longer axial lengths with the contact technique and proposed that the spring-loaded ultrasound probe and gentle technique eliminated significant indentation[9].

Although it has been submitted that the immersion technique is more precise than the contact technique, no significant difference in the reproducibility of the techniques has been reported[6,9]; albeit those studies recruited a small number of patients. In this study, both techniques, whether performed by experienced and less-experienced measurers, yielded good reproducibility over 385 eyes from 198 patients. Furthermore, the authors found the repeatability coefficient of the contact technique when performed by the less-experienced measurer was approximately two-fold

Table 1. Repeatability coefficient of contact and immersion techniques

	Intra-observer SD*	Repeatability coefficient	
		Contact	Immersion
Measurer 1	0.15	0.24	0.21
Measurer 2	0.21	0.43	0.22

* SD = standard deviation

Table 2. Mean difference between both techniques and 95% limit of agreement

	Mean difference (mm*)	95% CI** of mean difference	95% limit agreement	
			Lower	Upper
Measurer 1	-0.03	-0.01, -0.06	-0.46	0.40
Measurer 2	-0.07	-0.04, -0.10	-0.66	0.52

* mm = millimeter

** CI = confidence interval

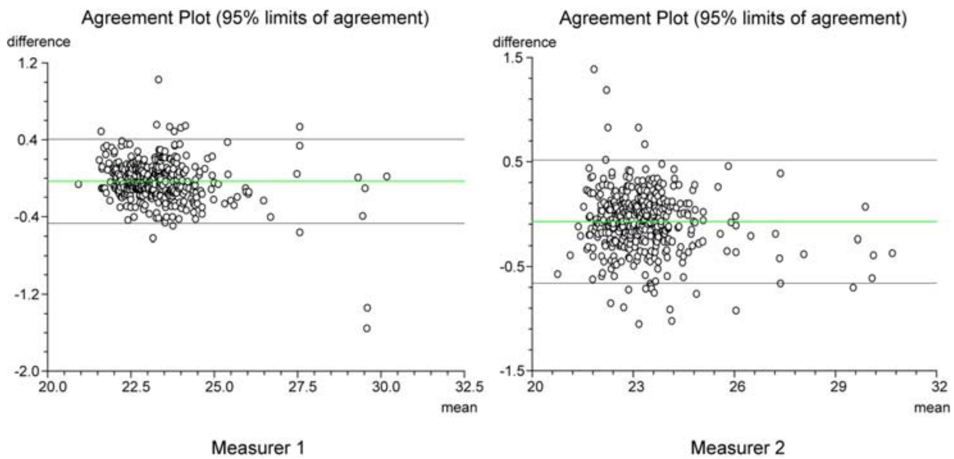

Fig. 1 Agreement of contact and immersion techniques

that of the experienced measurer, which is probably explained by more corneal indentation. By comparison, there was no significant difference in the repeatability coefficient of the immersion techniques by either measurer.

Fig. 1 presents the agreement between both techniques by each measurer with broader 95% limit of agreement for measurer 2. The overlapping of the upper and the lower limits indicates more agreement for the experienced measurer. In addition, the intra-ocular lens power change, from the mean difference of the axial length measured with both techniques, by the less-experienced measurer was more than by the experienced measurer by 0.50 D.

The present study indicates the contact technique is comparable to the immersion technique with experienced measurer; however, for the less-experienced measurer, the immersion technique would be more precise and appropriate, particularly in the era of multifocal intraocular lens.

Acknowledgements

The authors wish to thank the Faculty of Medicine, Khon Kaen University for its support and Mr. Bryan Roderick Hamman for assistance with the English-language presentation of the manuscript.

References

1. Olsen T. Sources of error in intraocular lens power calculation. J Cataract Refract Surg 1992; 18: 125-9.
2. Olsen T, Nielsen PJ. Immersion versus contact technique in the measurement of axial length by ultrasound. Acta Ophthalmol (Copenh) 1989; 67: 101-2.
3. Olsen T. The accuracy of ultrasonic determination of axial length in pseudophakic eyes. Acta Ophthalmol (Copenh) 1989; 67: 141-4.
4. Shammas HJ. A comparison of immersion and contact techniques for axial length measurement. J Am Intraocul Implant Soc 1984; 10: 444-7.
5. Hoffmann PC, Hutz WW, Eckhardt HB, Heuring AH. Intraocular lens calculation and ultrasound biometry: immersion and contact procedures. Klin Monatsbl Augenheilkd 1998; 213: 161-5.
6. Watson A, Armstrong R. Contact or immersion technique for axial length measurement? Aust N Z J Ophthalmol 1999; 27: 49-51.
7. Schelenz J, Kammann J. Comparison of contact and immersion techniques for axial length measurement and implant power calculation. J Cataract Refract Surg 1989; 15: 425-8.
8. Giers U, Epple C. Comparison of A-scan device accuracy. J Cataract Refract Surg 1990; 16: 235-42.
9. Hennessy MP, Franzco, Chan DG. Contact versus immersion biometry of axial length before cataract surgery. J Cataract Refract Surg 2003; 29: 2195-8.
10. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986; 1: 307-10.
11. Bland JM, Altman DG. Comparing methods of measurement: why plotting difference against standard method is misleading. Lancet 1995; 346: 1085-7.

ความสอดคล้องและความสามารถในการวัดซ้ำของการวัดความยาวลูกตาด้วยวิธี contact และ immersion และการคำนวณกำลังเลนส์ตาเทียม

กิตติศักดิ์ กิจทวีสิน, วรัทพร มังสิงห์

วัตถุประสงค์: *ศึกษาความสอดคล้องของการวัดความยาวลูกตาและกำลังเลนส์ตาเทียมด้วยวิธี contact และ immersion*

วิธีการศึกษา: *ศึกษาแบบไปข้างหน้าชนิดตัดขวาง*

วัสดุและวิธีการ: *สุ่มวัดความยาวลูกตาในผู้ป่วยต้อกระจก 198 ราย ด้วยวิธี contact และ immersion โดยผู้วัดรายแรกมีประสบการณ์มากกว่าค่าแตกต่างของกำลังเลนส์ตาเทียมคำนวณจากค่าเฉลี่ยของค่าแตกต่างของการวัดทั้งสองวิธี*

ผลการศึกษา: *ค่าเฉลี่ยของค่าแตกต่างของการวัดทั้งสองวิธีโดยผู้วัดทั้งสองคือ 0.03 และ 0.07 มิลลิเมตรตามลำดับ ค่า repeatability coefficientระหว่างผู้วัดทั้งสองเป็นสองเท่าในวิธี contact แต่ไม่แตกต่างกันด้วยวิธี immersion ค่าแตกต่างของกำลังเลนส์ตาเทียมโดยผู้วัดทั้งสองคือ 1.15 และ 1.65 ไดออพเตอร์ตามลำดับพบความสอดคล้องอย่างมีนัยสำคัญทางสถิติระหว่างสองวิธี อย่างไรก็ตาม ความสามารถในการวัดซ้ำของทั้งสองวิธีคล้ายคลึงกันในผู้วัดที่มีประสบการณ์ แต่พบความสามารถในการวัดซ้ำสูงกว่าเมื่อวัดด้วยวิธี immersionในผู้วัดที่มีประสบการณ์น้อย*

สรุป: *ค่าแตกต่างของกำลังเลนส์ตาเทียมที่วัดได้จากวิธีทั้งสองอาจจะมีนัยสำคัญทางคลินิก ดังนั้นวิธี immersion น่าจะเหมาะสมโดยเฉพาะในผู้วัดที่มีประสบการณ์น้อย*