Performance of Conventional Biometry vs. Integrated Laser Interferometry with Keratometry Device in Intraocular Lens Measurement

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Objective: *To compare the performance of the Conventional Biometry (CB) (Applanation Ultrasound and Keratometry) and the Integrated Laser Interferometry with Keratometry Device (LI) in the measurement of Intraocular Lens (IOL).*

Material and Method: *A prospective study of 100 eyes in 50 cataract patients was conducted. The IOL measurement using the LI followed by the CB was done on all eyes. The keratometry (K), axial length (AL), IOL power, and time required for both methods were compared in the same subject by ANOVA with repeated measurement.*

Results: *The LI could not obtain the AL in 14%. There were 21% that the signal to noise ratio was below 1.6. The AL obtained by the LI was significant higher compared to the CB by mean of 0.28 mm ($p < 0.05$). The K showed no statistically significant difference ($p = 0.05$). There was statistically significantly higher IOL power calculated by the LI compared to the CB by mean of 0.63 D ($p < 0.05$). The time required for the LI was 2.77 $\pm$ 1.44 min and the CB was 9.63 $\pm$ 3.82 min ($p < 0.05$).*

Conclusion: *The LI required less time than the CB in measurement of the IOL but could not measure the AL in the group of patients with dense cataracts. The LI give a higher IOL power compared to the CB.*

Keywords: *Laser interferometry, Conventional biometry, IOL power*

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Cataract is one of the major causes of low vision and blindness in developing countries[1-3]. Most of the patients suffer from advanced degrees of cataract. Many of the government hospitals in these countries have to provide high-volume cataract surgeries to serve the need of their patients. In order to provide good quality surgeries, several pre-operative evaluations must be carried out with extra care. The intraocular lens (IOL) power is one of the most critical calculations. Corneal power and axial length of the eye are required for calculation of the IOL power. The conventional biometry (CB) uses the simple keratometer to obtain corneal power and an A-scan biometry to obtain axial length. Typically, it requires two separate stations for measurement of each patient. The current technology of the integrated Laser Interferometry with Keratometry Device (LI) combines keratometry and axial length measurement in one machine, allowing IOL power calculations to be made quicker and easier. The present study was undertaken to compare the performance of the CB and the LI in calculation of the intraocular lens power for cataract patients.

Material and Method

A prospective study of 50 cataract patients (100 eyes) from the eye clinic at the Out Patient Department (OPD), Siriraj Hospital, Mahidol University was conducted. The intraocular lens power of all eyes were calculated using the CB which involved keratometry by autorefractor (ARK-730A, Nidek, Japan) and appla-

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nation ultrasound (Axis II, Quantel Medical, France) followed by the LI (IOL Master v 4.20, Carl Zeiss, Germany). All measurements were taken by a trained technician. The keratometry (K), axial length (AL), IOL power given by SRK-T formula (using A-constant labeled on the IOL box for the CB and A-constant from the User group for Laser Interference Biometry website for the LI) and time required for both methods were compared for any significant difference within the same subject by using Analysis of Variance (ANOVA). A descriptive mean, standard deviation (SD) of all continuous data were presented. The relationship of keratometry, axial length, IOL power obtained by LI and CB were used to analyze the correlation (r) and coefficient of determination (R^2). A p-value of less than 0.05 was considered statistical significance. All statistical analysis was calculated using Microsoft Excel 2003 (Microsoft Corporation, Seattle, Washington).

Results

The mean age (+ SD) of the patients was 63 (+ 12) years. The mean uncorrected visual acuity (+ SD) in Log Minimum Angle of Resolution (Log-MAR) unit was 0.94 (+ 0.75) (range 0 to 4.00). All eyes could be measured for both K and AL by the CB. The LI could not obtain the AL in 14 eyes that had dense cataracts (14%) and there were 21 eyes (21%) where the signal to noise ratio (SNR) was below 1.6, which is not recommended by the manufacturer. There was no correlation between SNR and level of visual acuity (Log MAR). The K, AL, IOL power and time required by the CB and the LI are shown in Table 1.

The actual values of K, AL, and IOL power of each method are plotted against each other in Fig. 1, 2 and 3. The LI measured AL and IOL power was significantly higher than the CB (by mean of 0.28 mm and 0.63 D respectively). However, there was a strong correla-

Table 1. Shows the mean (+ SD) of keratometry, Axial length, IOL power and time required for each method (n = 100 eyes)

	CB	LI	p-value
Keratometry (D)	44.15 + 1.47	44.24 + 1.66	0.05
Axial Length (mm)	23.68 + 1.94	23.96 + 2.25	<0.05*
IOL power (D)	20.30 + 5.02	20.93 + 4.72	<0.05*
Time (min)	9.63 + 3.82	2.77 + 1.44	<0.05*

* Statistically significant difference by unpaired t-test

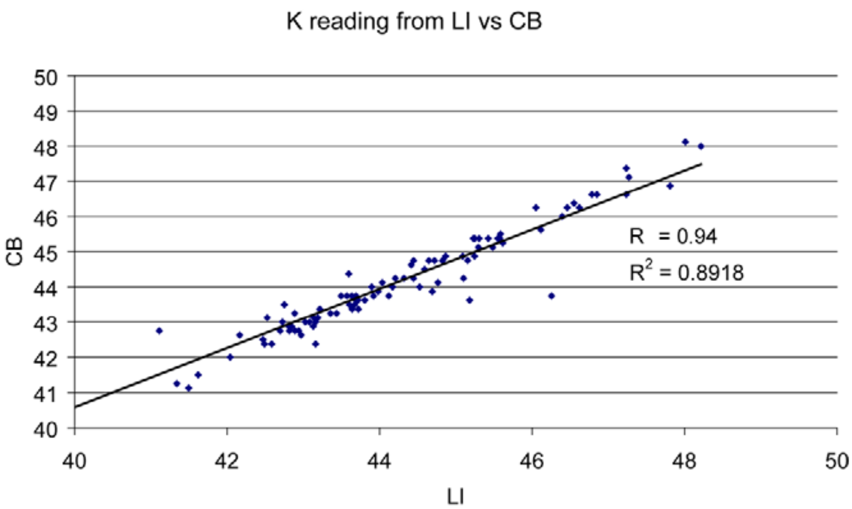

Fig. 1 Shows the relationship of keratometry obtained by LI and CB in 100 eyes [Note the strong correlation between them (r = 0.94), (R^2 = 0.89)]

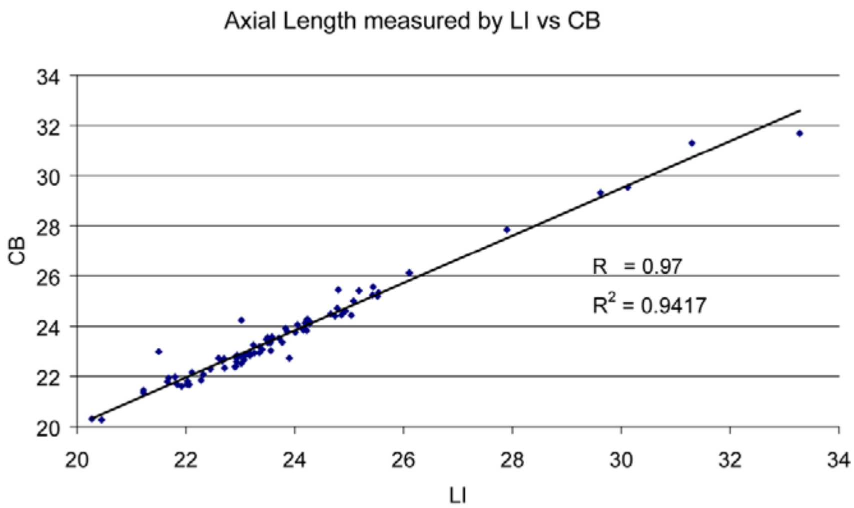

Fig. 2 Shows the relationship of axial length obtained by LI and CB in 100 eyes [Note the strong correlation between them (r = 0.97), (R^2 = 0.94)]

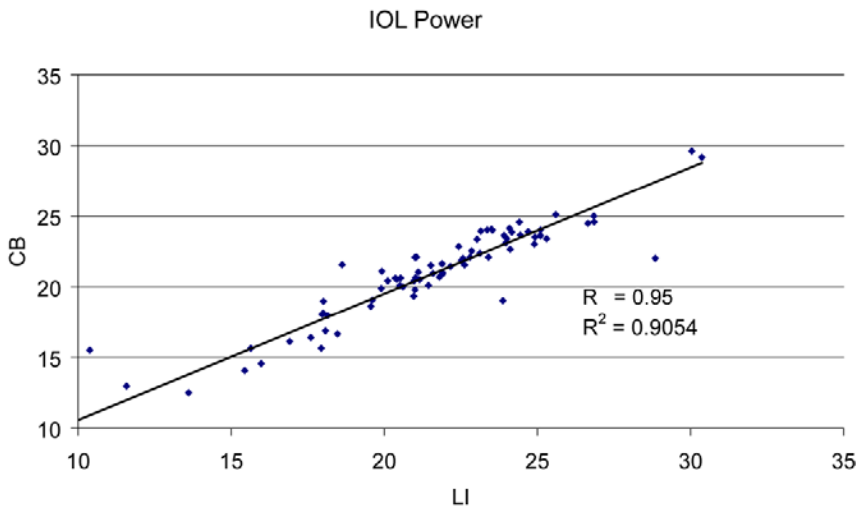

Fig. 3 Shows the relationship of IOL power obtained by LI and CB in 100 eyes [Note the strong correlation between them (r = 0.95), (R^2 = 0.90)]

tion between both methods. The time required for the LI was shown to be significantly less.

Discussion

The present study is statistically significantly higher in the IOL power calculation achieved in the LI compared to the CB for cataract patients. The LI has advantage over the CB for reduced processing time but the disadvantage of the LI is the inability to measure AL in the group of patients with dense cataracts.

The LI offers clinicians the ability to accurately measure AL with a non-contact technique and measure the central corneal power within the same instrument[4-6]. It promises to be a straightforward and time efficient instrument in the calculation of IOL power. Our government hospital seeks an instrument that aims to help expedite the authors' service for cataract patients. The present study was the first set up to evaluate the performance of the LI by comparing it to our CB. The CB that the authors used comprised of manual keratometry and applanation ultrasound. Due to the large number of cataract patient visits per day, the applanation technique is used instead of the immersion technique to expedite the set up time. The hospital's technicians are specifically trained for this applanation technique and for IOL calculation, which in turn leads to good post-operative refractive outcomes.

The principle of the AL measurements by the LI is using the light (optical biometry) instead of the sound. Therefore, it would achieve a significantly higher reading compared to the CB because the light is reflected back from the retinal pigmented epithelial layer instead of internal limiting membrane[7,8]. Moreover, any significant axial opacity poses a potential problem. Clinical cases such as those with mature or darkly brunescent lenses, may interfere with the partially coherent light beams to the point that may preclude a meaningful measurement. Unfortunately, there are quite a number of cataract patients suffering from this type of cataract in typical Southeast-Asian ophthalmology practices[9,10]. The present study found that 21% of the presented cataract patients could not be measured by the LI despite several techniques recommended by the manufacturer. The level of visual acuity was not a predicting factor for successful measurement. This percentage is considered to be fairly high in the authors' practice, especially when the authors have to deal with a large number of cataract patients per day. The significant advantage of the LI is the less time that is required for the measurement. By simple calculation, if the authors perform the measurement in 10 eyes by conventional biometry, it will take 96.3 minutes to complete the measurement. If the authors can do the measurement with the LI in eight eyes and the other two eyes require the conventional biometry, it will take 41.4 minutes. Therefore, it takes only about half the time to complete the measurement using the LI. Since most of the ultrasound technique being used worldwide is the immersion technique, it may require a longer time to finish the measurement and this time difference (immersion ultrasound vs. LI) may be more. However, the cost of the LI is also higher compared to the conventional biometry. A cost-effectiveness analysis should be implemented to see whether the benefits are worth the cost.

Furthermore, to the fact that an optically measured axial length is different from the measurement result obtained with ultrasound, IOL constants like e.g. the A constant or ACD constant will in general fail to give good results when used in optical biometry[11]. The present study used the IOL constant recommended by the User Group for Laser Interference Biometry (ULIB) for the LI. Despite using the A constant, provided by ULIB, the IOL power achieved by the LI is still significantly higher than the CB. Therefore, an individual optimization for a given intraocular lens type is necessary.

The present study was not intended to evaluate the accuracy of the IOL power obtained by LI. Therefore, no post-operative data was analyzed between the two methods.

In conclusion, the LI requires less time than the CB but there are several aspects to be carefully approached such as adjusting the IOL constant and the measurement in dense cataract patients.

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ความสามารถในการคำนวณค่าเลนส์แก้วตาเทียมโดยวิธีตามแบบแผน (conventional biometry) และโดยใช้เครื่องระบบรวมระหว่าง laser interferometry และ keratometry

สบง ศรีวรรณบูรณ์, มรกต ธเนศักดิ์

วัตถุประสงค์: *เพื่อเปรียบเทียบความสามารถในการวัดค่าเลนส์แก้วตาเทียมโดยวิธีตามแบบแผน (applanation ultrasound และ keratometry) และโดยใช้เครื่องระบบรวมระหว่าง laser interferometry และ keratometry*

วัสดุและวิธีการ: *เป็นการศึกษาไปข้างหน้าในผู้ป่วยต้อกระจกที่มาวัดค่าเลนส์แก้วตาเทียมที่โรงพยาบาลศิริราช 50 ราย 100 ตา โดยทำการวัดด้วยวิธีตามแบบแผนและโดยใช้เครื่องระบบรวมระหว่าง laser interferometry และ keratometry แล้วนำมาเปรียบเทียบค่าความโค้งกระจกตา ค่าความยาวของลูกตา ค่าเลนส์แก้วตาเทียม และระยะเวลาที่ใช้ในการวัดของทั้ง 2 วิธี โดยวิธี ANOVA*

ผลการศึกษา: *เครื่องระบบรวมระหว่าง laser interferometry และ keratometry ไม่สามารถวัดค่าความยาวของลูกตาได้ 14% และมี 21 % ที่มีค่า signal to noise ratio ต่ำกว่า 1.6 ค่าความยาวกระบอกตาที่วัดได้จากเครื่องระบบรวมระหว่าง laser interferometry และ keratometry มีค่ามากกว่าวิธีตามแบบแผน โดยเฉลี่ย 0.28 มิลลิเมตร ($p < 0.05$) โดยที่ค่าความโค้งกระจกตาไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ค่าเลนส์แก้วตาเทียมที่วัดได้จากเครื่องระบบรวมระหว่าง laser interferometry และ keratometry มีค่ามากกว่าวิธีตามแบบแผน โดยเฉลี่ย 0.63 D ($p < 0.05$) ระยะเวลาที่ใช้ในการวัดโดยเครื่องระบบรวมระหว่าง laser interferometry และ keratometry มีค่า 2.77 $\pm$ 1.44 นาที เมื่อเทียบกับวิธีตามแบบแผน ที่ค่า 9.63 $\pm$ 3.82 นาที ($p < 0.05$)*

สรุป: *เครื่องระบบรวมระหว่าง laser interferometry และ keratometry ใช้เวลาในการวัดค่าเลนส์แก้วตาเทียมน้อยกว่าวิธีตามแบบแผน แต่ไม่สามารถวัดในรายที่มีต้อกระจกทึบได้*
