Original Article

Personal A-constant in relation to axial length with various intraocular lenses

Mohamed A Eldaly, Khaled A Mansour

Purpose: To study the relationship between the axial length and personal A-constant for the 1-piece Tecnis (Abbott ZCB00), AcrySof MA60AC (Alcon) and the Quatrix aspheric preloaded (CROMA) intraocular lenses (IOL). **Materials and Methods:** Patients matching the inclusion criteria were further subdivided according to the implanted IOL in this prospective comparative study. The obtained refractive outcomes were introduced into the formula installed in the biometry machine (Humphrey model 820 ultrasonic biometer) to obtain the personal A-constant for each eye. Polynomial regression analysis was done to study the individualized A-constant for each type of IOL in relation to preoperative axial length measurement. **Results:** Two hundred and forty five eyes of 186 patients were enrolled into this study, of whom 73 eyes with Tecnis 1-piece, 116 eyes with MA60AC, and 56 eyes with Quatrix. The median of personalized A-constant for Tecnis 1-piece, MA60AC, and Quatrix were 119.21 (SD 1.3, Std. Mean error 0.15), 119 (SD 1.2, Std. Mean error 0.11) and 120.4 (SD 1.2, Std. Mean error 0.16) respectively. Regression plots for the same range of axial length among all the groups showed that the Tecnis1 group followed the same pattern of the Quatrix group in which there was a linear relationship of a trend towards myopia when the axial length had increased and a hyperopic shift when decreased. This relationship changed into a plateau when the axial length became in the range of 23.5 mm to 27 mm in the MA60AC group. **Conclusions:** Personal A-constant follows different trends with different IOLs even for the same range of axial length.

Access this article online

Website: www.ijo.in

DOI: 10.4103/0301-4738.138300

Quick Response Code:

Key words: A-constant, biometry, individualized, intraocular lenses, personal, Tecnis

New techniques of cataract surgery led to decline of the surgically induced astigmatism, highlighting the importance of the spherical equivalent for postoperative spectacle independence.[1] Results of randomized controlled trial by Raymond *et al*. showed that the calculation of intraocular lens (IOL) power based on ocular axial length measurement with partial coherence interferometry technology provided no clinical advantage over the conventional applanation ultrasound, as measured by postoperative refractive outcome.[2] Researchers demonstrated that automated refraction becomes stable one week after the phacoemulsification and can be used to prescribe corrective lenses at this time.[3]

Different types of IOLs are represented in IOL formulas with specific constants; 'Surgeon factor' for Holladay I, 'ACD' for Hoffer Q and the 'A-constant' for Sanders-Ritzlaff-Kraff (SRK) formulas. Manufacturers of IOLs always advised optimization of these constants rather than depending on those provided by manufacturers in order to achieve higher rates of accuracy.[4] Nemeth *et al*. illustrated that optimization of A-constant was the main factor leading to significantly better outcomes.[5] For getting the best out of using the personal A-constant, surgeons need to use the personalized A-constant obtained after operating on the non-dominant eye in the calculations for the fellow dominant eye. It is important to know the patients who are suitable to get the best benefits out of personalization of their A-constant. Little is reported in medical literature to answer this question and to what extend is the influence of axial length measurement on personalization of A-constant with different types of IOLs.

Another factor is the accuracy of formulas for IOL power calculation, which presented a limiting factor facing the achievement of spectacle independence. Subsequently, it would be assumed that formula induced errors were independent of the type or the physical properties of the used IOL and consequently, it's A-constant. The aim of this study was to analyze the relationship between the axial length and personal A-constant for the 1-piece Tecnis (Abbott ZCB00), AcrySof MA60AC (Alcon) and the Quatrix aspheric preloaded (CROMA) intraocular lenses.

Materials and Methods

Eyes of patients matching the inclusion criteria were enrolled in this prospective comparative study. Inclusion criteria were patients with dense senile cataract undergoing uncomplicated phacoemulsification through 2.8 mm clear corneal incision, and in-the-bag foldable intraocular lens implantation. The IOLs were either 1-piece Tecnis (Abbott ZCB00), the 3-piece AcrySof MA60AC (AcrySof, Alcon), or the one-piece Quatrix (QUATRIX aspheric pre-Loaded, CROMA) IOLs (Manufacturers' A-constant were 118.8, 118.4 and 119.3 respectively). The IOLs were assigned using randomly generated computer numbers. All surgeries were performed by the same surgeon. All eyes have undergone preoperative biometry, performed by the same examiner, using the same Javal keratometer and acoustic biometer (Humphrey model 820 ultrasonic biometer). The refractive outcomes were obtained at least two weeks postoperatively, and the postoperative sphere and cylinder were introduced in the formula installed on the same biometry machine to obtain the personal A-constant for each eye. The biometer utilized the SRK/T formula to calculate the IOL

Department of Ophthalmology, Faculty of Medicine, Cairo University, Giza, Egypt

Correspondence to: Dr. Mohamed A. Eldaly, Department of Ophthalmology, Cairo University Hospitals (Kasr ElAini), Al-Saray Street, El Manial, Cairo, Postal address: 11956, Egypt. E-mail: eldaly_mohamed@yahoo.com

Manuscript received: 05.11.13; Revision accepted: 22.03.14

power preoperatively. Personal A-constant was automatically computed by the biometer as a default accessory in model 820. The same person who performed all the surgeries was not involved in analyzing and interpreting the results to avoid performance bias. Because of the difference in the range of available powers among IOLs (+6 to +30 for Tecnis1 and MA60AC, +10 to +30 for Quatrix IOLs), lower power IOLs for eyes with higher axial lengths were not available for the Quatrix group. Subsequently, comparative analysis of IOLs was also done after adjustment for the same range of axial length among all groups.

The research conforms to the tenets of the Helsinki declaration. Data were recorded on an electronic template specially designed for this study. Data were statistically represented in terms of range, mean, median, standard deviation (SD) and standard error of mean. Whenever required, comparisons were done using analysis of variance for parametric data. A probability value (*P* value) less than 0.05 were considered significant. For comparing nonparametric data, Chi-square and Kruskal-Wallis tests were performed. Polynomial regression analysis was done to study the relationship of the personal A-constant for each type of IOL to the measured preoperative axial length. Regression analysis was also done after adjusting data for the same range of axial length among studied IOLs. All statistical calculations were done using computer program›s Microsoft Excel version 7 (Microsoft Corporation, NY) and SPSS (Statistical package for the social science) and statistical programs (SPSS Inc., Chicago, IL).

Results

Two hundred and forty five eyes of 186 patients were enrolled into this study. They were grouped according to type of IOL used: 73 eyes (51 patients) were implanted with Tecnis 1-piece (Abbott ZCB00), 116 eyes (92 patients) with 3-piece AcrySof MA60AC (AcrySof, Alcon), and 56 eyes (43 patients) were implanted with one-piece Quatrix IOLs (QUATRIX aspheric Pre-Loaded, CROMA). The axial lengths and personal A-constants for each type of IOL were shown in Table 1. Differences of axial lengths between types of used IOLs were not significant (P = 0.111). Statistically significant negative correlation existed between MA60AC personalized A constant and the corresponding axial length (-0.292, P = 0.001). The same correlation was higher with the Tecnis 1-piece and Quatrix IOLs (–0.311, P = 0.007; -0.548, P < 0.0001 respectively). The fit of the curve for polynomial regression analysis was highly significant with the three groups of IOLs (P < 0.0001). Plots of regression for personalized A-constant with the axial length in Tecnis 1-piece, MA60AC and Quatrix IOLs were illustrated in Figs. 1-3 respectively. Inspection of the data in the figures illustrated that this negative correlation did not extend across the entire range of axial length. It appears that the relation of the A-constant to axial length is more complex and that the A-constant became positively correlated with axial lengths above 27 mm. There was an interval between 24.5-27.5 mm outside which there was a hyperopic shift in the Tecnis 1-piece group [Fig. 1]. The same pattern was detected in the MA60AC group with a lesser steeper curve compared to Tecnis 1, outside the range 24.5-28.5 mm [Fig. 2]. The plots for the Quatrix group showed a different pattern with a linear relationship of a trend towards myopia when the axial length had increased and a hyperopic shift when decreased [Fig. 3].

Comparative analysis was done after adjusting the data for the same range of axial length among all groups, 21.5-27 mm [Table 2]. The fit of the curve for polynomial regression analysis was significant with the three groups of IOL (P < 0.0001, P = 0.002 and P < 0.0001 for the Tecnis 1, MA60AC and Quatrix groups respectively). Plots of regression for personalized A-constant with the adjusted range of axial length in Tecnis 1-piece, MA60AC and Quatrix IOLs were illustrated in Figs. 4-6 respectively. The plots for Tecnis 1 group followed the same pattern of the Quatrix group plots in which there was a linear relationship of a trend towards myopia when the axial length had increased and a hyperopic shift when decreased [Fig. 4] [Fig. 6]. On the other hand, In the MA60AC

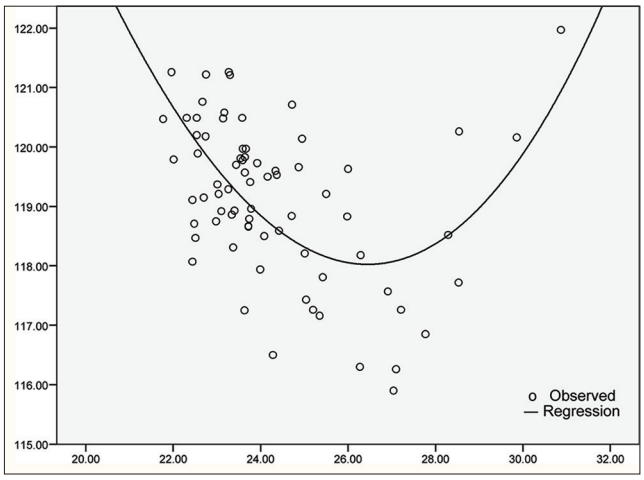

Figure 1: Regression analysis of Tecnis1 group (X-axis: Axial length in mm, Y-axis: Personal A-constant)

Table 1: Axial length and personal A-constant in the Tecnis1, MA60AC and Quatrix groups

	Tecnis1 axial length	Tecnis1 personal A-constant	MA60AC axial length	MA60AC personal A-constant	Quatrix axial length	Quatrix personal A-constant
Included eyes	73	73	116	116	56	56
Minimum	21.8	115.9	20.7	116.2	21.4	117.4
Maximum	30.9	122.0	30.5	122.2	26.9	122.7
Median	23.7	119.2	23.8	119.0	23.5	120.4
Mean	24.3	119.1	24.1	119.0	23.6	120.3
Std. Deviation	1.9	1.3	1.8	1.2	1.2	1.2
Std. Error of mean	0.2	0.2	0.2	0.1	0.2	0.2

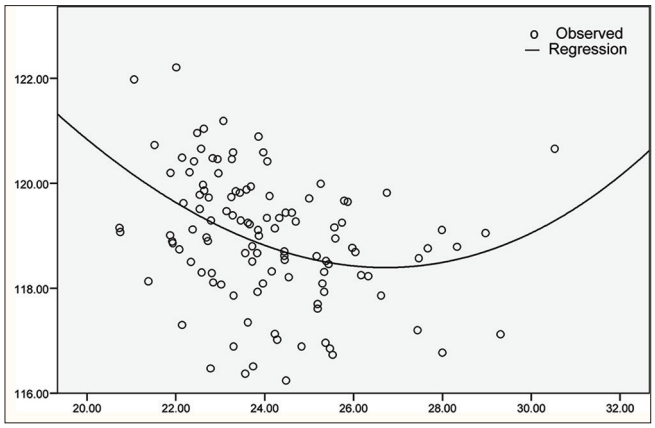

Figure 2: Regression analysis of MA60AC group (X-axis: Axial length in mm, Y-axis: Personal A-constant)

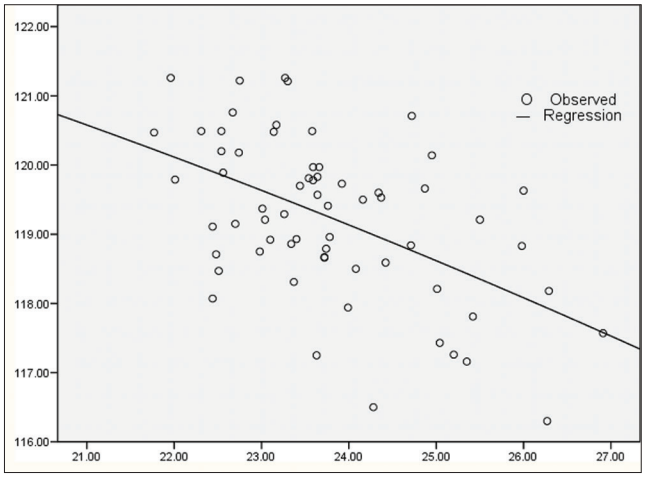

Figure 4: Regression analysis of Tecnis1 group: Adjusted for the same range of axial length (21.5 – 27 mm) among all groups (X-axis: Axial length in mm, Y-axis: Personal A-constant)

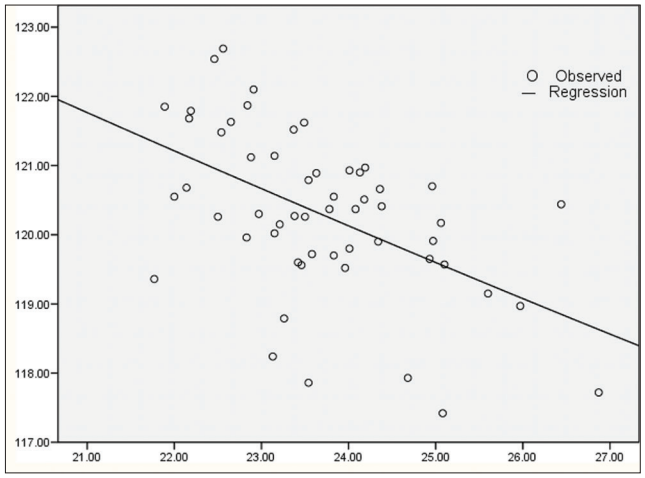

Figure 6: Regression analysis of Quatrix group: Adjusted for the same range of axial length (21.5 – 27 mm) among all groups (X-axis: Axial length in mm, Y-axis: Personal A-constant)

group, this relationship changed into a plateau when the axial length became in the range of 23.5 mm to 27 mm [Fig. 5].

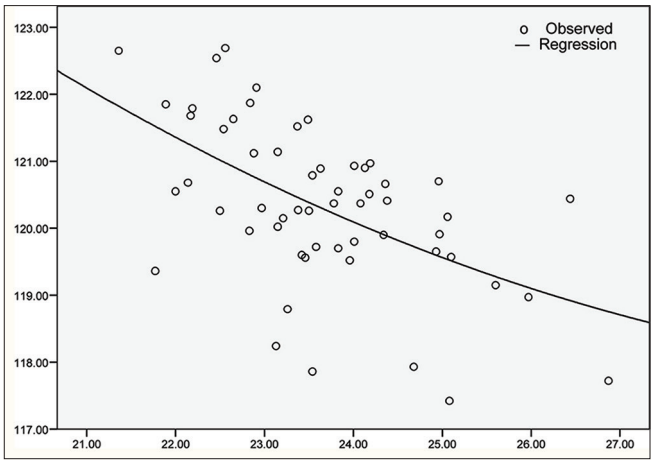

Figure 3: Regression analysis of Quatrix group (X-axis: axial length in mm, Y-axis: personal A-constant)

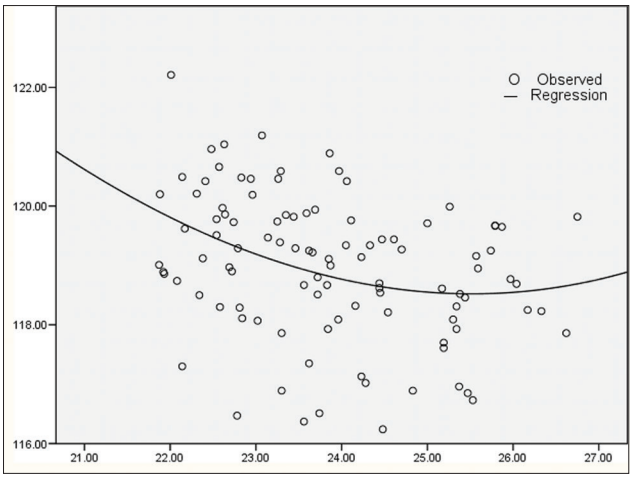

Figure 5: Regression analysis of MA60AC group: adjusted for the same range of axial length (21.5 – 27 mm) among all groups (X-axis: Axial length in mm, Y-axis: Personal A-constant)

Discussion

Various reports advised the continuous review of refractive outcomes as part of the quality control management. They added that optimization of A-constant helps improving the refractive outcomes. Few studies were published regarding the optimization and even fewer ones that have studied the trends of personalization of manufacturers' A-constant in different types of IOLs.[6-8] Langenbucher and his colleagues recommended standardizing the practice setting and that all cases to be operated by a single surgeon for valid individualization of A-constant.[6] On the other hand, Aristodemous *et al*. described that the differences in personalized A-constant between most surgeons as clinically insignificant. They further added that optimization for an IOL was far exceeding any additional benefit for individual surgeon personalization.[9]

A recent report described that different types of IOL show different trends even with standardization of the same practice settings.[6] Haigis reported the strong dependence of A-constants on axial length. He emphasized that even for the same IOL and same instrumentation, different IOL constants were necessary for different ranges of axial lengths.[10]

Table 2: Axial length and personal A-constant in the Tecnis1, MA60AC and Quatrix groups adjusted for an equal range of axial lengths (21.5 to 27.0 mm)

	Tecnis1 axial length	Tecnis1 personal A-constant	MA60AC axial length	MA60AC personal A-constant	Quatrix axial length	Quatrix personal A-constant
Included eyes	64	64	102	102	55	55
Minimum	21.8	116.3	21.9	116.2	21.8	117.4
Maximum	26.9	121.3	26.8	122.2	26.9	122.7
Median	23.6	119.3	23.7	119.1	23.5	120.4
Mean	23.8	119.2	23.9	119.0	23.7	120.3
Std. Deviation	1.2	1.1	1.3	1.2	1.1	1.2
Std. Error of Mean	0.1	0.1	0.1	0.1	0.2	0.2

These findings were in agreement with those of our study. A hyperopic shift was reported in the surgical experience with Tecnis 1-piece IOL. That was explained due to the special design of the IOL haptics that allowed a potential for the optic to move posteriorly. That was not reported with AcrySof IOL (IQ) due to a more appropriate design of lens haptics.[11] In our study, we found a trend towards hyperopia outside a range of axial lengths when personalizing the A-constant for the Tecnis 1-piece and AcrySof MA60AC IOLs. However, there were a small number of patients with higher axial lengths as the lowest possible IOL powers for Tecnis 1 and MA60AC was + 6, while for Quatrix was + 10. Subsequently, it was not possible to study the trend of personal A-constant with the Quatrix IOL for axial lengths beyond 27 mm. In the comparative analysis using the same range of axial lengths between the three groups, Tecnis 1 and Quatrix groups followed the same trend.

With the earlier versions of SRK formula, a tendency towards hyperopia had been reported with axial lengths shorter than 22.0 mm, and myopia when longer than 24.5 mm.[12] The SRK/T formula had been developed to overcome this error. Eom *et al*. reported the same trends which we found with Tecnis 1 and Quatrix IOLs, when they studied AcrySof IQ (similarly, single piece). They attributed this finding to the differences they found in corneal curvature among their patients.[13] Nejima *et al*. reported that MA60AC (3-piece) showed some forward shift when compared to single-piece IOLs.[14] This forward shift could possibly induce some myopia that counteracted with the comparative hyperopia found with the same range of axial lengths in Tecnis 1 and Quatrix groups. This could provide some explanation to the plateau found in this study with MA60AC.

In conclusion, different IOLs showed different trends when personalizing their A-constant even for the same range of axial lengths. Analyzing the same comparative range of axial length among all groups, MA60AC showed no significant myopic/hyperopic shift within the range of 23.5-27 mm. A linear trend was found towards myopia with the increase of axial length in the Tecnis 1 and Quatrix groups. Further studies are needed to investigate of these relationships with various IOLs.

References

1. Olsen T. Calculation of intraocular lens power: A review. Acta Ophthalmol Scand 2007;85:472-85.
2. Raymond S, Favilla I, Santamaria L. Comparing ultrasound biometry with partial coherence interferometry for intraocular lens power calculations: A randomized study. Invest Ophthalmol Vis Sci 2009;50:2547-52.
3. de Juan V, Herreras JM, Pérez I, Morejón Á, Río-Cristóbal A, Martín R, *et al*. Refractive stabilization and corneal swelling after cataract surgery. Optom Vis Sci 2013;90:31-6.
4. Shammas HJ. Modern formulas for intraocular lens power calculations. In: Shammas HJ. Intraocular Lens Power Calculations. 1st ed. Slack Incorporated; 2004. p. 15-24
5. Nemeth G, Nagy A, Berta A, Modis L Jr. Comparison of intraocular lens power prediction using immersion ultrasound and optical biometry with and without formula optimization. Graefes Arch Clin Exp Ophthalmol 2012;250:1321-5.
6. Langenbucher A, Eppig T, Viestenz A, Seitz B, Müllner G, Schönherr U. Individualization of IOL constants for two hydrophobic intraocular lenses. SRK II, SRK/T, Hoffer-Q, Holladay 1 and Haigis formula. Ophthalmologe 2012;109:468-73.
7. Bonfadini G, Ladas JG, Moreira H, Campos M, Matthaei M, Muñoz B, *et al*. Optimization of intraocular lens constant improves refractive outcomes in combined endothelial keratoplasty and cataract surgery. Ophthalmology 2013;120:234-9.
8. Korynta J. Importance of individualizing the formula for improving the accuracy of calculating emmetropia in intraocular lenses before cataract surgery. Cesk Slov Oftalmol 1995;51:45-50.
9. Aristodemou P, Knox Cartwright NE, Sparrow JM, Johnston RL. Intraocular lens formula constant optimization and partial coherence interferometry biometry: Refractive outcomes in 8108 eyes after cataract surgery. J Cataract Refract Surg 2011;37:50-62.
10. Haigis W. Influence of axial length on IOL constants. Acta Clin Croat 2012;51:59-64.
11. Allen Q. Clinical Comparisons of Two Aspheric IOLs. Available from: http://www.bmctoday.net/crstoday/2009/01/insert/article.asp?f=CRST0109SUP_02.php [Last retrieved on 2013 Apr 22].
12. Sanders DR, Retzlaff J, Kraff MC. Comparison of the SRK II formula and other second generation formulas. J Cataract Refract Surg 1988;14:136-41.
13. Eom Y, Kang SY, Song JS, Kim HM. Use of corneal power-specific constants to improve the accuracy of the SRK/T formula. Ophthalmology 2013;120:477-81.
14. Nejima R, Miyai T, Kataoka Y, Miyata K, Honbou M, Tokunaga T, *et al*. Prospective intrapatient comparison of 6.0-millimeter optic single-piece and 3-piece hydrophobic acrylic foldable intraocular lenses. Ophthalmology 2006;113:585-90.

Cite this article as: Eldaly MA, Mansour KA. Personal A-constant in relation to axial length with various intraocular lenses. Indian J Ophthalmol 2014;62:788-91.

Source of Support: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.
Conflict of Interest: None declared.