Original Article

Comparison of the Sanders–Retzlaff–Kraff II and Barrett Universal II Intraocular Lens Formula in Eyes with Normal Axial Lengths

Angela S. D. Amita[1], Angelo Doniho[2], Devina Permatasari[3], Kristian D. Kusnadi[1], Andrew A. Halim[4]

[1]Department of Ophthalmology, School of Medicine and Health Science, Atma Jaya Catholic University of Indonesia, North Jakarta, Indonesia, [2]Department of Ophthalmology, Faculty of Medicine, Udayana University/Sanglah General Hospital, Bali, Indonesia, [3]Department of Ophthalmology, Faculty of Medicine Diponegoro University/Dr. Kariadi General Hospital, Semarang, Jawa Tengah, Indonesia, [4]Department of Health Science, The University of Canterbury, Christchurch, New Zealand

Abstract

Introduction: This study evaluates the difference between two intraocular lens (IOL) power calculation formulas in postphacoemulsification surgery patients with the axial length (AXL) ranging from 22.00 to 24.50 mm. **Aim:** This study aimed to know the accuracy and the relevancy of Sanders–Retzlaff–Kraff (SRK) II IOL formula compared with Barret Universal II IOL formula to minimize the refractive prediction error (RPE) Value in eyes with normal AXL. **Methods:** This retrospective study reviews the medical records of 35 patients who had cataract surgery. The differences of RPE value in SRK II and Barrett Universal II IOL formula were analyzed using repeated-measures analysis of variance. **Results:** There is no statistically significant difference in the RPE value between the two IOL formulas. Each formula has the standard deviation of RPE value ±0.50 D in 62.8% of patients and ±1.00 D in 94.3% to 97.1% of patients. **Conclusion:** The RPE distribution range in both formulas in eyes with normal AXL was within the benchmark standard of The United Kingdom National Health Service. SRK II formula can be preferred in a high backlog country.

Keywords: Barrett, cataract, IOL calculation formulas, phacoemulsification, Sanders–Retzlaff–Kraff, refractive prediction error

Key Messages

Barret Universal II is one of the most accurate IOL formulas to use because of the known ability to minimize the RPE value, but due to the increased number of backlogs and some limitations that some countries had in biometric devices, the use of regression-based formula can be preferred.

Introduction

Due to the coronavirus disease 2019 pandemic, many ophthalmic healthcare services are postponed to prevent the spread of the virus. So that, as an impact, the increasing backlog for elective cataract surgery was followed.[1] Along with the increased number of demands, cataract surgery not only focuses on the visual rehabilitation but also in the implementation of cost-effectiveness in surgery as well as achieving the precise postoperative refractive prediction value.[1,2] Refractive prediction error (RPE) postcataract surgery needs to be as low as possible. The aim of the RPE value that needs to be achieved according to The United Kingdom National Health Service is ±1.00 D in 85% cases, and 0.50 D in 55% cases.[3] Accurate data measurement of axial length (AXL), anterior chamber depth (ACD), corneal curvature (K1 & K2), and intraocular lens (IOL) power calculation formula is needed

Access this article online

Quick Response Code:

Website: www.nigerianjournalofophthalmology.com

DOI: 10.4103/njo.njo_46_21

Address for correspondence: Angela Shinta Dewi Amita, Department of Ophthalmology, School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, 2 Pluit Raya Street, North Jakarta, 14440, Indonesia. E-mail: angela.dewi@atmajaya.ac.id

Received: 8 October 2021 **Revised:** 28 December 2021
Accepted: 29 January 2022 **Published:** 20 May 2022

How to cite this article: Amita AS, Doniho A, Permatasari D, Kusnadi KD, Halim AA. Comparison of the Sanders–Retzlaff–Kraff II and Barrett Universal II Intraocular Lens Formula in Eyes with Normal Axial Lengths. Niger J Ophthalmol 2022;30:12-5.

to minimize RPE value.[4] Several IOL power calculation formulas can be used with similar results.[5]

One of the most accurate IOL power calculation formula nowadays is Barrett Universal (BU) II. This formula uses "paraxial ray tracing" (Gaussian/thick lens) variables to minimize the RPE value. Barrett formula is also known as "universal formula" because it was designed to be used in many kinds of lens types and AXL conditions.[5-7] First introduced in 1993 and modified later in 2010. Barrett formula is easy to implement as it can be accessed freely via the Internet (http://www.apacrs.org/disclaimer.asp?info=5). This formula requires AXL, K, ACD variables, and with/without additional variables such as lens thickness and horizontal white to white distance for more accurate calculation.[8]

In this study, we compared the accuracy of IOL power calculation methods, which was calculated automatically using *SonomedPac 300A-scan* device, commonly used in Atma Jaya Hospital [Sanders–Retzlaff–Kraff (SRK) II], with another more advanced formula, BU II. The aim of the study was to know whether SRK II methods were still relevant when used in comparison with newer IOL calculation methods.

Subjects and Methods

This retrospective study reviews the medical records of patients who underwent phacoemulsification cataract surgery and posterior chamber IOL (PCIOL) implantation between July and August 2017 at Atma Jaya Hospital, North Jakarta, Indonesia. Ethical clearance was sought and obtained from the ethical clearance committee of Medical Catholic University of Atma Jaya in September 2017 and was performed 1 week before the data were extracted. Inclusion criteria were as follows: Surgery was performed by a single surgeon with superotemporal approach phacoemulsification and PCIOL within the bag implantation (square edge, aspheric, foldable PCIOL); clear corneal incision 2.75 mm; biometric examination was carried out preoperatively with *SonomedPac 300A-scan*; postoperative best corrected visual acuity is 5/7.5 or better; AXL ranging between 22 and 24.5 mm; and there is no postoperative complication until the 21st days. Whereas the exclusion criteria were: eyes with any history of intraocular surgery before, ocular trauma, and intraoperative or postoperative complications that could affect the refractive outcomes.

The sample size required to compare the IOL power calculation methods was 26, calculated using repeated-measures analysis of variance (ANOVA) with 0.05 *P*-value, 80% of power. The mean difference of the RPE value was ±0.50 D, with standard deviation of ±0.30 D. The assumption correlation between two formulas was 0.9.

The SRK II of IOL power calculation was the results calculated automatically with *SonomedPac 300A-scan* and manually by using Microsoft Excel application to ensure the results. BU II was calculated by using an online calculator available at http://www.apacrs.org/disclaimer.asp?info=5 AXL, ACD, K1 & K2, and lens thickness (L) variables were extracted from the patients' medical records for the calculation.

The RPE is known as the difference between presurgical refraction of patients subjectively in the Snellen chart and postsurgical refraction or the prediction of refractive value postsurgically from each formula. For statistical analysis, we use the smallest RPE value as a target and the data were extracted after 21 days postsurgery. The frequency and percentage of distribution from every RPE (0.50 D, 1.00 D, and 2.00 D) was calculated and analyzed to find the differences between the two formulas. Statistical analysis computed with R Statistics (version 3.3.3) and R studio (version 1.0.136). Biographical and Biometrical data were used. Repeated-measures ANOVA were used to compare the mean value of RPE from SRK II and BU II formulas.

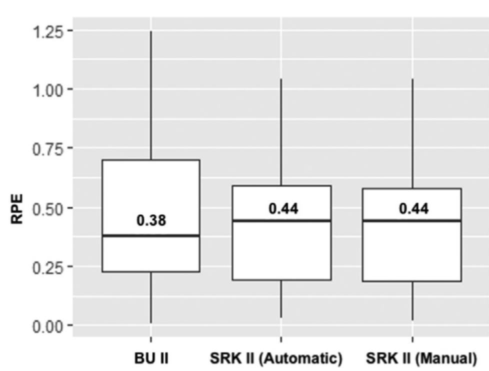

Figure 1: Box plot showing the median value of RPE from BU II and SRK II IOL formulas. BU II, Barret Universal II; IOL, intraocular lens; RPE, refractive prediction error; SRK, Sanders–Retzlaff–Kraff.

Results

There were a total number of 81 postphacoemulsification eyes performed by a single surgeon. Thirty-five eyes of 34 patients met the inclusion criteria and included in this study. Demographic and biometric data are summarized in Table 1.

Each median of the RPE value from BU II and SRK II formula is 0.38 D and 0.44 D [Figure 1]. The distribution analysis was performed by the histogram visualization and

Table 1: Demographic and preoperative biometric data

	N (%)		Mean (SD)
Gender		Age	64 (10.19)
Man	16 (47.05)	AXL	23.27 (0.66)
Woman	18 (52.94)	K1	43.62 (1.44)
Ocular		K2	44.44 (1.49)
OD	18 (51.43)	ACD	2.88 (0.32)
OS	17 (48.57)	L	4.04 (0.66)

ACD, anterior chamber depth; AXL, axial length; K, keratometry; L, lens thickness; OD, oculi dextra; OS, oculi sinistra; SD, standard deviation.

Table 2: The distribution of RPE value from BU II and SRK II formula

	≤0.50 D	<1.00 D	<2.00 D
BU II	22 (62.8%)	33 (94.3%)	35 (100%)
SRK II	22 (62.8%)	34 (97.1%)	35 (100%)

BU, Barret Universal; D, diopter; RPE, refractive prediction error; SRK, Sanders–Retzlaff–Kraff.

quantile plot. The Mauchly sphericity test showed that the sphericity had been violated [$\chi^2(2) = 0.003$, $P < 0.001$], so further analysis used the Greenhouse–Geisser correction test. Repeated-measures ANOVA test showed no significant difference in RPE value between both formulas [$F(1,17.53) = 0.75$, $P = 0.47$].

Both formulas had the RPE value ranges within <0.50 D in 22 patients (62.8%); <1.00 D in 33 patients (94.3%) for BU II formula; and 34 patients (97.1%) for SRK II formula. All patients ($N = 35$, 100%) had the RPE value ranging within <2.00 D from the refractive target [Table 2].

Discussion

The success of cataract surgery is determined by a good postoperative refractive value results.[9] An accurate prediction of postsurgical refraction still poses a challenge. An appropriate formula to determine an accurate IOL is an essential determining factor.[10] Ever since Fyodorov *et al*. in 1960 first came up with a formula for IOL calculation, various other theories followed suit, trying to achieve postsurgical refraction with better accuracy.[11,12] However, this study evaluated the accuracy of two different IOL formulas from the older to newer generation, which are SRK II and BU II, on 35 eyes with 22 to 24.5 mm AXL to know whether the older method would still be relevant.

The SRK II, integrated in the biometric device *SonomedPac 300A-scan* for normal AXL, is a second generation of regression-based IOL formula similar to SRK I, adjusting A-constant empirically through thickness of the lens, optical configuration, location of principal plane, and ocular position.[10,13] BU II is a fourth generation formula calculating IOL used utilizing corneal diameter and lens thickness to predict the IOL position more accurately.[14] This formula utilizes the “paraxial ray tracing” theory, otherwise known as the Gaussian/thick lens variable.[15]

The RPE is known as the deviation from presurgical predicted target refraction and postsurgical refraction. RPE is often used as an indicator to predict the accuracy of IOL formula.[14] In this study, both formulas had good RPE ranges within the benchmark standard as The United Kingdom National Health Service presented and there was no statistically significant difference between both formulas [Table 2]. This study used repeated-measures ANOVA analysis to adjust for individual variability. Our study has a similarity with Kuthirummal *et al*. who also compared four IOL formulas, which include second and third regression-based formula (SRK II and SRK/T) and BU II formula. However, the study was using eyes with short, normal, and long AXL groups. This study stated that BU II had a significant difference and more superior than both of the regression-based formulas, yet more importantly both BU II and SRK/T formulas achieved the target distribution of RPE value as presented by The United Kingdom National Health Service but not for SRK II formula.[7] Kane *et al*. also concluded that the BU II formula indeed was the most accurate formula to predict the eye with many kinds of AXL.[16]

However, both regression-based formulas (SRK II and SRK/T) are still one of the most common IOL formulas used in India by most cataract surgeons. It is because they are easy to implement without the necessity of advanced biometry devices.[7] And former study by Elder stated that there was no significant difference between SRK II and SRK/T to predict the refraction value in eyes with normal AXL similar with our finding.[17]

Although both SRK II and BU II formulas achieved the target distribution of RPE value as presented by The United Kingdom National Health Service and there was no statistically significant difference between both formulas in our study, these findings must be interpreted with caution and some number of limitations should be borne in mind. In spite of partial coherence interferometry (PCI), biometric examination was performed preoperatively using applanation technique with *SonomedPac 300A-scan*. A study by Cooke and Cooke stated that the BU II formula performs better when the measurement is done using PCI.[8] Furthermore, Zhang *et al*. stated that the BU II formula had the lowest RPE compared to some other formulas in patients with high myopia (AXL >24.5 mm).[5] But the sample in this study had a normal AXL range (22–24.5 mm).The PCI has the highest test accuracy, followed by the immersion technique then the applanation technique. PCI has the advantage of higher accuracy in patients with myopia, pseudophakia, and staphyloma.[18] The accuracy difference in applanation technique (contact technique) can be due to the pressure on the cornea, causing the AXL to be 0.1 to 0.3 mm shorter than other methods.[19] However, trained surgeons will be able to achieve relatively similar AXL results even using A-scan biometry.[18] On the other hand, PCI is less accurate in cases of mature cataracts, posterior subcapsular cataracts, or in patients with difficulty in visual fixation. The A-scan is more appropriate for these types of cases.[20] The authors believe that PCI is still a superior approach to use, but not in every situation due to the cost.[21]

Based on these findings, we concluded that the use of regression-based formula in eyes with normal AXL still can be relevant especially in a low-resource setting. The high backlog number of cataracts in Indonesia requires effective and efficient operative procedures. Remembering that our data analysis did not find any statistically significant difference from both IOL formulas used on eyes with normal AXL. Additionally, the RPE distribution range between two formulas was still within the benchmark standard of The United Kingdom National Health Service.

Conclusion

Postoperative vision is an indicator of cataract surgery success. An important factor in determining postoperative refraction is the accuracy of the IOL formula. Our study did not find any statistically significant difference in RPE between SRK II formula and BU II in patients with normal ocular AXLs. A cheaper procedure can be used in the limited setting area.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Aggarwal S, Jain P, Jain A. COVID-19 and cataract surgery backlog in medicare beneficiaries. J Cataract Refract Surg 2020. Publish ahead of print.
2. Kaswin G, Rousseau A, Mgarrech M, Barreau E, Labetoulle M. Biometry and intraocular lens power calculation results with a new optical biometry device: comparison with the gold standard. J Cataract Refract Surg 2014;40:593-600.
3. Gale RP, Saldana M, Johnston RL, Zuberbuhler B, McKibbin M. Benchmark standards for refractive outcomes after NHS cataract surgery. Eye Lond Engl 2009;23:149-52.
4. Hayashi K, Ogawa S, Yoshida M, Yoshimura K. Influence of patient age on intraocular lens power prediction error. Am J Ophthalmol 2016;170:232-7.
5. Zhang Y, Liang XY, Liu S, Lee JWY, Bhaskar S, Lam DSC. Accuracy of intraocular lens power calculation formulas for highly myopic eyes. J Ophthalmol 2016;2016:1917268.
6. Chong EW, Mehta JS. High myopia and cataract surgery. Curr Opin Ophthalmol 2016;27:45-50.
7. Kuthirummal N, Vanathi M, Mukhija R, Gupta N, Meel R, Saxena R, *et al.* Evaluation of Barrett Universal II formula for intraocular lens power calculation in Asian Indian population. Indian J Ophthalmol 2020;68:59-64.
8. Cooke DL, Cooke TL. Comparison of 9 intraocular lens power calculation formulas. J Cataract Refract Surg 2016;42:1157-64.
9. Reitblat O, Assia EI, Kleinmann G, Levy A, Barrett GD, Abulafia A. Accuracy of predicted refraction with multifocal intraocular lenses using two biometry measurement devices and multiple intraocular lens power calculation formulas. Clin Experiment Ophthalmol 2015;43:328-34.
10. Barrett GD. An improved universal theoretical formula for intraocular lens power prediction. J Cataract Refract Surg 1993;19:713-20.
11. Fyodorov SN, Galin MA, Linksz A. Calculation of the optical power of intraocular lenses. Invest Ophthalmol 1975;14:625-8.
12. Xia T, Martinez CE, Tsai LM. Update on intraocular lens formulas and calculations. Asia-Pac J Ophthalmol Phila Pa 2020;9:186-93.
13. Miraftab M, Hashemi H, Fotouhi A, Khabazkhoob M, Rezvan F, Asgari S. Effect of anterior chamber depth on the choice of intraocular lens calculation formula in patients with normal axial length. Middle East Afr J Ophthalmol 2014;21:307-11.
14. Karabela Y, Eliacik M, Kocabora MS, Erdur SK, Baybora H. Predicting the refractive outcome and accuracy of IOL power calculation after phacoemulsification using the SRK/T formula with ultrasound biometry in medium axial lengths. Clin Ophthalmol Auckl NZ 2017;11:1143-9.
15. Abulafia A, Barrett GD, Rotenberg M, Kleinmann G, Levy A, Reitblat O, *et al.* Intraocular lens power calculation for eyes with an axial length greater than 26.0 mm: comparison of formulas and methods. J Cataract Refract Surg 2015;41:548-56.
16. Kane JX, Van Heerden A, Atik A, Petsoglou C. Intraocular lens power formula accuracy: comparison of 7 formulas. J Cataract Refract Surg 2016;42:1490-500.
17. Elder MJ. Predicting the refractive outcome after cataract surgery: the comparison of different IOLs and SRK-II v SRK-T. Br J Ophthalmol 2002;86:620-2.
18. Savini G, Hoffer KJ, Barboni P, Balducci N, Schiano-Lomoriello D, Ducoli P. Accuracy of optical biometry combined with placido disc corneal topography for intraocular lens power calculation. PLoS One 2017;12:e0172634.
19. Eldaly MA, Mansour KA. Personal A-constant in relation to axial length with various intraocular lenses. Indian J Ophthalmol 2014;62:788-91.
20. Ademola-Popoola DS, Nzeh DA, Saka SE, Olokoba LB, Obajolowo TS. Comparison of ocular biometry measurements by applanation and immersion A-scan techniques. J Curr Ophthalmol 2015;27:110-4.
21. Srivannaboon S, Chirapapaisan C, Chonpimai P, Koodkaew S. Comparison of ocular biometry and intraocular lens power using a new biometer and a standard biometer. J Cataract Refract Surg 2014;40:709-15.