Journal of Clinical & Experimental Ophthalmology
ISSN: 2155-9570

Zheng and Merriam, J Clin Exp Ophthalmol 2018, 9:6
DOI: 10.4172/2155-9570.1000765

Research Article Open Access

A Method to Improve the Accuracy of Optimized A-Constant for IOL Calculation Formulas

Lei Zheng* **and John C Merriam**

Department of Ophthalmology, Columbia University, New York 10032, USA

***Corresponding author:** Lei Zheng, Department of Ophthalmology, Columbia University, New York 10032, USA, Tel: +1 9173791187; E-mail: zl36@columbia.edu

Received date: November 05, 2018; **Accepted date:** November 27, 2018; **Published date:** December 10, 2018

Copyright: © 2018 Zheng L, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Objective: To achieve more accurate IOL calculation results using multiple A-constants for SRK/T formula.

Methods: This is a retrospective clinical study. The study includes 650 cases of phacoemulsification with an Acrysof SN60WF IOL (Alcon, TX). The study excluded eyes that had corneal refractive surgery, eyes with any condition that precluded accurate and consistent keratometry. The study used the average of 5 valid measurements of axial length (AL) and corneal curvature using IOLMaster (Carl Zeiss Meditec, Inc. Germany) prior to surgery and manifest refraction measured at least 3 months after surgery. Patients were divided into 7 groups based on AL from less than 22 mm to greater than 27 mm. The average A-constant with standard deviation was calculated in each group, and these groups were compared to each other using independent two-sample t-test ($p<0.05$).

Results: The A-constants changed with AL. The A-constant of the four groups with AL less than 25 mm did not differ significantly each other ($P<0.05$). The two groups with AL less than 26 mm and less than 27 mm also did not differ statistically. Both are different than the first four groups. The A-constant for the group of AL 27 mm and more were different from all other groups. Second order polynomial described the relationship of the A-constant to AL.

Conclusion: Our results suggest that using different A-constants for eyes with different ALs, especially longer than 26 mm, may improve the accuracy of post-operative refraction results.

Keywords: Cataract; IOL; Intraocular lens; Phacoemulsification; Formula; A-constant; Axial length

Introduction

Accurate biometry and a good intraocular lens (IOL) formula are essential to reach the target postoperative refraction [1-3]. The SRK/T formula includes an A-constant which varies with IOL types. The IOL manufacturer provides an A-constant for each specific type of IOL, and optimizing the A-constant is important to minimize refractive errors [1-4].

IOL calculation may be affected by axial length (AL), anterior chamber depth, and corneal curvature. Olsen study in 1992 [5] showed that 54% of predicted refractive error was attributable to AL measurement error, 8% to corneal power, and 38% to the predicted postoperative ACD. Partial coherence interferometry measured AL has greater accuracy than ultrasound [6,7]. However, even with precise measurement of AL, the range of AL from short eyes to long eyes affects the predictive accuracy of one fixed A-constant, even if it is adjusted and optimized [4,8-11].

With the use of multiple optimized A-constants, rather than just one fixed optimized A-constant, as is commonly used, we suggest that clinicians should achieve more accurate IOL calculation results, especially for patients with shorter or longer eyes. In order to test the assumption, we divided our study patients into groups based on an incremental change of axial length by 1 mm, ranging from less than 22 mm to more than 27 mm. We optimized the A-constant for each patient in all groups based on the post-operative refraction and then calculated the average of the optimized A-constant for each group to analyze whether the A-constant varied with AL.

Methods

The institutional review board (IRB) approved this research. Data were collected into a specially-designed electronic clinical research database. All data entries were monitored by qualified medical personnel, and an error data entry alert system was built into the database to assure the accuracy and validity of all data collected.

This was a retrospective study of 650 cases phacoemulsification performed by a single surgeon with a 2.2 or 2.6 mm temporal incision and in-the-bag implantation of an Acrysof SN60WF IOL (Alcon Laboratories, Texas). The study excluded eyes with previous corneal refractive surgery, corneal scars, corneal dystrophies, severe dry eye, or other conditions that might preclude accurate biometry.

Five consistent and reproducible measurements of AL and three reproducible measurements of corneal curvature were obtained with the IOLMaster (Carl Zeiss Meditec, Inc. Germany) prior to surgery. The averaged measurements were used to calculate IOL power with the SRK/T formula. With the spherical equivalent of the stable refraction measured manually 3 to 6 months post-operatively, we calculated the precise A-constant for each patient with an SRK/T A-constant optimization formula programmed by Dr. Donald R. Sanders (Personal communication).

The cases were divided into 7 groups based on AL from less than 22 mm to greater than 27 mm in 1 mm increments (Table 1). The mean

A-constant with its standard deviation and standard error for each AL group were calculated. An independent two-sample t-test was used to compare each group with other six groups. A second degree polynomial shows the change of A-constant with AL.

Results

The averaged optimized A-constants in each group are different (Table 1). The Fish ANOVA t-test (Table 2) shows that there is no significant difference (p ≤ 0.05) for the A-constant of the 4 groups with AL less than 25 mm. The AL group 26 does not differ statistically with AL group 22, but does differ statistically from groups 23, 24, and 25. The AL group 27 differs from AL groups 22, 23, 24, and 25 but not 26. AL group 28 differs statistically with all other groups. Second degree polynomial regression describes the relationship of AL and A (Table 3 and Figure1).

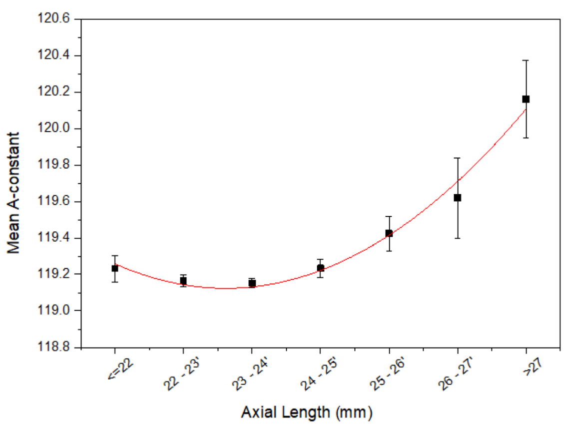

Figure 1: Polynomial Fit for mean A-constant with different range of axial length.

Discussion

Modern phacoemulsification surgery combined with smaller and smaller incisions has reduced postoperative complications, hastened recovery, and reduced surgically-induced astigmatism. Therefore, minimizing postoperative refractive error has become more and more important to patient satisfaction, even after technically perfect surgery [12-14].

The SRK/T formula is considered one of the best formulas for predicting the postoperative error in relation to axial length [15]. The A-constant suggested by the manufacturer for the SN60WF IOL is 118.7, and the A-constant derived from the pooled data of the ULIB (User group for Laser Interference Biometry) is 119.0. In the current study the optimized A-constant ranges from a minimum of 119.152 to a maximum of 120.161 based on AL (Table 1).

AL Group (Range)	Mean	SD	SE	N
22 (≤ 22)	119.232	0.37	0.073	26
23 (22–23)	119.166	0.352	0.033	111
24 (23–24)	119.152	0.427	0.026	271
25 (24–25)	119.234	0.586	0.05	137
26 (25–26)	119.424	0.671	0.094	51
27 (26–27)	119.619	1.141	0.219	27
28 (>27)	120.161	1.109	0.213	27

Note: AL: Axial Length. Mean: Average of optimized A constant. SD: Standard deviation. SE: Standard error of mean. N: Total number for each group.

Table1: Mean A-Constant with different range of AL.

Groups Between	P value	Significance
22 *vs* 27	0.012	1
22 *vs* 28	2.60E-09	1
23 *vs* 26	0.00674	1
23 *vs* 27	1.75E-04	1
23 *vs* 28	6.98E-16	1
24 *vs* 26	0.00153	1
24 *vs* 27	3.90E-05	1
24 *vs* 28	4.22E-18	1
25 *vs* 26	0.03892	1
25 *vs* 27	0.00112	1
25 *vs* 28	1.51E-14	1
26 *vs* 28	4.51E-08	1
27 *vs* 28	4.06E-04	1

Note: For group number with its equivalent AL ranges: 22 (≤ 22), 23 (22–23), 24 (23–24), 25 (24–25), 26 (25–26), 27 (26–27), 28 (>27); Significance: 1 is significant.

Table 2: The significant level and its P values using Fisher LSD ANOVA analysis between two AL groups (only showing the groups with a significant difference).

Figure 1 demonstrates that the optimized A-constants are positively correlated with AL. It indicates that a single optimized A-constant is not sufficient for the range of axial lengths. One single optimized A-constant value will lead to greater error when calculating the IOL power for shorter and longer axial lengths [4,8-10,13,14,16-19].

	Value	Standard Error
Intercept	147.6981	3.8466
B1	-2.41963	0.30914
B2	0.05122	0.00618

Table 3: Parameters for second degree polynomial regression.

This study suggests a simple method to improve the accuracy of IOL power calculation, which is to divide the axial length into 1 mm increments to create a range of optimized A-constants, instead of using one single optimized A-constant. In this study, we have only explored the A-constant for the SRK/T formula. We believe that other formulas also should optimize their constants based on the range of AL to increase IOL power prediction accuracy.

Conclusion

To achieve more accurate IOL power calculation, any IOL power calculation formula should optimize its constants based on a range of AL.

References

1. Retzlaff JA, Sanders DR, Kraff MC (1990) Development of the SRK/T intraocular lens implant power calculation formula. J Cataract Refract Surg 16: 333-340.
2. Hoffer KJ (1993) The Hoffer Q formula: a comparison of theoretic and regression formulas. J Cataract Refract Surg 19: 700-712
3. Aristodemou P, Knox Cartwright NE, Sparrow JM, Johnston RL (2011) Intraocular lens formula constant optimization and partial coherence interferometry biometry: Refractive outcomes in 8108 eyes after cataract surgery. J Cataract Refract Surg 37: 50-62
4. Petermeier K, Gekeler F, Messias A, Spitzer MS, Haigis W, et al. (2009) Intraocular lens power calculation and optimized constants for highly myopic eyes. J Cataract Refract Surg 35: 1575-1581.
5. Olsen T (1992) Sources of error in intraocular lens power calculation. J Cataract Refract Surg 18: 125-129.
6. Olsen T, Thorwest M (2005) Calibration of axial length measurements with the Zeiss IOLMaster. J Cataract Refract Surg 31: 1345-1350.
7. Lam AK, Chan R, Pang PC (2001) The repeatability and accuracy of axial length and anterior chamber depth measurements from the IOLMaster. Ophthalmic Physiol Opt 21: 477-483.
8. Bang S, Edell E, Yu Q, Pratzer K, Stark W (2011) Accuracy of intraocular lens calculations using the IOLMaster in eyes with long axial length and a comparison of various formulas. Ophthalmology 118: 503-506.
9. Kora Y, Kitazato T, Inatomi M, Koide R, Yaguchi S, Ozawa T, Kaneko M (1995) An intraocular lens power calculation for high myopia. Nippon Ganka Gakkai zasshi 99: 692-695.
10. Kora Y, Nishihara H, Inatomi M, Koide R, Ozawa T, Kaneko M (1995) [Intraocular lens power calculation for short eye]. Nippon Ganka Gakkai zasshi 99: 1186-1189.
11. Aristodemou P, Knox Cartwright NE, Sparrow JM, Johnston RL (2011) Formula choice: Hoffer Q, Holladay 1, or SRK/T and refractive outcomes in 8108 eyes after cataract surgery with biometry by partial coherence interferometry. J Cataract Refract Surg 37: 63-71.
12. Madge SN, Khong CH, Lamont M, Bansal A, Antcliff RJ (2005) Optimization of biometry for intraocular lens implantation using the Zeiss IOLMaster. Acta ophthalmologica Scandinavica 83: 436-438.
13. MacLaren RE, Natkunarajah M, Riaz Y, Bourne RR, Restori M, et al. (2007) Biometry and formula accuracy with intraocular lenses used for cataract surgery in extreme hyperopia. Am J Ophthalmol 143: 920-931
14. Gavin EA, Hammond CJ (2008) Intraocular lens power calculation in short eyes. Eye 22: 935-938
15. Zuidervaart W, Luyten GP (2005) A retrospective analysis of five intra-ocular lenses and the predictive value of six different intra-ocular lens power calculation formulas. Ophthalmologica 219: 390-393.
16. Wang JK, Hu CY, Chang SW (2008) Intraocular lens power calculation using the IOLMaster and various formulas in eyes with long axial length. J Cataract Refract Surg 34: 262-267.
17. Fam HB, Lim KL (2009) Improving refractive outcomes at extreme axial lengths with the IOLMaster: the optical axial length and keratometric transformation. Br J Ophthalmol 93: 678-683.
18. Wang L, Shirayama M, Ma XJ, Kohnen T, Koch DD (2011) Optimizing intraocular lens power calculations in eyes with axial lengths above 25.0 mm. J Cataract Refract Surg 37: 2018-2027.
19. Olsen T (2012) Intraocular lens power calculation errors in long eyes. J Cataract Refract Surg 38: 733-734.