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Improving the Accuracy of Optimized A-Constants in Intraocular Lens Calculation Formulas

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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]. Ue SRK/T formula includes an A-constant which varies with IOL types. Ue 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

Ue 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.

Uis 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). Ue 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. Ue 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).

Ue 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). Ue 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

Ue averaged optimized A-constants in each group are different (Table 1). Ue Fish ANOVA t-test (Table 2) shows that there is no significant difference ($p \leq 0.05$) for the A-constant of the 4 groups with AL less than 25 mm. Ue AL group 26 does not differ statistically with AL group 22, but does differ statistically from groups 23, 24, and 25. Ue 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.
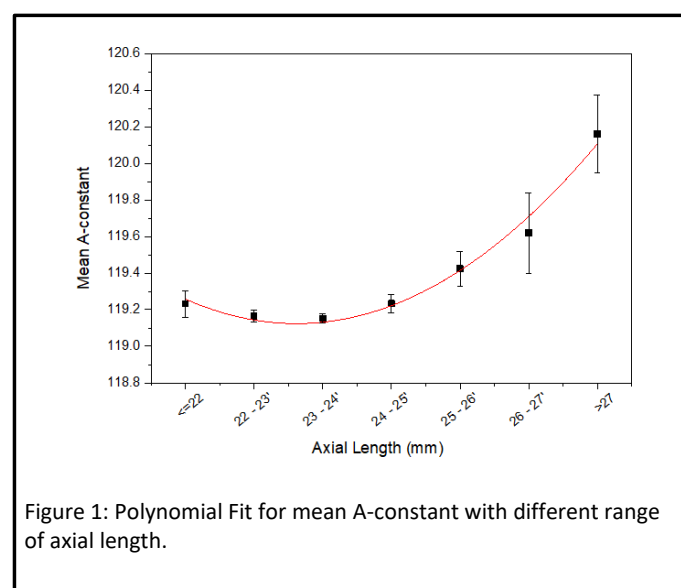
Discussion

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

Ue SRK/T formula is considered one of the best formulas for predicting the postoperative error in relation to axial length [15]. Ue 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: Ue 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.

Uis 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.

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