

Validity of Novel Microsoft excel Software for Calculating Surgically Induced Astigmatism

Abstract

Purpose: Present study investigated validity and predictability of a new software calculator for surgically induced astigmatism quantification.

Techniques and methods: New astigmatic calculator was designed based on Pythagorean principle and trigonometric functions using Microsoft office excel 2007. Astigmatic magnitude quantified in diopters and axis depicted in degrees. Calculator applicability investigated and analyzed on 30 pseudophakic eyes that underwent temporal scleral incision surgery with in the bag intraocular lens implantation. Pre and post operative anterior corneal curvature measured with Bausch and lamb keratometer. Similarities and differences compared with existing version 1.1 and 2.1 calculators and statistical analyses performed by Microsoft excel.

Results: Population mean age was 60.3 (+/- 8.66) years with 14 males (46.66%) and 16 (53.34%) females. Mean pre and post operative astigmatic magnitude of 62.67 (+/- 2.40) and 62.83 (+/- 2.29) diopters calculated. Mean pre and post operative astigmatic axis was 89.74 (+/- 1.37) and 89.51 (+/- 1.37) degrees. Pearson's coefficient (r) of 0.91 and 0.83, coefficient of determinations (R^2) of 0.82 and 0.68 for astigmatic magnitudes and axes found respectively. *p* value less than 0.05 considered as statistically significant difference at 95% confident intervals. T values of 0.39 and 0.26 calculated for astigmatic magnitude and axis by student chi-square test. Validity compared with existing surgically induced astigmatism calculators 1.1 and 2.1 versions. Predictability assessed by $y=2.83+0.95x$ for astigmatic magnitude and $y=15.28+0.83x$ equations for astigmatic axis.

Conclusion Present Microsoft excel calculator application is validated as the values for astigmatic magnitude and axis comparable with existing SIA calculators and can be used for astigmatic predictability.

Keywords: surgically induced astigmatism (SIA), Pythagorean principle, trigonometric and calculus formulae, astigmatic magnitude and direction

Introduction

Unexpected and post cataract surgical refractive astigmatic surprises not uncommon in clinical practice. Understanding surgically induced astigmatism enlightens modifications in astigmatic control. Clinical prediction about pre and postoperative astigmatic magnitude and axis after cataract surgery improves acceptable modifications of surgeons' incision techniques that provide least astigmatic correction to patients. Surgically induced astigmatism (SIA) determination uses subtraction method, vector analysis, vector decomposition, Cravy's vertical vector, Naeser's polar values and algebraic methods for calculations.¹⁻²

Recently, minimum standard format for reporting astigmatic outcomes and terminology to defined astigmatism was formulated by astigmatic project group of the American national standard institute (ANSI).³ Because astigmatism is manifested in magnitude and direction simultaneously, principles of vector Cartesian coordinate system calculations were adapted in the present study. Research rationale of this novel simple Microsoft (MS) excel 2007 software construction is to validate and correlate with existing SIA calculator 1.1 and 2.1 software. Furthermore predictability of post operative SIA vectors were evaluated by means of regression equations.

Subjects and Methods

Present experimental study conducted primarily on patients' recruited from an ongoing study on manual keratometric analysis of anterior corneal curvature following temporal scleral incision cataract surgery. Informed consent was taken from all patients. This project was approved by the institutional ethical committee and conducted in accordance with the Declarations of Helsinki of 1975. A new yet a simple MS excel software functions employed to analyze SIA on the basis of

Cartesian coordinate vector system. Thirty eyes of 30 cataract patients included after three months of surgery as refraction stabilizes by this time.⁴ Procedure followed was temporal scleral incision cataract surgery with in the bag intra ocular lens implantation. Eyes with intra operative complications excluded. Pre and post operative keratometric horizontal (Kh) and vertical meridians (Kv) measured by Bausch and Lomb keratometer (Appasamy KMS 6) and the data provided in table 4. As Microsoft Excel is easily available and accessible it can be used similarly on other versions also.

MS excel SIA software-Basic Principles

Formulae were constructed accordingly as astigmatism characterizes power in diopters and axis direction in degrees abide by vector analysis system. Magnitude and axis of pre and post operative SIA vectors was expressed in diopters and in degrees respectively. Generally in day to day practice astigmatism involves correction of two principle meridians that are perpendicular to each other; hence resultant vector is the hypotenuse of Pythagorean right angle triangle that was used to calculate magnitude of SIA vector.

Pythagorean principle applies to right angle triangles composed of adjacent and opposite sides with hypotenuse. The formula is $\text{adjacent side}^2 + \text{opposite side}^2 = \text{hypotenuse}^2$, hence hypotenuse is equal to sum square root of adjacent and opposite side that represents net astigmatic magnitude in diopters. (Figure 1) Pre and post operative keratometric horizontal and vertical values substituted for opposite coordinate (a) and adjacent coordinate (b) respectively. Resultant and displaced coordinate is the magnitude of SIA vector represented by hypotenuse value that was expressed in diopters of astigmatism.

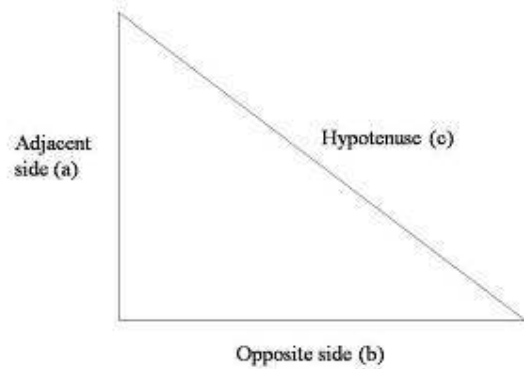


Figure 1 Calculation of SIA vector magnitude based on Pythagorean principle

Figure 1 Calculation of magnitude of SIA vector based on Pythagorean principle

For example 1

Pre operative cylinder -1.00 Dx90 degrees

Post operative cylinder -2.00 Dx180degrees

$$c^2 = a^2 + b^2 \quad \text{therefore } c = \sqrt{a^2 + b^2}$$

Therefore $c = \sqrt{1^2 + 2^2} = \sqrt{5} = 2.2$ D which is the resultant displaced magnitude of SIA vector

To find out resultant pre and post operative vector direction (angle) that is the astigmatic axis in degrees, trigonometric and calculus functions applied. Here law of cosine was used for calculation of the angle theta for the resultant axis of SIA vector.

$$\begin{array}{cc} \text{Adjacent side} & \text{opposite side} \\ \text{Cosine } \emptyset = \frac{\quad}{\text{Hypotenuse}} & \text{sine } \emptyset = \frac{\quad}{\text{hypotenuse}} \end{array}$$

Therefore, adjacent side = hypotenuse $\cos \emptyset$ and opposite side = hypotenuse $\sin \emptyset$. This formula is for understanding law of cosines to calculate vertical and horizontal components when hypotenuse is known and vice versa. However we want to find out the angle of hypotenuse which is the axis of SIA vector. Value for astigmatic angle is calculated from tangent formula as shown below.

95

96 Opposite side (horizontal curvature)

97 $\tan \emptyset = \frac{\text{Opposite side (horizontal curvature)}}{\text{Adjacent side (vertical curvature)}}$ OR

98 Adjacent side (vertical curvature)

99

100 $\emptyset = \tan^{-1} \{Kh/Kv\}$ that is derived from referring to tables and Microsoft excel trigonometry
101 functions. Since astigmatic axis doubles in direction, the formula was multiplied by 2. Then $\emptyset = 2$
102 $\tan^{-1} \{Kh/Kv\}$ which is the final formula for calculating pre and post operative resultant axis of SIA
103 vector in degrees.

104

105 For example, Substituting our pre operative keratometric readings, when Kh is 42.74 diopters and
106 Kv is 42.25 diopters in the formula we get, $\tan \emptyset = 42.74/42.25$ is equal to 0.99. Because $\emptyset = 2$
107 $\tan^{-1} \{0.99\}$ which is equal to 0.78 radians converted into 89.34 degrees automatically in the present
108 software calculator. Therefore practically resultant axis of SIA vector becomes 90 degrees.
109 Subtracting post operative axis of SIA vector from pre operative axis of SIA vector, resultant axis
110 of SIA vector was obtained. This new SIA calculator applied for validification in pseudophakic
111 eyes irrespective of incision dimensions however scleral incisions ranged from 5.5 mm to 8.00 mm
112 and the results from new calculator compared with presently available SIA calculator version 1.1
113 and 2.1.

114

115 **Results**

116 Surgically induced astigmatism in 30 pseudophakic eyes of 30 patients studied by applying newly
117 formulated Microsoft Excel software calculator. Mean age was 60.3 (+/- 8.66) years with 14 males
118 (46.66%) and 16 (53.34%) females. All cases operated from temporal side and in the bag
119 intraocular lens placement performed in 30 (100 %) eyes by same surgeon. Linear relationship and

120 line of best fit for magnitude and axis of pre and post operative magnitude and axis of SIA vectors
 121 is shown in Figure 2 and 3.

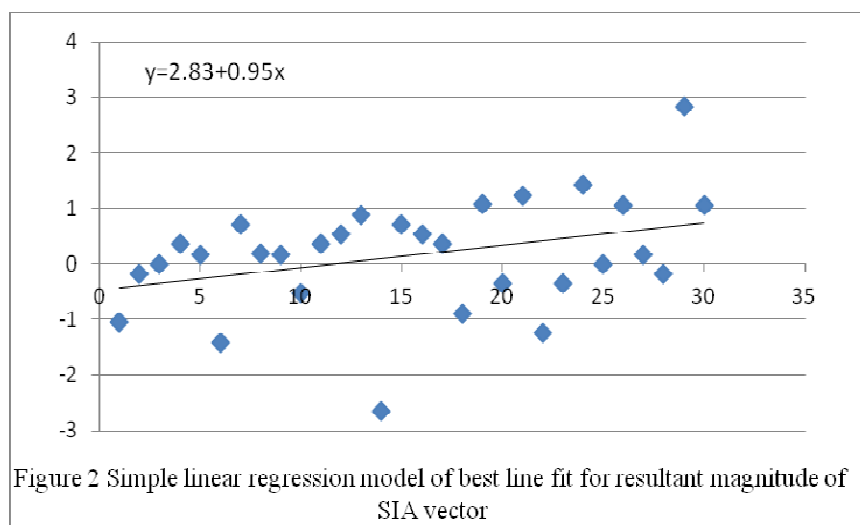


Figure 2 Simple linear regression model of best line fit for resultant magnitude of SIA vector

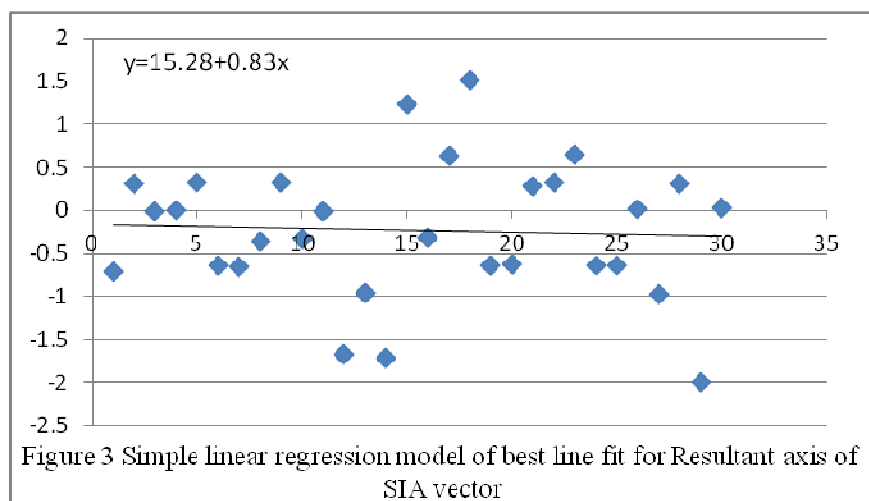


Figure 3 Simple linear regression model of best line fit for Resultant axis of SIA vector

126 Descriptive statistics of pre and postoperative magnitude with resultant magnitude of SIA vector in
 127 diopters is shown in Table 1. Descriptive statistics of axis pre and post operative axis with resultant
 128 axis of SIA vectors in degrees is shown in Table 2. Student t test performed to find out t values to
 129 know difference in the means. Statistical significant levels set at 0.05 *p* value. Regression equation
 130 employed to find out predictability of post operative SIA vectors. This is calculated from the
 131 equation $y = a + bx$, where 'y' is dependant variable, 'a' is intercept and 'b' is slope for SIA vector.

(Table 3) Validity was tested by comparing with existing SIA calculator version 1.1 and 2.1. Table 4 and 5 shows pre and post operative keratometric data of study patients and summarizing similarities and differences between SIA calculator 1.1, SIA calculator 2.1 and new SIA calculators.

Table 1 Descriptive statistics of pre and post operative magnitude of SIA vectors in diopters

(D)

n=30	Mean	Standard deviation	Standard error (SE)	Minimum	Maximum
Pre op magnitude	62.67 D	+/-2.40 D	1.03	56.93 D	67.20 D
Post op magnitude	62.83 D	+/- 2.29 D	0.47	57.11 D	67.20 D
Resultant magnitude of SIA vector	0.75 D	+/-0.68 D	0.19	0.00 D	2.83 D

Table 2 Descriptive statistics of pre and post operative axis of SIA vector in degrees (d)

n=30	Mean	Standard deviation	Standard error (SE)	Minimum	Maximum
Pre operative axis	89.74 d	+/- 1.37 d	0.29	86.99 d	91.96 d
Post operative axis	89.51 d	+/- 1.37 d	0.28	86.99 d	92.25 d
Resultant axis of SIA vector	0.60 d	+/- 0.48 d	0.33	0.00 d	1.72 d

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Table 3 Student t test results and regression equations for SIA vectors

	Resultant astigmatic magnitude	Resultant astigmatic axis
Pearson correlation (r)	0.91	0.83
Coefficient of determination (R^2)	0.82	0.68
Degree of freedom	29	29
T value	0.39	0.26
t critical one tail value	1.67	1.67
p value	0.59	0.11
Regression equation	$y=2.83+0.95x$	$y=15.28+0.83x$
Confident intervals	0.51 to 0.99	0.43 to 0.77

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150 Discussion

151 Present study attempted to design a new SIA calculator using Microsoft office excel 2007 functions
 152 and applied on 30 psuedophakic eyes intended for study on anterior corneal curvature analysis
 153 following temporal scleral incision cataract surgery.

154

155 Previous methods of surgically induced astigmatism were calculated from subtraction method, polar
 156 methods and vector method. Simple subtraction method involves subtracting the post operative
 157 average keratometric reading from preoperative reading that was insufficient to address overall
 158 change in anterior corneal curvature. Polar analysis of SIA is complicated and involves dioptric
 159 conversion in to plus cylinder form that involves laborious work up. Both polar method and vector
 160 analysis was followed for construction of SIA calculator version 1.1 and 2.1. Present calculator

construction is only based on vector analysis. Vector analysis of SIA is reliable and acceptable method since it takes into account of astigmatic magnitude expressed in diopters and astigmatic axis direction expressed in degrees.

Existing SIA calculator version 1.1 and 2.1 are used to evaluate single case and multiple case analysis although their theoretical aspects of analysis of SIA are similar. Simultaneous representation and measurement of astigmatic magnitude and axis add to the complexity of assessment that can be solved by applying principles of vector based system. Both these versions are based on astigmatic vector that assigned a position represented by x and y points.

Following equations were used to arrive at x and y values. $x = a \cos 2p$ (equation no. 1) where 'a' is the astigmatic magnitude and 'p' is the astigmatic axis and $y = a \sin 2p$ (equation no. 2) where p is doubled for astigmatic axis repeats. Before using these equations all keratometric data were converted into plus cylinder format, for example 44 D x195 and 43.5 D x75 translate to an astigmatic vector 0.5x165 degrees according to polar method. Essentially keratometric reading difference is taken as astigmatic magnitude and steep axis is taken as astigmatic axis. This transformation presupposes astigmatism where steep and flat meridians are at right angles as in the case in most people. Present calculator works irrespective of astigmatic axes.

Then x and y values are generated for both pre operative and postoperative data. Thus we now have x-pre, y-pre, x-post and y-post. To calculate SIA, preoperative values need to be subtracted from the post operative values to generate a new set of x and y values, to represent SIA vector. Therefore $x_{SIA} = x_{post} - x_{pre}$ (equation no. 3) and $y_{SIA} = y_{post} - y_{pre}$ (equation no.4).

These values are converted back in to astigmatic vector form that is achieved by using the following equations. Magnitude = square root of $x_{SIA}^2 + y_{SIA}^2$ (Equation no.5) and Angle = $0.5 \arctan$

(ySIA/xSIA) (Equation no.6). Halving of the angle was considered which reverts the doubled axis used for calculating back to 180 degrees astigmatic scheme. If xSIA <0 then to add 90 degrees and if xSIA is >0 but ySIA < 0 then to add 180 degrees was considered. After tabulation, mean values are X-pre, Y-pre, X-post and Y-post and to calculate mean SIA, Xsia =Xpost-Xpre and Ysia=Ypost –Ypre used. Now applying equations 5 and 6 we obtain a resultant astigmatic vector which is the mean SIA vector and is called centroid.

Present SIA calculator constructed on the basis of vector analysis since astigmatism constitutes cylindrical power and axis due to perpendicularity of its principle meridians in most of the cases. Pythagorean Theorem ($c^2=a^2+b^2$) for magnitude determination and trigonometric functions ($\theta=2\tan^{-1}\{Kh/Kv\}$) for axis determination used to arrive at astigmatic quantity and direction respectively. In this calculator each component of vector was dealt separately for ease of SIA calculations and understandings. The coordinates of right angle triangle was considered similar to keratometric horizontal and vertical meridians and assigned the same value to calculate hypotenuse which represents magnitude of SIA vector. Similarly axis was calculated from the equation $\theta=2\tan^{-1}\{Kh/Kv\}$ here the value was multiplied by 2 as astigmatic axis repeats itself in 360 degrees.

Resultant magnitude and axis of SIA vector calculated after subtracting pre operative values from post operative values. Pre and post operative astigmatic magnitude unchanged and resultant astigmatic magnitude was similar with narrow standard error of mean. (SEM) Resultant magnitude of SIA vector was 0.48 with narrowed standard deviation and SEM compared to SIA calculator version 2.1 that showed resultant magnitudes of 0.75 which is closure to the results of present new SIA calculator. Resultant astigmatic magnitude ranged from 0.00 diopters to 2.83 diopters in the present study. (Table 1)

Mean pre and postoperative axis of SIA vector seems to be similar with equivalent standard deviation and SEM. Resultant axis of SIA vector displaced by 0.60 degrees. Resultant axis of SIA vector was displaced in a range from 0.00 degrees to 1.72 degrees. (Table 2) Pearson's correlation coefficient and coefficient of determination showed high interrelationship for magnitude and axis of SIA vector. However there was no statistical significant difference discerned either of magnitude or axis of SIA vectors. (p 0.59, p 0.11) No significant difference perceived on comparing means of magnitude and axis of SIA vectors as the t values calculated from student t test unveiled less than the t critical one tail values. (Table 3) Analyses of resultant magnitude between SIA version 2.1 and present calculator was shown with pre and post operative keratometric data. (Table 4)

Linear regression analysis demonstrated data point's distribution closure to trend line that suggested best fit model line. Predictability assessed by substituting pre operative magnitude of SIA in place of independent variable 'x' in the regression equation $y=2.83+0.95x$. (Figure 2) Similarly for axis of SIA vector, predictability assessed by regression equation $y=15.28+0.83x$. Data points' distribution was not closure to trend line suggesting axis of SIA vector discrepancy as majority of data points scattering widely and sparsely. (Figure 3)

Working of new SIA software

Novel calculator consists of five excel spreadsheets named as pre op magnitude, post op magnitude, pre op axis, post op axis of SIA vector and lastly predictability equations. There are two equations in the new calculator for calculating resultant magnitude and axis of SIA vector while SIA version 2.1 constitutes 6 equations. Although theoretically vector is shown as containing magnitude and directions as constructed by SIA version 2.1 where as present calculator considers dealing magnitude and axis separately for SIA analysis as shown in the calculator. Although both calculators showed similar resultant axis while showing variations in resultant magnitude (table 5) however there was no statistically significant difference between two calculators (table 6)

By Simply entering horizontal and vertical keratometric values; automatically software calculates magnitude and axis of SIA vectors. Subtracting pre operative from post operative magnitude or axis of SIA vectors values arrives at resultant magnitude or axis respectively. Predictability for post operative magnitude and axis of SIA vectors can be calculated in the last spreadsheet. Innumerable patients' data entry can be performed with the present new calculator. Proposed formula can be applied in all Microsoft office excel software as calculator constructed on basic principles of vector analysis.

Other advantages of SIA version 2.1 Calculator may be also be used to analyze SIA for foldable lenses used through temporal approach and when calculating IOL power for toric IOL. A high value of coherence means that SIA value generated is truly representative of the whole data set not calculated with present calculator. Both calculators provided a detailed analysis presented on the pages entitled for detailed report and could be used when publishing scientific studies. Both calculators derived similarly with respect to resultant astigmatic axis calculations. Another difference is predictability equation deduced from regression formula to find out predicated post operative SIA vector is provided with new calculator while predictability equations were not considered in SIA calculator 1.1 and 2.1 versions. Other limitations of present calculator are centroid and coherence facilities which are available in SIA version 1.1 and 2.1 were not constructed.

Comparative analysis of new SIA calculator

Samar basak developed SIA calculator for single case (SIA soft version 1.1) and multiple case analysis (SIA soft version 2.1) based on vector analysis and reported 6.15 (+/-0.50) seconds to calculate SIA vector with software calculator method compared to 5.27 (+/-0.48) minutes by manual methods and recommended vector analysis is the gold standard for determining SIA. Mean astigmatic resultant magnitude of 0.48 diopters calculated on present calculator and 0.75 diopters

with SIA calculator version 2.1. (Table 5) However existing calculator did not show post operative predictability of magnitude and direction of astigmatic vector formulae for predication.¹

Dam johansen calculated SIA in 197 eyes and reported 0.61 and 0.77 diopters of astigmatic magnitude for 4 mm and 6 mm scleral tunnel phacoemulsification four months after surgery by vector analysis that exhibited different outcomes from the present study results which was performed irrespective of incision dimensions.⁵ Jauhari studied SIA on various incision sizes and reported a mean SIA vector of -0.88 (+/- 0.61) diopters at 90 degrees with inverted V incision that was statistically significant by SIA calculator version 2.1. Present study revealed 0.48 (+/- 0.38) diopters as resultant astigmatic magnitude irrespective of incision configuration.⁶

Mallik studied 110 eyes in superior and temporal incision manual cataract surgery cases and reported a mean magnitude of SIA vector of 1.45 (+/- 0.74) diopters in superior group and 0.75 (+/- 0.41) diopters in temporal incision category by SIA version 1.1 calculator with Z score of 5.71 with statistically significant difference. Similar values obtained from present new calculator for temporal incision cataract surgery, that revealed 0.48 (+/- 0.38) diopters as magnitude of SIA calculator. However statistical significant difference not found in the current study either for magnitude or axis of SIA vector.⁷⁻⁸

Marek reported 0.63 (+/-0.28) diopters of astigmatic magnitude for temporal phacoemulsification with 2.8 mm corneal incision with statistical significant difference comparable to the present study outcomes.⁹ Naeser demonstrated univariate and bivariate polar analysis method for SIA calculations and reported astigmatic magnitude of 1.02 diopters for 9 mm incision, 0.71 diopters for 5.5 mm and 0.64 diopters for 4 mm corneal incisions.¹⁰ Polar methods not analyzed in the present study. Ernest study of SIA following squared posterior limbal and clear corneal incisions during phacoemulsification revealed average 0.25 (+/- 0.14) diopters for 2.2 mm incision size. There was

no statistical significant difference between two types of incision sites similar to results of present study and SIA calculated from statsoft Inc ‘statistica’ software.¹¹⁻¹³

Ofir studied SIA by vector analysis for 2.4 mm corneal incision in 70 eyes and compared between three corneal measuring devices (Lenstar LS900, Haag-Streit, Koeniz, Switzerland; IOLMaster 500, Carl Zeiss Meditec, Dublin, CA; and Atlas topographer, Carl Zeiss Meditec) with similar results. Bausch and lamb keratometry used to assess SIA in the present study.¹⁴ Hala Ali reported a mean SIA vector or 0.5-0.7 diopters following small incision cataract surgery and recommended inclusion of measurements variation of biometric devices when interpreting the results, when calculating SIA using the doctor-hill.com online SIA calculator.¹⁵

Derya reported lower SIA values for superior limbal incision group on the basis of vector analysis although the difference was not statistically significant.¹⁶ Yoon reported mean SIA of 0.81 and 0.92 diopters respectively for temporal and nasal 3.0 mm clear corneal incision in bilateral phacoemulsification with equivocal astigmatic change at three months follow up.¹⁷

Kawahara study calculated astigmatism using the Alpins method that showed no statistical difference in mean SIA score between one handed and two handed phacoemulsification techniques however results indicated corneal side port in two handed cataract surgery had a torque effect on astigmatic axis.¹⁸ Denoyer recommended consideration of biomechanical features of cornea such as corneal hysteresis and corneal resistance factor for better predictability of refractive outcomes of cataract surgery.¹⁹

Limitations of study

Magnitude and axis of SIA quantified and studied irrespective of incision dimensions and configuration. Small sample size was chosen for new calculator application as a pilot study to

corroborate validity and predictability. Strength of new calculator is in determining accurate axis and post operative predictability of magnitude and axis of SIA vector.

In conclusion, new SIA calculator provided comparable results with existing calculators in addition to predictability judgment on astigmatic quantification and axis direction. Added value of present new SIA calculator is magnitude and axis separately dealt for ease of understanding and knowledge on predictability on post operative SIA vector was highlighted. Ophthalmic surgeons with fair knowledge concerning Microsoft office excel software 2007 are sufficient to enter their patients pre and post operative keratometric readings for appraising surgically induced astigmatic quantifications and provide maximum post operative visual rehabilitation with prescription of minimum amount of induced astigmatic error.

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Table 4 showing pre and post operative keratometric data of patients with comparative analysis

		Pre operative data		Post operative data		SIA version 2.1	Present calculator
Name	Age	Kh	Kv	Kh	Kv	Resultant magnitude	Resultant magnitude
Ananda murthy	61	42.75	43.75	41.75	43.25	0.5	1.06
Nagendra	58	45.25	45	45.25	44.75	0.25	0.18
Mangalamma	75	46.25	48.75	46.25	48.75	0	0
Javaramma	70	45	44.25	45.25	44.5	0	0.35
Mahadevamma	46	44	44.5	44.25	44.5	0.25	0.18
Boregowda	65	45.5	45.5	44.25	44.75	0.5	1.41
Basavanna	65	44.5	43.5	44.75	44.25	0.5	0.7
Honnaboregowda	70	39.75	40.75	39.75	41	0.25	0.18
Shilaja	35	44.25	45.25	44.5	45.25	0.25	0.18
Leela	63	43.5	43	43	42.75	0.25	0.53
Channabasappa	58	45	44	45.25	44.25	0	0.35
Mahadevamma	60	43.25	42.25	43	43.25	1.25	0.53
Prabhudev	68	43	43.75	43.25	44.75	0.75	0.89
Subramanya	41	44	44.5	41.5	43.25	1.25	2.6
Nagamma	61	46	45.75	47	45.75	1.00	0.71
Nagendra	58	45.75	45	46	45.5	0.25	0.53
Ananda chary	63	44.75	45.25	45.25	45.25	0.5	0.35
Veerajamma	68	45.5	47.75	45.5	46.5	1.25	0.9
Veeresh	49	41	42.5	41.5	43.5	0.5	1.07
Krishnaveni	60	46	47.75	45.5	47.75	0.5	0.35
Basavanna	60	44.5	43	45.5	43.75	0.25	1.24
Channabasappa	57	45.25	45.5	44.5	44.5	0.25	1.24
Mahadevamma	54	44	44.5	44	44	0.5	0.36
Sundramma	58	44.75	44.5	45.5	45.75	0.5	1.41
Bhagyamma	61	45	43.5	44.75	43.75	0.5	0
Honnaboregowda	70	39.75	40.75	40.5	41.5	0	1.06
Thimmamma	65	44.25	43.5	44	44	0.75	0.18

Puttamadamma	64	45.75	46.25	45.75	46	0.25	0.18
Vasanth kumara	59	43	42	44.25	44.75	1.25	2.83
Aktha Begum	67	45	46.25	45.75	47	0	1.06

Table 5 Summarizing features showing SIA calculator version 2.1 and present calculator for astigmatic magnitude

	Principle	equations	Z score	P value	Mean magnitude	Standard deviation
SIA version 2.1	Vector system	6 equations	-1.4119	0.16	0.46 D	+/- 0.38 D
New calculator	Vector system	2 equations	-1.4119	0.16	0.75 D	+/- 0.68 D