“ROLE OF ‘A’ SCAN IN PREDICTION OF INTRAOCULAR LENS POWER- A ONE YEAR CROSS SECTION STUDY”

By

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DISSERTATION

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IN

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Under the Guidance of

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" Arise ! Awake ! And stop not till the goal is reached"

-Swami Vivekanand.

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Dr. SHIVAKUMAR G. HIREMATH

LIST OF ABBREVIATIONS

ACIOL	Anterior chamber intraocular lens
AXL	Axial length
D	Diopter
DC	Diopter cylinder
DS	Diopter spherical
IOL	Intraocular lens
IOP	Intraocular pressure
K	Keratometry reading
m/s	Metres per second
PCIOL	Posterior chamber intraocular lens
Wks	Weeks

ABSTRACT

INTRODUCTION

Cataract is the most common curable cause of blindness in India. Today's cataract surgery occurs at an earlier age and with implants for monofocal and multifocal corrections, patients now anticipate excellent '**uncorrected acuity**', not just improved '**best corrected vision'**. This expectation places increased importance on accurate biometry and intraocular lens (IOL) calculations.

OBJECTIVE OF THE STUDY:

To assess the accuracy of 'A' scan unit in determining intraocular lens power.

METHODOLOGY

One hundred and twenty patients undergoing cataract surgery, at KLESPKH and Medical Research Centre, Belgaum were taken in the study.

Prior to the surgery a complete ocular examination was done including measuring the intra-ocular pressure and patency of lacrimal drainage system. Routine pre-operative investigations were done and pre-operative medications were given to all the patients. Keratometry was done using Bausch and Lomb type keratometer. The axial length was measured with Appasamy(Appascan2000) A scan unit,

Retinoscopy was done at 6^{th} week post-operatively and the readings were recorded. The post-operative refraction was taken as spherical equivalent.

OBSERVATIONS AND RESULTS

The results of this study showed that the predictive error varied in the range of +/-1 in 82.5% of patients, +/-2 in 95.0% of patients and +/-3 in 100%. Out of 120 patients

48% had the best corrected visual acuity of 6/9 and of these subjects 41% were in the age group of 51-60 years .

CONCLUSION

Biometry is definitely essential and accurate in calculating intra-ocular lens power. A careful selection of intraocular lens power might reduce unexpected surprises but will not eliminate them and both the patient and the surgeon should be prepared for the same.

Key words: A-scan, intraocular lens power calculation, post-operative refraction**.**

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INTRODUCTION

Cataract is the most common curable cause of blindness in India. Cataract removal and intraocular lens implantation is one of the most successful ophthalmic surgical procedures of today.[1]

In the 1st year of intraocular lens implantation, surgeons determined IOL power on the basis of the predictions using old spectacle prescriptions or sometimes implanted a single "**standard**" power IOL in all patients. With increasing sophistication of cataract surgery, accurate determination of the patient's post-operative refractive status has become one of the principal determinants of successful cataract surgery. The ideal goal is to achieve post-operative good, unaided distant vision.[2]

With increased safety of the procedure itself, cataract surgery is now being performed in patients who have less visual disability than several years ago. Today's cataract surgery occurs at an earlier age and with implants for monofocal and multifocal corrections, patients now anticipate excellent '**uncorrected acuity**', not just improved '**best corrected vision'**. Because patients have come to view cataract surgery as both, a rehabilitative and refractive procedure, surgeons for better or worse are now being judged mainly for their refractive outcomes. This expectation places increased importance on accurate biometry and intraocular lens (IOL) calculations.[3]

The pre-operative calculations of intraocular lens power today, are an established technique which is being adopted by ophthalmic surgeons world-wide. A number of factors can affect the outcome including keratometry errors, positions of IOL

& intraocular lens power calculating formulae, but accurate axial length measurement is as important as any of the other factors to achieve the desired post-operative visual acuity.[4]

Since the lens implantation is a one-time surgery, the refractive power of pseudophakos is final & patients will have to live with any mistakes committed or be subjected to unnecessary 2nd operation namely exchange of IOLs.

So, an accurate estimate of power of the lens to be implanted in each patient assumes paramount importance.

OBJECTIVE OF THE STUDY:

To assess the accuracy of ‘A’ scan unit in determining intraocular lens power.

REVIEW OF LITERATURE

It was on 29 November 1949, Sir Harold Ridley a noted British Ophthalmologist made history by implanting the first intraocular lens, after performing an extra capsular cataract extraction. At the same time he unwittingly opened the door to the subject of IOL power calculation as his patient's post operative refraction was -12.0 DS +6.0 DC X 30^{o}.[5]

The least accurate method of determining IOL power is simply to implant the same strength ("**standard**") lens in every patient. This can often result in unacceptable large post-operative residual refractive errors.

A second method which utilizes the concept of the patient's basic refraction is slightly better, but is really an educated guesswork. With the basic refraction method, a careful history, examination of old glasses, past records and clinical examination are used to determine the patients basic refraction prior to the development of a significant cataract. An 18 dioptre (D) IOL power is used as a base value that is estimated to restore the eye to the basic refraction value. For each diopter hyperopia or myopia of the basic refraction, 1.25D of IOL power is added or subtracted respectively to that 18D basic implant power.[10] The use of this '1.25D rule' assumes that the dioptric effectivity of the IOL is 25% higher than spectacle correction. With this basic refraction method, 10 D of inadvertent residual refractive error may occur. Therefore this method must also be considered unacceptable.

The two most accurate methods of predicting correct implant power are the use of theoretical & empirical formulae.

It was in 1967, when Fyodorov, Russian presented a theoretical formula based on geometric optics utilizing keratometry and A scan ultrasonography.[5]

A variety of formulae followed that of Fyodorov; the best known are Binkhorst, Colenbrander, Shammer & Van der Heijde.

In 1980, Sanders, Retzlaff and Kraff published regression formulae for power calculation based solely on predictive factors known pre-operatively. The technique of regression analysis analyses the relationship between a dependent or criterion variable (implant power for emmetropia) & a set of independent or predictor variables (pre operative axial length and keratometry measurements) to produce a formulae that fits the given data. The SRK formula unlike the theoretical formulae, is based on the observed relationship between the pre-operative variable (axial length & Keratometry readings) and actual results (implant power required to achieve emmetropia).

Keratometry

Hermann Von Helmholtz (1821-1894), a noted physicist and physiologist, is credited with the development of the 1st Keratometer. Improvements & refinements were made in late 19th century by Javal, Schiotz & others.[6]

Keratometry is the measurement of curvature of the anterior surface of cornea across fixed chord length, usually 2-3mm, which lies within the optical spherical zone of the cornea. Measurement of corneal curvature by Keratometre plays a critical role in the accuracy of the intraocular lens power calculation. A 1.0D error in Keratometry readings results in 0.9 D error in intraocular lens power.

Keratometry is based on the fact that anterior surface of the cornea acts as a convex mirror and the size of the image formed varies with its curvature. The greater the curvature of the cornea lesser is the image size.[7] It can be done by manual or automated method.

Presently there are two manual Keratometers:- The Bausch & Lomb and Javal Schiotz Keratometer. Both project a pair of illuminated mires on the corneal surface & use targets of known size & distance of reflecting mires. The reflected mires from steeper surface are smaller & closer than those from flatter surface.

The image is seen as an object by Keratometer & can be measured within the instrument, the instrument can be calibrated to read the radius of curvature directly. The refractive power in diopters can be calculated by the following formula.

$$D = \frac{(n-1)}{r}$$

Where n is index of refraction of the cornea.

r is radius of curvature in metres.

AXIAL LENGTH MEASUREMENT

The ultrasonography denotes a single diagnostic procedure where we have different modes of examination eg; A, B, C modes.

The ultrasonic transducer is most important component of A-scan measurement device. It is capable of both sending and receiving signals. When a crystal is struck by an electric force, it vibrates producing a sonic pulse that can be focused and directed into ocular tissue. Conversely, when the crystal is mechanically disturbed by returning sonic echo, the mechanical distortion can be changed into electrical signal. With A- scan ultrasonography, the transducer is struck electrically and then quickly dampened to allow detection of weak returning echo from the focused sonic pulse. The cycle is repeated thousands of times per second. Because the speed of sound in ocular tissue is known, distance calculation is possible based on the amount of the time required for sonic waves to travel to target and return. Thus ultrasonic measurement relies on the conversion of measured time interval between echoes into distance based on the speed of the sound in the ocular structure that the ultrasonic sound pass through. The speed of the sound in aqueous and vitreous is 1532 m/s; through the normal clear crystalline lens is 1640m/s and through a cataractous lens is between 1590 & 1670m/s.

There are two basic systems or methods of ultrasonic axial length measurement

1. Immersion method
2. Applanation method[9]
    a. Applanation using slit lamp
    b. Hand held method

IMMERSION METHOD

This method employs a small water bath to avoid placing probe directly on the cornea. The immersion technique is generally performed with the patient reclined close to the screen. After topical anaesthetic drops are instilled, a small cylinder (scleral shell) is inserted between the lids and filled about 2/3rd by methyl cellulose. Air bubbles in the methyl cellulose should be avoided, because the presence of air bubble causes variation in the speed of the sound and is responsible for noise formation within ultrasound pattern.[8]

Using high gain setting initially examiner immerses the probe into the fluid just until an echogram is displayed. With the patient fixating on the target in the primary gaze, the sound beam is directed perpendicular to the centre of the cornea along visual axis. This results in display of double peaked corneal spike and single peaked spike from anterior and posterior lens surface, retina and sclera. Once steeply rising highly reflective spikes are displayed from these interfaces at high gain, the decibel level is reduced slightly for improved resolution. As the gain is turned down, the displayed spikes decrease in height necessitating close observation of the screen to ensure that all spikes remain as high and distinct as possible. It may be necessary to adjust the position of the probe during this procedure to maintain perpendicular sound beam incidence.

Advantages

1. Not touching the cornea prevents inaccurate reading due to corneal compression
2. Display of a separate corneal spike may facilitate the alignment.

CONTACT METHOD

In this method probe is placed gently on the centre of the cornea & sound is directed towards macula. This technique can be performed either by placing the probe in chin rest device (slit lamp) or by holding the probe in the hand (hand held).

Applanation using slit lamp

In this method, a chin rest apparatus is used, with the probe secured within holder or sleeve. If available, pressure sensitive probe holder can be used to help minimize the corneal compression. The patient is seated upright, with the chin positioned firmly in the chin rest and forehead pressed against headrest. The patient is instructed to fixate in the primary gaze at tiny fixation light located within the centre of the probe tip. Initially, joy stick is retracted as far away from the eye as possible. The joystick is advanced until the probe gently touches the centre of the cornea.

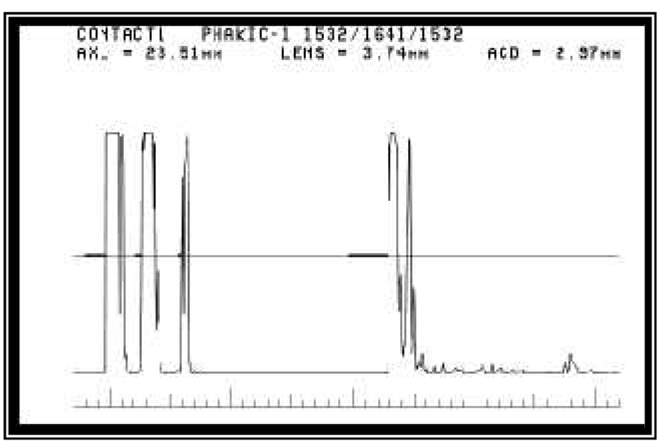
Hand held method

In this method, extra caution must be employed because cornea is more easily compressed.

Contact method Using slit lamp(I)

Contact method hand held(II)

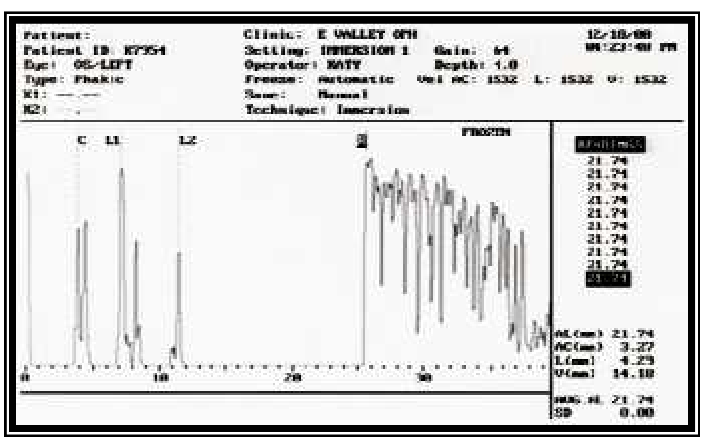
Contact method-Graph(III)



Immersion method (IV)

Scleral shell(V)

Immersion-method-Graph-VI



Methods of intraocular lens power calculation

The methods used to calculate IOL power can be broadly classified into 2 categories

1. Method based on basic refraction
2. Method based on measurements.

Estimation of IOL power based on basic refraction

The estimation of the strength of the intraocular lens to be implanted on the basis of the primary refraction is far less accurate than if one calculates the lens power on the basis of measurements.

It depends upon whether primary refraction is known or not.

1. Known primary refraction

Known primary refraction means the refractive error present before cataractous changes developed in crystalline lens. Cataract especially nuclear type often causes a shift to myopia. To discover the primary refraction a careful history has to be taken, including the type of glasses patient is wearing. One must also carefully evaluate the patients previous activities to ascertain his past visual needs, which have to be matched with refractive history.

2. Primary refraction unknown

When it is impossible to determine the primary refraction, especially if one cannot visualize the fundus, prediction of IOL power may go wrong. Therefore if primary refraction cannot be ascertained beyond doubt, one has to then determine the axial length with ultrasound for accurate prediction of IOL power.

Idem lenses

It is known that a +20D (diopter) lens in the posterior chamber adjacent to iris usually restores the primary pre-operative error. This is called "idem lens".

Gernet & Zorkendorfer have shown that refractive power of natural lens is +23.7D. The cardinal plane of this lens is approximately 6mm behind the corneal apex. The distance for cardinal plane of posterior chamber IOL is less. In order to focus the parallel rays of light on the retina, it must be weaker than the natural lens.[11]

Limitations

A +20D artificial lens in the posterior chamber will restore the pre-operative refractive error only if the natural lens is about +23.70D. This is not always the case. The refractive power of an eye is result of the combination of different factors, such as corneal power, distance of lens from the cornea, dioptric power of lens and axial length.

Rule of thumb for idem lenses[11,12]

Description of lens		**Power in diopters**
1. Angle supported lens	AACL	+17
2. Iris clip lens	ACL	+18
3. Iris plane lens		+19
4. Lens in the posterior chamber close to iris, convexity of optics facing forwords	PCL	+20
5. Posterior chamber lens with nodal point closer to retina than the PCL	PPCL	+21
6. Posterior chamber with the haptic angulated	PPPCL	+22

forwords & convexity of optic towards the retina		

Therefore using the primary refraction as a basis to determine the IOL power to be implanted entails the possibility of significant errors. Deviation of 2.0D is common and more than 3.0D not rare.

Emmetropia lenses

Here eye is made emmetropic post-operatively by a rule, that is based on primary refraction. The rule is defined in mnemo-technical formula.

Rule: In farsightedness, add the primary refraction to and in nearsightedness subtract it from +20.0D that is the idem lens.

In reality one to one relation is not correct. Generally 1.1 to 1.4D have to be added or subtracted from 20.0D for every diopter of primary refraction. A work compromise 1:1.25 ratio has proved useful.

Standard lenses

The standard lens is one that is approximately 2.0D stronger than the idem lens. There by rendering the pseudophakic eye about 1.5D myopic compared to primary refraction. Because these lenses are most commonly used implants, they are called “standard lens”.

The standard lens for PCIOL is +22.0D

ACIOL is +20.0D

One has to know, however that the standard lens is good only for a minority of, but by no means for all eyes.

Iseikonic lenses

The image of an object on the retina of an aphakic eye becomes larger, in proportion to the distance of the corrective lenses from the retina. The difference of magnification is called aniseikonia.

A large disparity of the retinal image size can cause diplopia and asthenia. Image size is dependent upon the axial length and optical power. According to Gernet et al,more than 5% aniseikonia is not tolerable.

Selection of iseikonic lenses[11]

1. Iseikonia is clinically important only if patient has binocular vision.
2. The determination of a lens power is on the basis of primary refraction.
3. PPCL doesn’t seem to lead to aniseikonia

Calculations of power of Intraocular lens to be implanted based upon measurement

The human eye is an optical instrument that combines two light elements: anterior surface of the cornea and crystalline lens.

The power of the lens to be implanted can be calculated if the following values are known:

1. The refractive power of anterior surface of cornea.
2. The distance of the retina from the anterior surface of cornea.
3. The anticipated distance of IOL from the anterior corneal surface.[13]

1. The refractive power of anterior surface of cornea.

It is the most important refractive part of the eye and could be accurately calculated from radius of curvature of anterior surface. It is measured with the help of keratometer or ophthalmometer.

$$P = \frac{(N-1)}{R}$$

Where P-power of cornea

N-refractive index of cornea

R-radius of curvature

Most keratometers use an arbitrary refractive index[14]

1.3375 by Haag-Steit,& Bausch&Lomb

1.336 by American optical

1.332 by Gambs

The implant for emmetropia is decreased by 0.9D for every 1.0D decrease in K –reading[15]

2. The distance of the retina from the anterior surface of cornea.

Axial length of the eye from anterior surface of the cornea to macula, is measured with ultrasonic unit (A-scan). Tissue of different density creates peaks of high amplitudes on the echogram. These are utilized for measurement of length.

A 1mm error in axial length leads to refractive error of 2.5D.

3. The anticipated distance of IOL from the anterior corneal surface.

(ANTERIOR CHAMBER LENGTH)

Anterior chamber depth is calculated from anterior surface of the cornea to apex of crystalline lens or artificial lens by ultrasound biometry.[24] The anterior chamber length is least important factor affecting the IOL power calculations. An error of 1mm affects post-operative refraction by approximately 1.0D in myopia, 1.5D in emmetropia & up to 2.5D in hyperopic eyes. Pre-operative measurement of anterior chamber depth is of little importance and actual position of IOL after surgery cannot be accurately predicted.

Average post-operative anterior chamber depth according to IOL style

Anterior chamber lens	
Plano-convex, vaulted	2.8-2.9 mm
Biconvex , non vaulted	3.2-3.3 mm
Iris supported lens	3.3-3.5 mm
Posterior chamber lens	
Fixated in the sulcus	4.0-4.1 mm
Fixated in the bag	4.3-4.5 mm
With convex posterior surface	5.1-5.3 mm

Theoretical formulae for implant power prediction

All the theoretical formulae for the IOL power calculation are based on the 2 optical system, the cornea and pseudophakos lens focusing the images on the retina.

Required measurements

L-Axial length

C-Post-operative anterior chamber depth

K-Corneal power

R-Radius of curvature

The different formulae are in fact identical, except for small correction factors. They can be algebraically transformed to

$$P = \frac{N}{(L - C)} - \frac{NK}{(N-KC)}$$

Basic theoretical formulae

Colenbrandr's, Fyodorov's and Von der Heilds formulae yield approximately same IOL power for emmetropia. Binkorst's yields a 0.5D stronger lens power.

Modified theoretical formulae

Hoffer's formula

Shanmaar's formula

Binkhorst's adjusted formula

Resultant refractive error

The resultant post-operative refractive error after the insertion of IOL with a certain power can be predicted before surgery by either Hoffer's formula or Binkhorst's formula.

Drawbacks;

1. Predict too large value in shorter eyes and too small in long eyes
2. Cumbersome to apply
3. Requires a guess about the anterior chamber depth.

Regression formulae

These are derived empirically from retrospective computer analysis of data on a great many patients who have undergone the cataract surgery. A new number of regression formulae are available. The commonly used are SRK formula and its modifications.

SRK I

In 1980 Sander's, Ritzlaff and Kraff proposed this formula

P=A-2.5L-0.9K[16]

P=IOL Power

A=Constant specific for each IOL

L= Axial length in mm

K= Average keratometry on dioptres

It performs well for eyes with axial length of 22to 24.5mm, it tends to predict too small value in small eyes and too large value in long eyes. To address this problem SRK I formula has been modified twice.

SRK II

It is same as SRK1 except A-constant is modified on the basis of axial length as follows.

If L is<20mm ;	A+3
20-20.99mm;	A+2
21-21.99mm:	A+1
22-24.5mm:	A
>24.5mm:	A-0.5

MODIFIED SRK 2

In this formula, A -constant is modified as follows

If L<20mm:	A+1.5
20-21mm:	A+1.0
21-22mm:	A+0.5
22-24.5mm:	A
24.5- 26mm :	A-1.0
>26.00mm:	A-1.5

SRK-T

It is a non linear theoretical optical formula empirically optimized for post-operative anterior chamber depth, retinal thickness and corneal refractive index. It combines the advantage of both the theoretical and empirical analysis. This formula is used for extremely long eyes >28mm.

Holladay formula

It is non linear, second generation theoretical formula. It is being considered more accurate because of its enhanced ability to predict the position of the implants.

Biometry in special conditions

1. Biometry in aphakia

In aphakia, sound travels at the speed of 1532 m/s (while in cataractous lens eye-1550m/s). The two lens spikes are absent in these cases or may be replaced by single spike obtained by anterior vitreous face. The immersion method is the method of choice in aphakic eyes.

2. Biometry in pseudophakic eyes[17]

It is required in those cases needing an IOL exchange. Such eyes have an extremely high spike at the lens followed by artificial chain of reduplication of the echoes which can be misinterpreted as spike from the retina. This can be avoided by lowering the gain which eliminates the artificial spikes and increase the retinal gain. In pseudophakic eyes speed of sound depends on the transmission characteristic and centre thickness of IOL.

2. Biometry in vitrectomized eyes[18]

In vitrectomized eyes sound attenuation within the liquid silicon causes the retinal spikes to be small and confusing to identify. The difficulty can be overcome by increasing the "system gain".

4. Biometry in high myopia and hyermetropia

The biometrist should look at the refraction and keratometer reading prior to axial length measurement. Special care must be taken not to indent the cornea especially in short eyes, since small axial length error result in proportionally larger refractive errors. High myopia is often associated with posterior staphyloma.

5. Biometry in previous keratectomy[19]

The proper optical corneal curvature value for use of implant power calculation in radial keratectomy is best determined by taking per-operative K-value and subtracting the refractive change induced by keratectomy.

6. Pediatric biometry and IOL power calculation [20,21,22]

Axial elongation and changes in the corneal curvature are the major factors influencing the refractive changes in the 1st few years of life. Dahan et al. suggested a very practical approach. The K-reading in newborn are ignored and replaced by average adult K-reading (44D). IOL power suggested for

21mm is 22.0D

20mm is 24.0D

19mm is 26.0D

18mm is 27.0D

17mm is 28,0D

Factors affecting the accuracy of implant power selection

Following factors are contemplated upon during implant power selection:

1. Life style: Active patients are best served by near emmetropia and sedentary patient may prefer myopia.[23]
2. Aim for emmetropia in a high hyperopic eye and towards slight myopia in high myopia.
3. Compromise between isometric and iseikonic lens power if fellow eye has good vision with no cataract.
4. Select implant power that minimizes the post-operative anisometropia and limit the problem due to aniseikonia.
5. Allow for error of approximated 1D in either direction from calculated value.
6. Avoid using lens power too far from normal range.
7. The refractive power of the fellow is noted.
8. Recommendation for selection of IOL in the operating room.
   A. The surgeon himself and responsible assistant should personally select the primary and back implants.
   B. IOL power and style to be implanted should be mentioned in the OT sheet against the patient name and fixed on the operating table.
   C. OT staff should be made aware of the importance of the implant power.
   D. Corresponding ACIOL power should be calculated pre-operatively for use in case needed.
   E. Before implantation the assistant and surgeon must recheck the IOL power.

9. Surgical technique: Lenses in the capsular bag are located more posteriorly, this necessitates approximately 0.50 to 0.75D stronger lens. Inserting the implant convex side backwards also necessitates a 1.0-1.25D stronger power lens.

METHODOLOGY

One hundred and twenty patients undergoing cataract surgery with posterior chamber intraocular lens implantation were selected for the study during the period of 1 year. All the patients attending the Department of Ophthalmology at KLESPKH and Medical Research centre, Belgaum were taken in the study.

The patients with ocular disease like uveitis, glaucoma, hypertensive retinopathy, diabetic retinopathy were excluded from the study. The patients with intra-operative and post-operative complications were avoided. The patient in whom post-operative refraction cannot be assessed due to various reasons (e.g poor compliance patients) were also excluded from the study.

Prior to the surgery a complete ocular examination was done including measuring the intraocular pressure and patency of lacrimal drainage system.

Routine pre-operative investigations were done and pre-operative medications were given to all the patients.

Depending on the patient's occupation and refraction of the other eye the desired the post-operative refraction of the patient was derived.

Keratometry was done using Bausch and Lomb type keratometer. The readings were recorded in diopters as follows.

1. Explain to the patient in simple language, the purpose of the measurement. Direct the patient's attention towards the procedure itself.

2. Position the patient comfortably in the chin rest, with the forehead snug against the head rest and chin in the vertical plane.
3. Provide the patient with the fixation target and direct them to gaze steadily at it. If the vision in the eye is being tested is very poor, it may be necessary to use the opposite eye for fixation.
4. Dim the room lights for easy visualization of the mires.
5. Turn the eyepiece so it is focused for the examiner's eye.
6. Turn the dials on the keratometer until the mires are properly superimposed. Remember the readings, write them on the paper.
7. Turn the dial to un-focus the mires and repeat step 6 until 2 readings are obtained in each meridian that are within 0.12D.
8. For significantly toric corneas (> 3Dof astigmatism or difference between K1 and K2), the keratometer should be rotated 90 degrees. Measure the vertical meridian with plus "+" mire because it is easy to visualize and superimpose.

The axial length was measured with Appasamy (Appascan2000) A scan unit, as follows.

1. Explain to the patient, in simple terms, the purpose of the A-scan and direct their attention to the procedure itself.
2. Insert a drop or two of the topical anesthetic. Ask the patient to blink once or twice and wipe any excess tears. The patient's eye should not contain the excess tears as it may form the "fluid bridge" to the end of the transducer and cause falsely long axial length measurement.

3. Position the patient in a semi-reclined position in the examination chair with the head secured in the headrest. Position the patient so that the screen can be seen with the minimum movement by the examiner.
4. Hold the transducer in the preferred hand. Rest the heel of the palm on the patient's face for stability.
5. Instruct the patient to gaze steadily at a stationary fixation target. Hold the lids open. It may be necessary for assistant to help with the lids.
6. Slowly bring the transducer in contact with the cornea. Ensure that transducer is in contact with the cornea. Ensure that the transducer is aligned exactly along the visual axis.
7. Do not leave the transducer on the cornea for more than 10 seconds. Do not slide the transducer on the cornea. If repositioning is necessary, pull the probe back away from the cornea, realign and then re-establish the contact.
8. Observe the screen for the good graph, repeat the procedure to obtain 3 reading, take the average.

The intraocular lens power is calculated using SRK II formula.

The intraocular lens power for emmetropia which was in fraction was rounded of to the nearest 0.5.

All surgeries were carried out by single surgeon, department of ophthalmology KLESPKH, Belgaum.

Retinoscopy was done at 6th week post-operatively and the readings were recorded. The post-operative refraction was taken as spherical equivalent.

The absolute difference between estimated refraction and actual refraction was calculated for all eyes and this was termed as predictive error.

The results are tabulated and analyzed.

RESULTS

In this study 120 patients were operated and the following observations were made.

Table 1: Sex wise distribution of cases

Sex	No. of Cases	Percentage
Male	54	45%
Female	66	55%

In the above table sex wise distribution of cases and incidence is shown. Out of total 120 cases studied, 54 were males (45%) and 66 were females (55%)

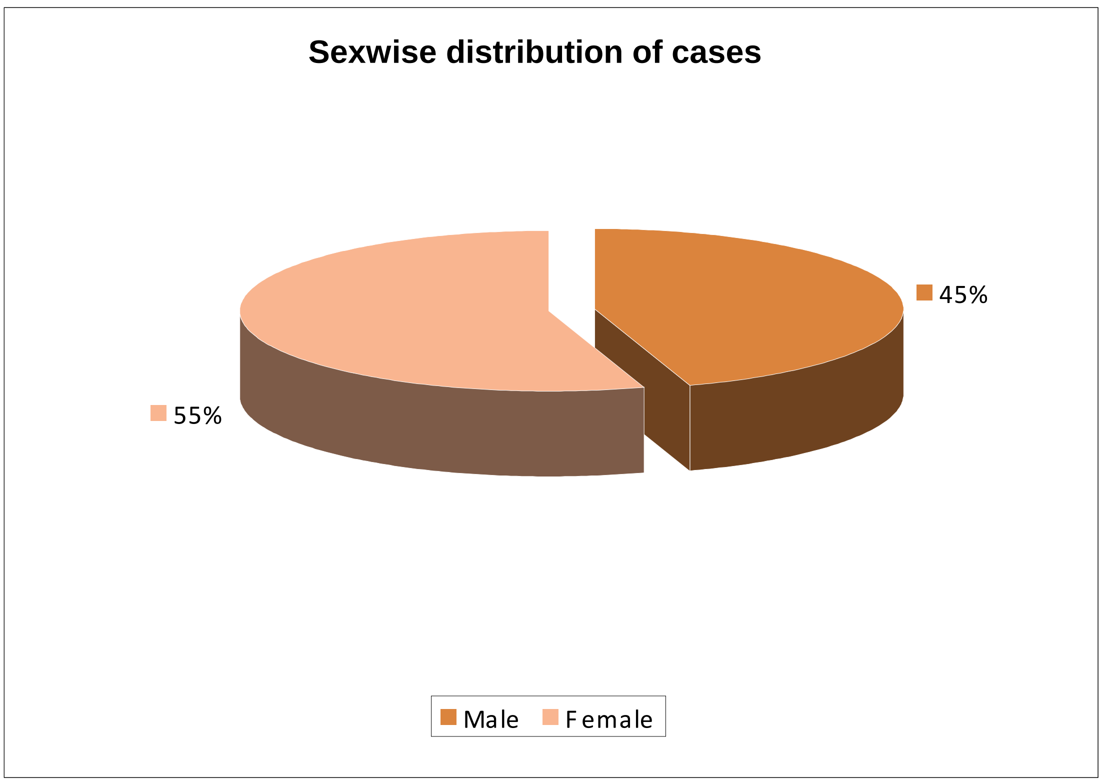


Table 2 : Table showing laterality

Laterality	No. of Patients	%
RE	68	56
LE	52	43

This table shows laterality of the patients in this study.

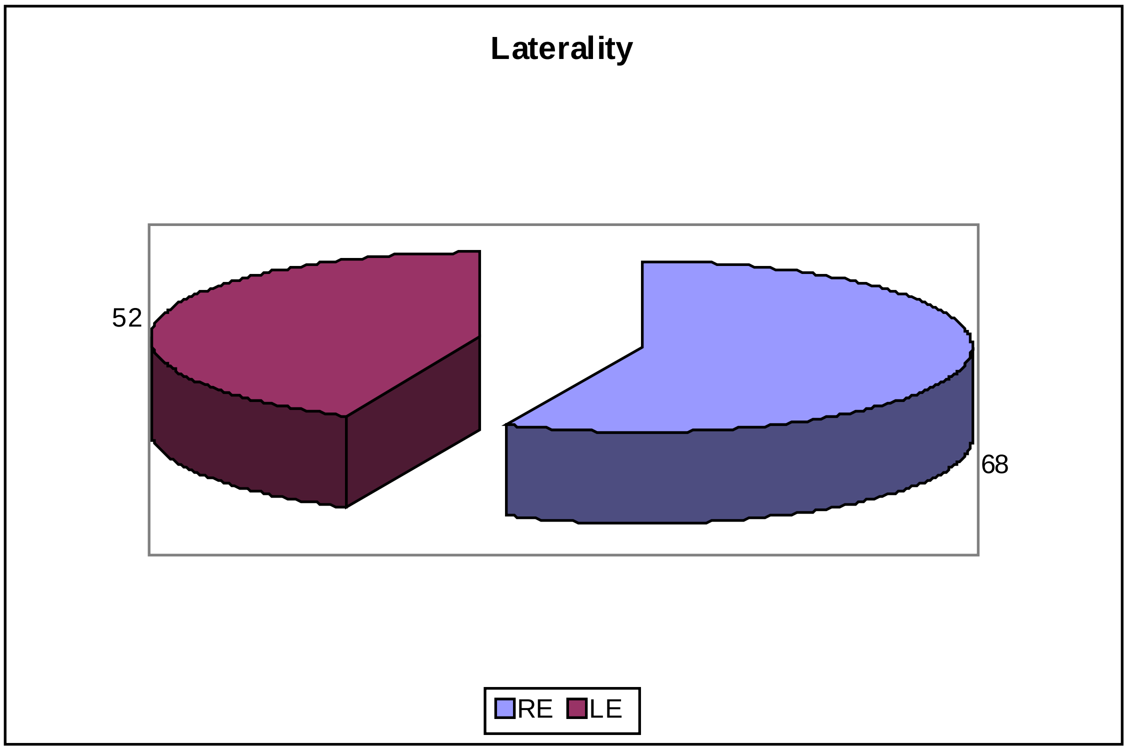


Table -3 Age-wise distribution of cases

Age group	No. of Patients	%
31-40	02	1.6
41-50	04	3.3
51-60	48	40
61-70	44	36.7
71-80	17	14.2
81-90	05	4.2

Table 3 Shows age wise distribution of cases. Of the 120 cases studied maximum cases were in the age group of 51-60yrs(40%), and the minimum cases were in the age group of 31-40(1.6%).

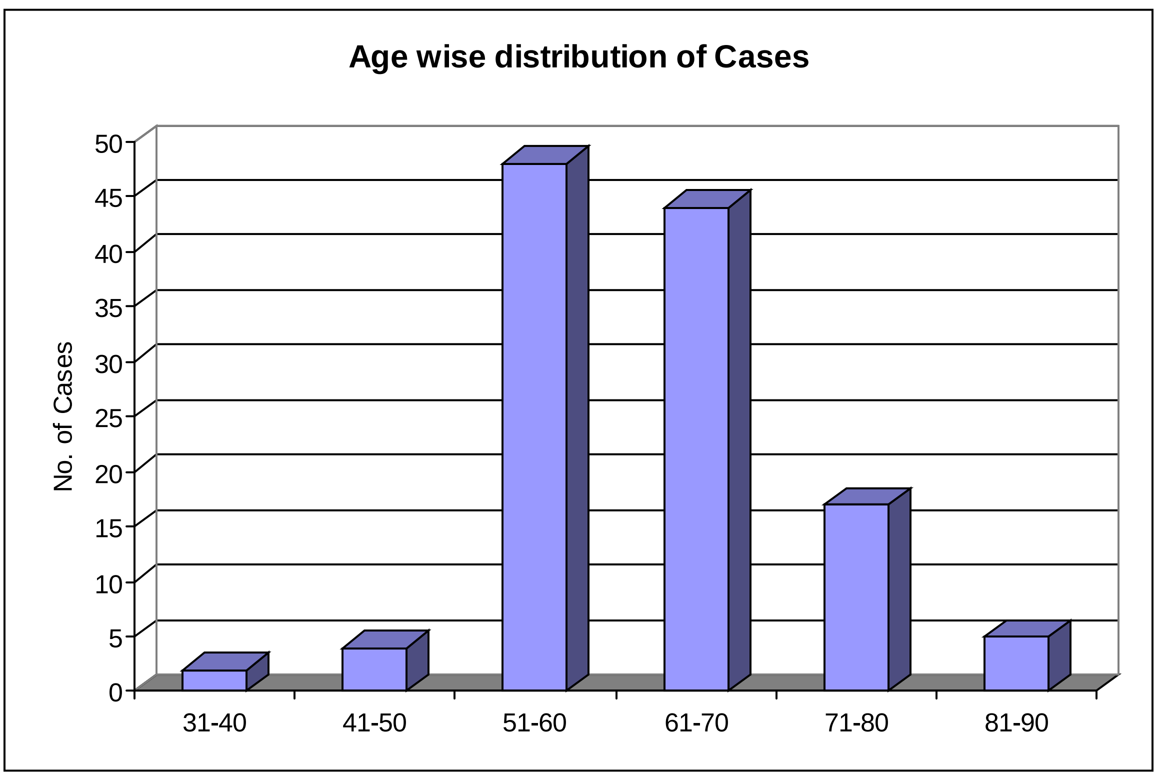


Table 4 : Range of parameters

Parameter	Minimum	Maximum	Average
Keratometry	40.00D	47.62D	43.92D
Axial length	20.33mm	25.08mm	23.00mm
IOL Power	+14.00D	+27.00D	20.90D

This table shows the three parameters used in the study. They are keratometry, axial length and IOL power and the average of the parameters obtained in the study.

Keratometry readings fell in the range of 40.0D and 47.62D. Axial length varied from minimum of 20.33mm to maximum of 25.08mm. The IOL power used in the study ranges from +14.00D to +27.00D.

Table 5 : Power of intraocular lenses used in the study

Power(D)	No. of patients
+14.00	02
+14.50	01
+15.00	00
+15.50	00
+16.00	00
+16.50	00
+17.00	01
+17.50	01
+18.00	03
+18.50	06
+19.00	07
+19.50	07
+20.00	13
+20.50	09
+21.00	17
+21.50	15
+22.00	13
+22.50	05
+23.00	07
+23.50	05
+24.00	06
+25.00	01
+26.00	00
+27.00	01

In the above table, the maximum number of intraocular lenses used in this study were +21.0D.

Table 6 : Estimated post-operative refraction

Estimated refraction	No. of patients	%
Emmetropia	48	40
Myopia	68	56.7
Hyperopia	04	3.3

This table shows the estimated post-operative refraction in this study. In 68 of cases, (56.7%) the estimated post-operative refraction was myopia, 48 of cases (40%) it is emmetropia and rest 4 cases, (3.3%) the estimated post-operative refraction is hyperopia.

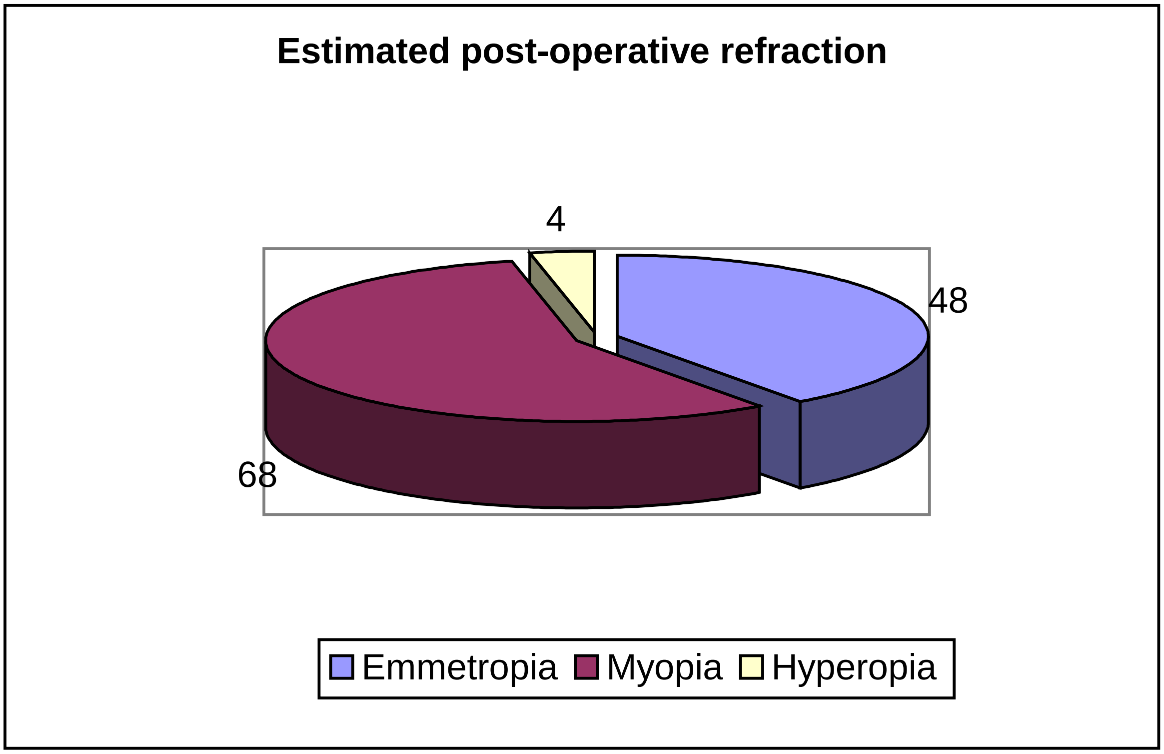


Table 7 : Actual post-operative refraction at 6 weeks (spherical equivalent)

Range	No. of Patients	%
> -1.50D	06	05
-1.50 to +0.50D	107	89.2
> +0.50	07	5.8

This table shows the actual post-operative refraction (spherical equivalent) at 6weeks. About 89.2% (107) of cases actual post-operative refraction was between -1.5D to + 0.50D, 5.0%(6) cases post-operative refraction was more than -1.5D, and in 5.8% (7) cases post-operative refraction was above +0.50D.

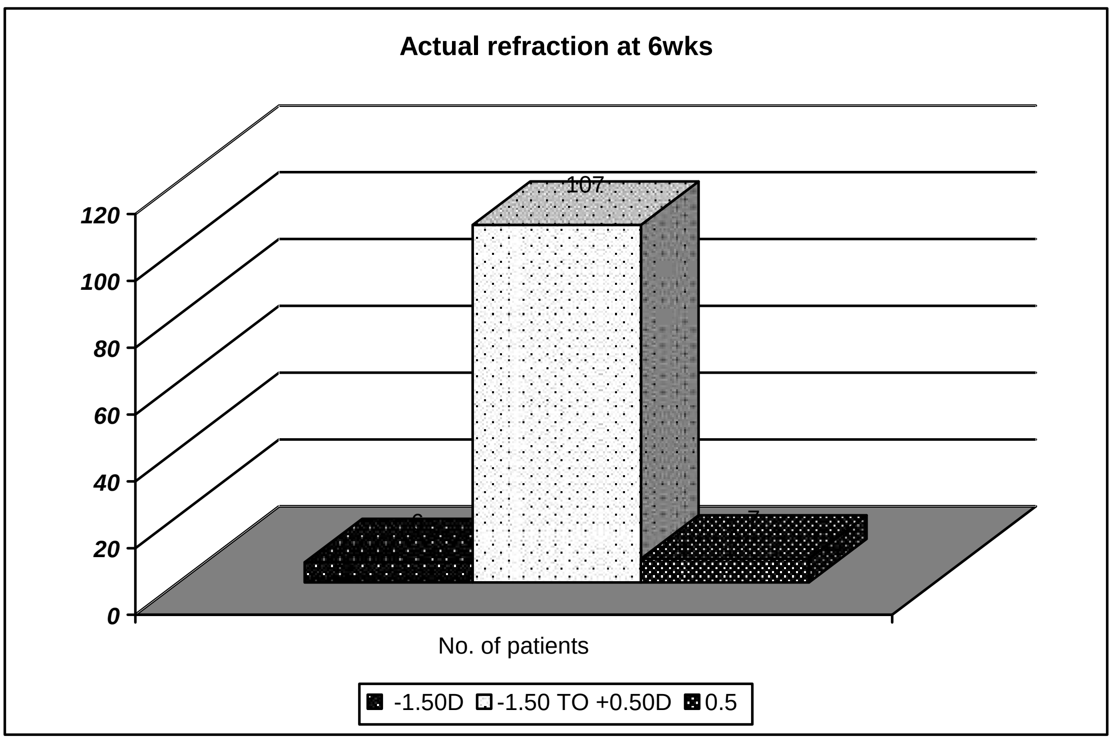


Table 8 : Predictive error

Range	No. of Patients	%
>-0.5D	30	25.00
-0.50 to +0.50D	74	61.50
>+0.50D	16	13.50

This table shows the predictive error observed in this study. 74 cases (61.50%) had predictive error was between -0.50D to +0.50D, 30 cases (25.0%) had predictive error more than -0.50D and in 16 cases (13.50%) the predictive error was more than +050D.

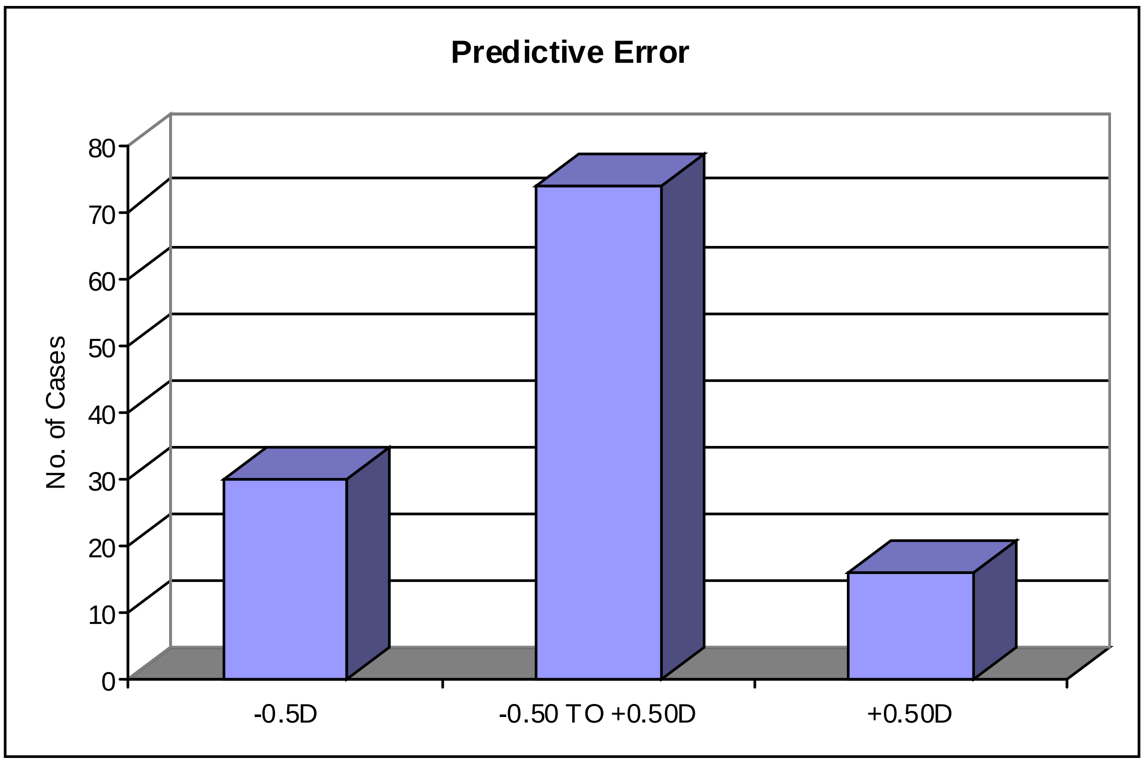


Table 9 : Predictive error for subgroup 1 (as per ‘K’ reading)

		Predictive error					
Parameter	**No. of Patients**	**[-0.5D**		**-0.50 to +0.50D**		**[+ 0.50D**	
		No	%	No	%	No	%
K≤43.50D	50	11	22	29	58	10	20
K>43.50D	70	20	28.6	44	62.8	06	8.6

This table shows the predictive error for the subgroup data who have K reading less than 43.50D and those patients who have K reading more than 43.50D.

Table 10: Predictive error for sub group 2 (As per axial length)

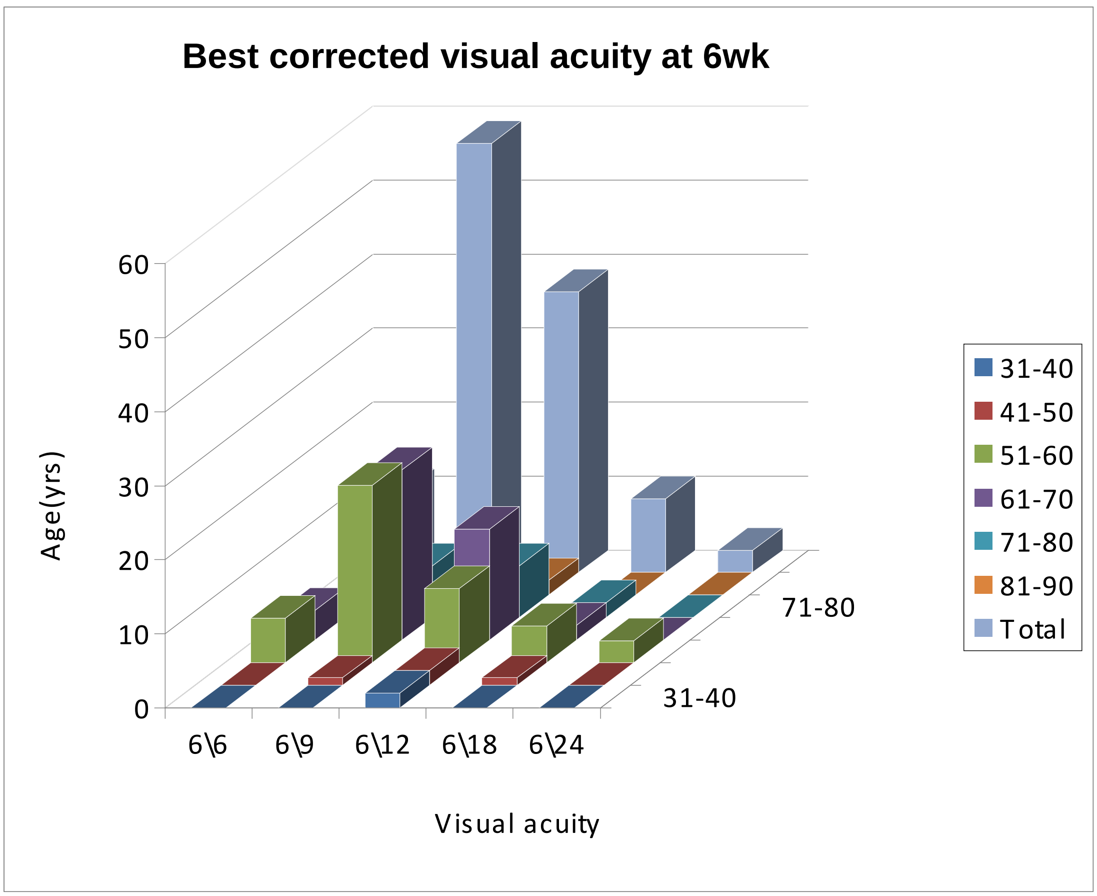
Parameter	No. of Patients	Predictive error					
		[-0.50D		-0.5 to +0.5D		[+O.5D	
		No	%	No	%	No	%
Axial length <23.50mm	89	24	26.90	53	59.50	12	13.50
Axial length >23.50mm	31	07	22.60	20	64.50	04	12.90

This table shows the predictive error for the subgroup data who have axial length less than 23.50mm and more than 23.50mm

Table 11 : Best corrected visual acuity at 6weeks

Age (Yrs)	6/6	6/9	6/12	6/18	6/24
31-40	00	00	02	00	00
41-50	00	01	02	01	00
51-60	06	24	10	05	03
61-70	04	23	15	02	00
71-80	01	07	07	02	00
81-90	00	03	02	00	00
Total	**11**	**58**	**38**	**10**	**03**

This table shows best corrected visual acuity at 6weeks after operation.



DISCUSSION

In this study 120 patients underwent SICS with PCIOL implantation for various types of cataracts to achieve post-operative emmetropia and myopia (in majority).They were followed at 6weeks to study actual post operative refraction achieved and document the predictive error there off.

Keratometry was measured carefully with Bausch & Lomb keratometer and axial length measurement was done by Appasamy A-scan unit by me. All patients underwent surgery by one surgeon of Department of Ophthalmology, KLESPK Hospital.

Retinoscopy was done at 6^{th} week post-operatively, because wound stabilizes by 6weeks (Duke-Elder'srefraction). The actual post-operative refraction (spherical equivalent) was noted with best corrected visual acuity.

Out of 120 patients operated, 54 cases (45%) were male and 66 cases (55%) were female (Table 1). Right eye accounted for 68cases (56%), and left eye 52 cases (43%) (Table2).

Age wise distribution of patients showed that maximum number of cases were in the range of 51-60 years (40%) and minimum cases were in the range31-40(1.6%) (Table 3).

Keratometry readings varied between 40.00D to 47.62 D and 41.6% of the patients had K- reading more than 43.5D, 58.3% of the patients had K reading less than

43.5D. The normal K reading (average) is 43.50 D.[30] The average reading in this study was 43.92D (Table 4).

The axial length varied between 20.33mm to 25.08mm and the average axial length obtained in this study was 23.00mm. The normal axial length reading is 23.5mm. In this study 74.2% of the patient had axial length less than 23.50mm and 24.8% of the patients had axial length more than 23.50mm (Table 4).

The maximum number of intraocular lens power used was +21.00D (17 cases) and the minimum intraocular lens power used in this study was + 14.00D (2 cases).The maximum intra-ocular lens power used in this study was +27.00D (Table 5).

In 40% of the patients, the estimated post-operative refraction was emmetropia, in 56.7% of cases the estimated refraction was slight myopia and 3.3% of cases it was slight hyermetropia (Table 6). Depending upon the patients occupation, surgeons choice and patients preference the estimated post-operative refraction was derived. Since majority of patients who underwent surgery in this study were farmers the estimated post-operative refraction was aimed at emmetropia and slight myopia in majority of the patients.

The results of this study showed that the actual post-operative refraction (spherical equivalent) was more than -1.50D in 5.0% of patients, -1.50D to +0.50D in 89.2% of patients and more than +0.50D in 5.8% of patients (Table7).

The predictive error was more than -0.50D in 25.00% of patients,-0.50 to +0.50D in 61.50% of patients, and more than +0.50D in 13.50% of patients. These figures show that there is slight myopic shift in majority of cases (Table8).

In patients who had K-reading more than 43.50D, 22% of the patients had predictive error of more than -0.5D, in 58.0% of patients had predictive error in the range of -0.5 to +0.5D and in only 20% of the patients had predictive error more than +0.5D. In patients with K-reading more than 43.50D , 28.6% of patients had predictive error more than -0.5D, 57.1% of the patients had predictive error in the range of -0.5 to +o.5D and in only 8.6% of patients predictive error was more than +0.5D (Table 9).

The sub group analysis shows that 89 patients had axial length less than 23.50mm and 31 patients had axial length more than 23.50mm. In patients with axial length of less than 23.50mm majority of the patients 59.50% had predictive error in the range of -0.5D to +0.5D, 26.91% had predictive error more than -0.50D and only 13.5% of patients had predictive error more than +0.5D. In patients with axial length more than 23.50mm majority had the predictive error in the range of -0.5 to +0.5D, 22.60% had predictive error more than -0.5D and only 12.9% of patients had predictive error more than +0.5D(Table 10). This shows that prediction is good even if axial length is more or less than 23.5mm. This contradicts to the previous studies which show that lesser the axial length more will be predictive error.

48% of the best corrected visual acuity of 6/9 and of these, 41% subjects were in the age group of 51-60 years (Table 11).

Table 12 : Average biometry by Limdi and Sheth compared to present study

Parameter	Present study	Limdi and Sheth [16]
Keratometry	43.92D	45.50D
Axial length	23.00mm	23.19mm
IOL Power	20.90D	20.91D

Table 12 shows average keratometry, axial length and IOL power used in this study and Limdi and Sheth study. The results of this study are tally closely to the Limdi and Sheth study.

Table 13 : Predictive error in this study compared to other studies

Predictive error	Present study	Limbdi & Sheth	Thomas & Oslen[26]	Jerry &Hillman[25]	P.T.S Gregory& D. L Boose[27]
±1.0D	82.50%	76.00%	82.00%	60.00%	67.94%
±2.0D	95.00%	96.00%	99.00%	80.00%	90.66%
±3.0D	100%	99.00%	100%	100%	100%
±4.0D		100%			

The results of this study showed that the predictive error varied in the range of +/-1 in 82.5% of patients, +/-2 in 95.0% of patients and +/-3 in 100% of patients (Table 13). The results obtained with this study are comparable to study conducted by Limbdi & Sheth, Thomas & Oslen, Jerry & Hillman, P.T.S Gregory & D L Boose.

Table 14 : IOL power used in present study compared to other study

IOL Power	Present Study	David Yanout & Allen Foster[28]
≤20.0D	28%	10%
20-22.0D	68%	57%
≥22.0D	24%	33%

IOL power analysis of this study showed majority are in range of 20 to 22D which well correlate with the David &Yanout , Allen & Foster(Table 14).

The results of this study shows that the calculation of IOL power pre-operatively helps to achieve a desired post-operative refraction and avoid unexpected high ametropia. It has been shown to be useful even for planned ametropia in patients who have larger refractive error in the fellow eye. The accuracy of the IOL power estimated in this study is similar to that found in previous reported studies.

This study shows that patients who received calculated IOL achieved a much better uncorrected visual acuity. Errors in calculating IOL power may arise in several ways. It may be in the form of instrumental error, surgical error, formula error etc.

The position of intraocular lens in the posterior chamber of the eye will definitely affect the predictive error, with the sulcus fixation producing a relative myopic shift from the estimated refraction.

CONCLUSION

Based on the results obtained from the present study, we conclude that an unexpected anisometropia can be avoided by doing intraocular lens calculation by using ultrasonic biometry. It has been shown to be useful even for planned ammetropia in those patients who have larger refractive error in the fellow eye and thus preventing post-operative anisometropia.

Biometry is definitely essential and accurate in calculating intraocular lens power. A careful selection of intraocular lens might reduce unexpected surprises but will not eliminate them and both the patient and the surgeon should be prepared for the same.

SUMMARY

To summarize, One hundred and twenty patients undergoing cataract surgery at KLESPKH and Medical Research centre, Belgaum were taken in the study.

Prior to the surgery a complete ocular examination was done including measuring the intraocular pressure and patency of lacrimal system Routine pre-operative investigation and pre-operative medications were given to all patients. Keratometry was done using Bausch and Lomb type keratometer. The axial length was measured with Appasamy (Appascan2000) A scan unit,

Retinoscopy was done at 6th week post-operatively, readings were recorded. The post-operative refraction was taken as spherical equivalent.

The results of this study showed that the predictive error varied in the range of +/-1 in 82.5% of patients, +/-2 in 95.0% of patients and +/-3 in 100%, 48% of the best corrected visual acuity of 6/12, of this age group of 51-60 years account for 41%.

Calculation of the IOL power pre-operatively helps to achieve a desired post-operative refraction and avoid unexpected post-operative ametropia, resulting in dependency on spectacles.[29] The residual spherical error is a function of the basic refractive power of the aphakic eye and the power of the IOL which is implanted.[31]

Careful keratometry and biometry will reduce the error in calculating the IOL power. In this study these were conducted by single person not relegated to paramedical worker. Majority of the lenses were not implanted in the bag, hence there is tendency towards myopia. This has to be recognized and is corrected during choice of IOL.

Unexpected high post-operative refractive error was not found in this study. The maximum predictive error obtained in this study was -3.0D. Significant number of cases had predictive error between -0.5D to +0.5D, but this error is acceptable to the patients as they will have good near vision. Similar observations have been reported by other studies conducted in the past. This data showed that margin of refractive error can be significantly reduced by pre-operative determination of intraocular lens power using ultrasound biometry.

Biometry is definitely essential and accurate in calculating intraocular lens power. A careful selection of intra-ocular lens might reduce unexpected surprises but will not eliminate them and both the patient and the surgeon should be prepared for the same.

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CONSENT FOR PARTICIPATION IN RESEARCH

Mr./Mrs.________________________________we are requesting you to enroll yourself in study titiled -,**“ROLE OF ‘A’ SCAN IN PREDICTION OF INTRAOCULAR LENS POWER-ONE YEAR CROSS SECTION STUDY”** IN PATIENTS ATTENDING KLESPKH AND MRC,BELGAUM, conducted by Dr. SHIVAKUMAR G. HIREMATH postgraduate student in M.S Ophthalmology under the guidance of Dr MAHESH I.MAGDUM at J.N Medical College, under KLE University, Belgaum.

You have been requested to participate in research because you are into the study group. During the study you will be asked some questions and you are supposed to answer to the best of your knowledge.

Your participation in research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N.M.C .If you decide to participate you are free to withdraw at any time.

The purpose of research is to determine accuracy of A-scan in determining intraocular lens power.

PROCEDURE INVOLVED:

A scan done in all patients enrolled in the study.

RISKS AND BENEFITS:

There are no extra risks involved and benefits are to be evaluated.

ALTERNATIVES:

Even if you decline the participation, you will get the routine line of management.

PRIVACY AND CONFIDENTIALITY:

The only people to know that you are a research subject are members of the research team. No information about you or provided by you during the research will be disclosed to others without your written permission except:

1.In emergency to protect your rights and welfare.

2.If required by law.

AUTHORIZATION TO PUBLISH RESULTS:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

FINANCIAL INCENTIVES FOR PARTICIPATION:

You will not be paid/offered any free gifts for participating in the research. You will not be reimbursed for expenses.

CONSENT STATEMENT:

I undersigned__________________________ have been explained in my vernacular language about the study and my participation in the study is voluntary. If I want, I can withdraw at any time. Also I have been given enough time to clear my doubts and rights as study participant.

In case you have any questions related to the study, you can contact Dr SHIVAKUMAR G.HIREMATH (Phone No 9986249960)

In case you have any questions about your rights as a study participant, you can contact Dr V.D Patil (0831-2471350)

Signature or the Left Thumb print of Participant or legally authorized representative

Participants Name______________________ Signature_________________________

Witness Name__________________________ Signature_________________________

Candidates Name___________________ Signature_________________________

Date___________________

Place___________________

PROFORMA

NAME :-

AGE:-

SEX:-

OCCUPATION:-

PRESENTING COMPLAINTS:- **DURATION**

FAMILY HISTORY:-

PERSONAL HISTORY:-

GENERAL EXAMINATION:-

OCULAR EXAMINATION:- **OD** **OS**

VISUAL ACUITY:-

ADNEXA:-

CONJUCTIVA:-

CORNEA:-

SCLERA:-

ANTERIOR CHAMBER:-

IRIS :-

PUPIL:-

LENS:-

INTRAOCULAR PRESSURE:-

SAC SYRINGING :-

BIOMETRIC READING:-

KERATOMETRIC READING: K1:
K2:

AXIAL LENGTH:-

FORMULA USED:-

IOL POWER:-

IOL FORMULA FOR EMMETROPIA:-

SURGERY:-

DATE:

ANAESTHESIA:

IOL PARTICULARS:

GOAL:

DESIGN:

POWER:

OVERALL DIAMETER:

OPTIC DIAMETER:

FOLLOW UP:

6TH WEEK:

RESIDUAL REFRACTION:

ACTUAL POST-OPERATIVE REFRACTION

PREDICTIVE ERROR:

COLOUR PLATES

LACRIMAL SYRINGING(I)

INTRAOCULAR PRESSURE EVALUATION (II)

KERATOMETRY(III)

AXIAL LENGTH MEASUREMENT (IV)

RETINOSCOPY (V)

KEY TO MASTER CHART

(P)	: Partial
△	: Diagnosis
AL	: Axial length
AR	: Actual refraction
BCVA	: Best corrected visual acuity
BE	: Both eyes
CF	: Counting fingers
D	: Diopter
EPOR	: Estimated post-operative refraction
F	: Female
HMCF	: Hand movement close to face
IOL	: Intraocular lens
K	: Keratometry reading
LE	: Left eye
M	: Male
MT	: Meters
PL PR +	: Perception of light and projection of rays present
PRED ERROR	: Predictive error
PRE-OP VISION	: Pre-operative vision
PSEUDO	: Pseudophakia
RE	: Right eye
SICS	: Small incision cataract surgery
SL	: Serial Number
SE	: Spherical equivalent
Wks	: Weeks

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SL NO	NAME	AGE	SEX	PRE-OP VISON	DIAGOSIS	EYE	K(D)	AL (mm)	IOL POWER	ESTIMATED POST OP REFRACTION	SURGERY	IOL IMPLANTED (D)	ACTUAL REFRACTION AT 6 WK(SE)	BCVA	PREDICTIVE ERROR
1.	LAGMAWWA	58	F	CF-1MT	BE SIMC	RE	44.50	22.91	23.00D	-0.5D	RE SICS	23.50	0.00D	6/9	-0.50D
2.	KALLAPPA	79	M	CF-5MT	RE SIMC	RE	40.00	23.91	22.50D	E	RE SICS	22.50	-0.25D	6/9	-0.25D
3.	ABDUL	53	M	CF-1MT	BE SIMC	LE	43.50	23.34	20.50D	E	LE SICS	20.50	-1.50D	6/9	-1.50D
4.	BASAWWA	65	F	HMCF	RE SIMC	RE	44.62	23.26	20.00D	E	RE SICS	20.00	-0.25D	6/9	-0.25D
5.	LAXMAN	58	M	CF-3MT	BE SIMC	RE	44.65	22.72	21.00D	E	RE SICS	21.00	-.050D	6/12	-0.50D
6.	SUSHILA	70	F	CF-1/2MT	BE SIMC	LE	45.00	23.33	19.50D	-0.5D	LE SICS	19.00	-0.75D	6/9	-0.25D
7.	RAMCHANDRA	60	M	PLPR+	RE SIMC LE SMC	LE	42.75	23.16	22.00D	-1.0D	LE SICS	21.00	-1.00D	6/18	0.00D
8.	MARUTI	75	M	CF-2MT	RE PSEDO LE SIMC	LE	44.35	22.90	18.50D	-0.5D	LE SICS	18.00	-0.75D	6/9(P)	-0.25D
9.	SHIVALINGAWWA	70	F	PLPR+	RE SMC LE SIMC	RE	43.75	24.5	14.5D	E	RE SICS	14.50	-1.00D	6/6(p)	-1.00D
10.	SHIVLING	70	M	PLPR+	RE SIMC LE SMC	LE	44.50	22.77	22.50D	-2.5D	LE SICS	20.00	-1.00D	6/12	+1.50D
11.	SUBHADRA	65	F	CF-1MT	BE SIMC	LE	42.25	24.26	18.5D	E	LE SICS	18.50	0.00D	6/6(P)	0.00D
12.	KRISHNA	56	M	PLPR+	RE SMC LE SIMC	RE	44.25	22.93	21.00D	-0.5D	RE SICS	20.50	-0.75D	6/12	-0.25D
13.	CHANDRABAGA	70	F	CF-1MT	BE SIMC	RE	43.35	23.84	19.50D	-0.5D	RE SICS	20.00	-2.50D	6\9	-2.00D
14.	SAVAKKA	58	F	6/60	BE SIMC	RE	42.75	22.32	24.00D	-2.0D	RE SICS	22.00	-1.25D	6/9(P)	+0.75D
15.	DEVAKI	80	M	PLPR+	RE SMC	RE	44.50	22.50	19.50D	-0.5D	RE SICS	19.00	-1.00D	6/18	-0.50D
16.	YALLAWWA	60	F	CF-4MT	LE SIMC	LE	45.50	22.50	23.00D	-0.5D	LE SICS	23.50	-0.50D	6/9	0.00D
17.	GANGUBAI	56	F	6/60	BE SIMC	RE	41.75	23.17	22.50D	-1.5D	RE SICS	24.00	-0.50D	6/24	+1.00D
18.	NINGAWWA	55	F	PLPR+	RE SMC	RE	47.00	21.85	22.50D	E	RE SICS	21.50	+0.50D	6/24	+0.50D
19.	GANGAWWA	75	F	CF-4MT	LE SIMC	LE	44.50	22.50	19.50D	-2.5D	LE SICS	20.50	-2.00D	6/12	+0.50D
20.	SUMATI	60	F	CF-3MT	LE SIMC	LE	43.00	24.21	19.00D	-3.0D	LE SICS	22.00	-0.50D	6/9	+2.50D
21.	NAGAPPA	88	M	HMCF	RE SIMC	RE	43.25	25.00	16.00D	-2.5D	RE SICS	18.50	-1.00D	6/12	+1.50D
22.	RAMANAGOUDA	70	M	CF-2MT	RE SIMC	RE	44.12	22.27	23.00D	-0.5D	RE SICS	22.50	-0.75D	6/9	-0.25D
23.	SARASWATI	60	F	6/60	LE SIMC	LE	45.00	22.20	21.50D	E	LE SICS	21.50	0.00D	6/18	0.00D
24.	AKBER ALI	60	M	6/60	RE SIMC	RE	41.87	22.03	21.50D	-1.0D	RE SICS	20.50	-1.00D	6/12	0.00D
25.	GOURAWWA	75	F	6/60	RE SIMC	RE	43.87	22.37	23.00D	-2.0D	RE SICS	21.00	-0.75D	6/12	+1.25D
26.	BASAPPA	70	M	HMCF	RE SIMC	RE	43.25	23.19	21.50D	E	RE SICS	21.50	0.00D	6/18	0.00D
27.	PANDIT	70	M	CF-1MT	RE SIMC	RE	43.25	22.97	22.00D	-0.5D	RE SICS	21.50	-0.50D	6/18	0.00D
28.	SUBHADRA	65	M	CF-1MT	BE SIMC	LE	43.25	24.26	18.50D	E	LE SICS	18.50	0.00D	6/12	0.00D
29.	MAHABUBEE	65	F	CF-1MT	LE SIMC RE PSEUDO	LE	43.50	23.68	19.50D	-0.5D	LE SICS	20.00	-0.37D	6/9(P)	+0.13D
30.	GURULING	73	M	CF-2MT	BE SIMC	RE	40.75	24.99	18.50D	-0.5D	RE SICS	18.00	-0.50D	6/12	0.00D
31.	TANGEWWA	60	F	CF-2MT	RE PSEUDO LE SIMC	LE	46.00	23.05	19.00D	E	LE SICS	19.00	-0.25D	6/12	-0.25D
32.	AMBUBAI	80	F	CF-4MT	RE SIMC LE PSEUDO	RE	45.37	22.06	22.00D	E	RE SICS	22.00	0.00D	6/9(P)	0.00D
33.	LAXMAPPA	85	M	6/60	RE PSEUDO LE SIMC	LE	41.12	24.05	20.00D	-1.0D	LE SICS	21.00	-0.50D	6/9	+0.50D
34.	SHRIKANT	65	M	CF1MT	BE SIMC	RE	45.25	25.08	14.50D	-0.5D	RE SICS	14.00	-0.50D	6/9	0.00D
35.	JYOTIBA	70	M	PLPR+	RE SMC LE PSEUDO	RE	44.12	23.43	20.00D	-1.0D	RE SICS	21.00	-3.00D	6/24	-2.00D
36.	DURGAPPA	55	M	CF-4MT	BE SIMC	LE	42.00	23.88	21.00D	-1.0D	LE SICS	20.00	-0.25D	6/18	+0.75D
37.	SHRIPATHI	65	M	CF-5MT	BE SIMC	LE	43.37	24.48	18.00D	E	LE SICS	18.00	-3.00D	6/9	-3.00D
38.	NOORJAHAN	65	F	6/24	RE SIMC LE PSEUDO	RE	44.12	24.05	18.50D	-0.5D	RE SICS	19.00	-0.75D	6/12	-0.25D
39.	BASAVRAJ	82	M	CF-4MT	BE SIMC	LE	47.25	21.75	24.50D	-1.0D	LE SICS	23.50	+0.50D	6/12	+1.50D
40.	MUMTAZ	40	F	6/36	RE PSIMC LEPSEUDO	RE	41.87	22.36	24.00D	E	RE SICS	24.00	+1.00D	6/12	+1.00D
41.	DATTATREYA	65	M	HMCF	BE SIMC	LE	41.50	23.64	22.00D	-0.5D	LE SICS	21.00	-0.75D	6/9	-0.25D
42.	SHIVABAI	65	F	6/60	BE SIMC	LE	42.68	22.65	23.00D	-1.0D	LE SICS	24.00	-1.00D	6/9(P)	0.00D

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43.	HANUMAWWA	55	F	PLPR+	RESMC LESIMC	RE	43.75	22.98	19.50D	-1.5D	RE SICS	21.00	+0.75D	6/12	+2.25D
SL NO	NAME	AGE	SEX	PRE-OP VISON	DIAGOSIS	EYE	K(D)	AL (mm)	IOL POWER	ESTIMATED POST OP REFRACTION	SURGERY	IOL IMPLANTED (D)	ACTUAL REFRACTION AT 6 WK(SE)	BCVA	PREDICTIVE ERROR
44.	BASAVANEWWA	68	F	CF-3MT	BE SIMC	RE	43.87	23.12	19.00D	-1.0D	RE SICS	20.00	-1.25D	6/6(P)	-0.25D
45.	GANGAWWA	65	F	CF-3MT	BE SIMC	RE	43.25	22.89	22.00D	E	RE SICS	22.00	-0.75D	6/9	-0.75D
46.	MALLPPA	62	M	CF-3MT	BE SIMC	RE	45.87	23.25	19.50D	-0.5D	RE SIMC	20.00	+0.75D	6/12	+1.25D
47.	PARVATIBAI	70	F	CF-5MT	BE SIMC	RE	43.75	22.91	24.00D	-1.0D	RE SICS	25.00	0.00D	6/12	-1.0D
48.	DAREPPA	60	F	6/36	RE SIMC LE PSEUDO	RE	43.62	23.80	19.50D	E	RE SICS	19.50	-0.75D	6/6(P)	-0.75D
49.	SHANKARA	55	M	6/60	BE SIMC	RE	45.25	22.96	20.00D	-2.0D	RE SICS	22.00	-1.75D	6/9	+0.25D
50.	DUNDAWWA	60	F	CF-3MT	BE SIMC	RE	42.50	23.33	21.50D	E	RE SICS	21.50	-0.25D	6/12	-0.25D
51.	FAKIRAPPA	65	M	PLPR+	RE SMC LE PSEUDO	RE	43.00	22.38	23.00D	-1.0D	RE SICS	22.00	-1.00D	6/12	0.00D
52.	JANABAI	60	F	CF-2MT	BE SIMC	RE	43.87	22.75	22.00D	-1.5D	RE SICS	23.50	-1.25D	6/9(p)	+0.25D
53.	GANGAWWA	35	F	CF-2MT	BE SIMC	RE	43.75	22.96	21.50D	+0.5D	RE SICS	21.00	-1.25D	6/12	-1.75D
54.	BHIMRAO	54	M	CF-4MT	BE SIMC	LE	44.62	22.36	21.00D	-0.5D	LE SICS	21.50	-0.75D	6/12	-0.25D
55.	SHINGAWWA	70	F	PLPR+	LE SMC RE SIMC	LE	42.62	23.43	21.00D	E	LE SICS	21.00	0.25D	6/9	-0.25D
56.	PARASAPPA	75	M	6\60	BE SIMC	RE	42.00	24.34	19.50D	-0.5D	RE SICS	20.00	-1.00D	6/12	-0.50D
57.	LAGAMAWWA	75	F	CF-4MT	BE SIMC	LE	46.00	22.82	20.00D	E	LE SIMC	20.00	-1.00D	6/12	-1.00D
58.	KASHAWWA	58	F	PLPR+	RE SMC LE SIMC	RE	47.62	22.75	18.50D	-2.0D	RE SICS	21.50	-1.25D	6/9	-0.75D
59	ADIVAPPA	55	M	CF-2MT	BE SIMC	RE	43.62	22.78	22.00D	-1.0D	RE SIMC	23.00	-0.75D	6/12	+0.25D
60	BHIMRAO	70	M	6\60	BE SIMC	RE	44.00	23.20	20.00D	-1.0D	RE SICS	19.00	-1.00D	6/9	0.00D
61.	SHIVAKKA	60	F	HMCF	BE SIMC	LE	42.00	23.13	22.50D	-0.5D	LE SICS	22.00	-1.25D	6/18	-0.75D
62.	LAXMI	70	F	CM-3MT	BE SIMC	RE	41.75	23.00	23.50D	-1.0D	RE SICS	22.00	-1.50D	6/12	-0.50D
63.	NAGAPPA	88	M	6\60	BE SIMC	LE	42.37	23.95	17.00D	-1.5D	LE SICS	18.50	+0.75D	6/9	+2.25D
64.	SAVAKKA	60	M	CF-2MT	BE SIMC	LE	43.37	22.45	23.50D	-0.5D	LE SICS	23.00	-0.50D	6/9	0.00D
65	BALAKRISHNA	52	M	CF-2MT	BE SIMC	LE	42.25	23.16	22.50D	+0.5D	LE SICS	22.00	-0.50D	6/6	-1.00D
66.	SHRIKANT	51	M	6\36	RE SIMC LE PSEUDO	RE	43.00	23.65	23.50D	-0.5D	RE SICS	23.00	-1.00D	6/9	+0.50D
67	PARVATHI	70	F	PLPR+	RE SMC LE SIMC	RE	47.25	21.54	21.50D	-1.0D	RE SICS	20.50	-1.00D	6/9	0.00D
68.	CHANDRAKANT	50	M	HMCF	BE SIMC	LE	44.87	22.69	21.00D	-2.0D	LE SICS	23.00	-0.50D	6/12	-1.50D
69.	ANNAPURNA	55	F	PLPR+	RE SMC LE SIMC	RE	41.87	23.16	21.50D	-0.5D	LE SICS	22.00	+0.75D	6/18	+1.25D
70.	SHARAWWA	55	F	CF-MT	RE SIMC	RE	45.50	22.16	22.00D	E	RE SICS	22.00	-0.50D	6/6	-0.50D
71.	SHINGAPPA	62	M	CF-2MT	BE SIMC	LE	43.87	23.20	21.00D	-0.5D	LE SICS	21.50	-0.25D	6/9	+0.25D
72.	DUNDAPPA	54	M	CF-4MT	BE SIMC	LE	44.87	22.75	21.00D	E	LE SICS	21.00	-1.00D	6/9	-1.00D
73.	BASAPPA	65	M	CF-3MT	BE SIMC	RE	47.17	22.78	19.00D	-1.5D	RE SICS	21.50	-0.75D	6/9	+0.75D
74.	VIDYA	58	F	CF-4MT	BE SIMC	LE	45.50	23.00	19.50D	-1.5D	LE SICS	21.00	+1.25D	6/9	+0.25D
75.	SONAWWA	80	F	PL PR+	RE SMC LE SIMC	RE	43.17	23.00	19.50D	-0.5D	RE SICS	20.00	+0.75D	6/18	+1.25D
76.	SANABAI	70	F	6\18	RE SIMC LE PSEUDO	RE	43.17	22.14	22.00D	-0.5D	RE SICS	22.50	-1.00D	6/9	-0.50D
77.	SATYAPPA	50	M	CF-1MT	RE SIMC LE SIMC	RE	44.25	23.60	19.50D	-0.5D	RE SICS	20.00	-0.75D	6/12	-0.25D
78.	BALAKRISHNA	60	M	PL PR+	LE SMC RE SIMC	LE	44.37	22.64	20.00D	-1.0D	LE SICS	21.00	-1.00D	6/9	0.00D
79.	ABRAHIM	80	M	CF-2MT	LE SIMC RE PSEUDO	LE	44.75	23.24	20.00D	E	LE SICS	20.00	-0.50D	6/6(p)	-0.50D
80.	ANAND	52	M	CF-3MT	BE SIMC	RE	46.50	23.37	17.50D	-1.0D	RE SICS	18.50	-1.25D	6/9	-0.25D
81.	KRISHNA	70	M	HMCF	RE SMC LE SIMC	RE	47.00	21.93	21.00D	E	RE SICS	21.00	-0.50D	6/12	-0.5D
82.	YALLAWWA	65	F	CF-1MT	BE SIMC	RE	44.50	23.15	21.00D	-1.5D	RE SICS	19.50	-1.25D	6/12	+0.25D
83.	RUKMINI	65	F	CF-3MT	BESIMC	RE	44.25	21.64	24.50D	-0.5D	RE SICS	24.00	-0.75D	6/12	-0.25D
84.	RAMAGOUDA	62	M	CF-3MT	BE SIMC	RE	44.87	22.00	22.00D	E	RE SICS	22.00	-0.75D	6/9	-0.75D

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85.	MALATAI	65	F	CF-5MT	RE SIMC	RE	40.62	23.00	23.00D	-1.0D	RE SICS	22.00	-1.00D	6/12	0.00D
86.	SHANKAR	60	M	CF-1MT	BE SIMC	RE	41.87	23.42	21.00D	-0.5D	RE SICS	21.50	+0.75D	6/12	+2.25D
SL NO	NAME	AGE	SEX	PRE-OP VISON	DIAGOSIS	EYE	K(D)	AL (mm)	IOL POWER	ESTIMATED POST OP REFRACTION	SURGERY	IOL IMPLANTED (D)	ACTUAL REFRACTION AT 6 WK(SE)	BCVA	PREDICTIVE ERROR
87.	RANGAWWA	70	F	CF-1MT	RE PSEUDO LE SIMC	LE	44.75	22.14	22.00D	+0.5D	LE SICS	21.50	+0.25D	6/9	-0.25D
88.	KAMAL	45	F	PLPR+	LE SMC RE SIMC	LE	44.50	25.53	15.00D	-1.0D	LE SICS	14.00	-1.00D	6/9	0.00D
89.	BASAWWA	60	F	PLPR+	RE SMC LE SIMC	RE	45.62	22.50	20.00D	+0.5D	RE SICS	19.50	-1.00D	6/6(p)	-1.50D
90.	JYOTIBA	55	F	PLPR+	RE SMC LE SIMC	RE	44.12	23.48	19.00D	-0.5D	RE SICS	18.50	-0.75D	6/9	-0.25D
91.	YELLUBAI	90	F	PLPR+	RE SMC LE SIMC	RE	43.25	22.00	22.50D	E	RE SICS	22.50	-0.75D	6/9	-0.75D
92.	JAMINEBI	70	F	PLPR+	RE SIMC LE SMC	LE	43.50	20.51	27.50D	-0.5D	LE SICS	27.00	-0.75D	6/9	-0.25D
93.	RAMA	55	M	PLPR+	BE SMC	LE	43.00	24.00	19.50D	-2.0D	LE SICS	21.50	-1.50D	6/12	-0.50D
94.	PARAPPA	77	M	CF-3MT	BE SIMC	LE	45.50	22.00	19.00D	-0.5D	LE SICS	19.50	-1.0D	6/12	-0.50D
95.	SUSHILA	60	F	CF-1MT	BE SIMC	RE	44.62	23.57	19.00D	E	RE SICS	19.00	-1.00D	6/6	-1.00D
96.	MARUTI	77	M	PLPR+	RE SMC LE PSEUDO	RE	42.75	24.00	19.50D	E	RE SICS	19.50	+0.50D	6/12	+0.50D
97.	RAMA	70	M	PLPR+	RE SMC LE SIMC	RE	45.17	21.27	24.50D	-0.5D	RE SICS	24.00	-1.00D	6/9	-0.50D
98.	PARAWWA	70	F	CF-5MT	RE SMC LE PSEUDO	RE	46.25	23.56	17.50	E	RE SICS	17.50	+0.25D	6/9	+0.25D
99.	SHANTABAI	50	F	CF-3MT	BE SIMC	LE	44.50	23.50	19.50D	E	LE SICS	19.50	-0.75D	6/18	-0.75D
100.	RATNAWWA	60	F	CF-2MT	BE SIMC	RE	45.25	23.48	19.00D	E	RE SICS	19.00	-0.75D	6/24	-0.75D
101.	PARVATAWWA	61	F	PL PR+	RE SMC LE SIMC	RE	41.625	23.99	21.00D	E	RE SICS	21.00	+0.50D	6/12	+0.50D
102.	SHEELA	72	F	CF-1MT	BE SIMC	LE	47.00	21.88	22.00D	-1.0D	LE SIMC	21.00	-1.00D	6/9	0.00D
103.	APANNA	70	M	CF-1MT	BE SIMC	LE	44.25	21.71	23.00D	E	LE SIMC	23.00	-1.00D	6/9	-1.00D
104.	SIDDAWWA	65	F	CF-3MT	BE SIMC	LE	42.50	23.92	21.00D	E	LE SIMC	21.00	-1.00D	6/6	-1.00D
105	GANAPATI	55	M	CF-3MT	BE SIMC	LE	43.25	21.92	24.00D	-1.0D	LE SIMC	23.00	-0.75D	6/9	+0.25D
106.	SOMAVVA	60	F	PL PR+	LE SMC RE PSEUDO	LE	43.00	23.10	24.00D	E	LE SICS	24.00	-0.75D	6/12	-0.75D
107.	BASANEWWA	63	F	CF-4MT	BE SIMC	LE	44.75	20.33	20.50D	E	LE SICS	20.50	-0.75D	6/12	-0.75D
108.	KAMALAWWA	60	F	CF-4MT	BE SIMC	LE	42.00	23.66	21.00D	E	LE SICS	21.00	-0.50	6/12	-0.50D
109.	SHRIKANT PATIL	65	M	CF-2MT	BE SIMC	LE	43.75	23.20	23.00D	E	LE SICS	23.00	-1.75D	6/9	-0.75D
110.	HIRABAI	70	F	PL PR+	LE SMC RE SIMC	LE	43.12	23.70	20.00D	E	LE SICS	20.00	-1.00D	6/9	-1.00D
111.	SHANTAWWA	60	F	CF-3MT	BE SIMC	RE	44.37	21.95	22.50D	E	RE SICS	22.50	+0.50D	6/9	+0.50D
112.	MALU	60	F	CF-3MT	BE SIMC	RE	44.12	22.07	21.50D	E	RE SICS	21.50	-1.00D	6/9	-1.00D
113.	SHARAWWA	60	F	CF-3MT	BE SIMC	RE	42.25	23.85	20.50D	E	RE SICS	20.50	-0.25D	6/6	-0.25D
114.	BASAVANEPPA	75	M	6/60	BE SIMC	RE	45.25	21.22	23.50D	E	RE SICS	23.50	+0.25D	6/12	+0.25D
115.	JANABAI	60	F	CF-3MT	BE SIMC	RE	45.00	22.86	20.50D	E	RE SICS	20.50	-1.25D	6/9	-1.25D
116.	KAMALAWWA	55	F	6/36	BE SICS	LE	40.75	23.94	21.50D	E	LE SICS	21.50	-0.5D	6/9	-0.50D
117.	NAGOJI	54	M	6/60	BE SIMC	LE	45.50	23.00	19.50D	E	LE SICS	19.50	-0.5D	6/9	-0.50D
118.	NEELAWWA	60	F	PL PR+	LE SMC RE SIMC	LE	43.25	23.49	20.50D	E	LE SICS	20.50	-1.75D	6/9	-1.75D
119.	ISHWAR	77	M	PL PR+	LE SMC RESIMC	LE	44.87	20.50	21.50D	E	LE SICS	21.50	-0.25D	6/9	-0.25D
120.	BHIMATAI	72	F	CF-3MT	BE SIMC	LE	46.50	23.16	17.00D	E	LE SICS	17.00	-0.75D	6/9	-0.75D

MASTER CHART