Refractive Surprises In Post Radial Keratotomy Cataract Surgery And Review Of Literature To Calculate Lens Power In Post Refractive Surgery Cases

Dr. Devdatt. S Raut, MBBS. **Dr. Suresh Ramchandani**, MS.,DNB.,DOMS,.
Dr. Charuta Desai, MBBS,. DOMS, **Dr. Pramod Kumthekar**, MS

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Abstract--- Number of patients who have undergone radial keratotomy in the past are now presenting for cataract surgery. Calculation of intraocular lens power poses a great challenge in these patients. Here we have documented one such patient who underwent cataract surgery 17 years after radial keratotomy. He had a high hypermetropic post operative refractive error. Possible causes of post radial keratotomy hypermetropia and the ways to prevent and tackle the problem are discussed. [2][7][8][10][11]

CASE --- A 43 Year old male was referred after left eye cataract surgery for post operative hypermetropia. Patient had undergone radial keratotomy in both eyes 17 years ago for high myopia of approx. 14D in right eye and approx. 11D in left eye. It was a 8 cut radial keratotomy. After radial keratotomy the vision had improved. Right eye had undergone cataract surgery 7 years ago and was kept aphakic with best corrected visual acuity of 6/9 using +2.50D Spherical and +0.50D cylindrical at 180 degrees and near vision of N6 with addition of +3.0D Spherical. The refractive error in the left eye prior to cataract surgery was -2.5DS/-4.0 D Cyl at 90 degrees improving to 6/18 and N12 with +2 add.

There was no other significant ocular history.

He is a known case of Manic Depressive pychosis and is on Carbamazepine, Largactil and Haloperidol .

Patients biometric values before cataract surgery were as follows:

Keratometry--- K1(horizontal)--- 52
K2(vertical)--- 38.5

Keratometry mires were very diffuse. So K readings were taken approximately. Proper readings were not possible and access to topography was not available as the patient lived in a mofussil area.

Axial length--- 30.25mm

Using SRK T formula ----- IOL Power--- +1.5D.

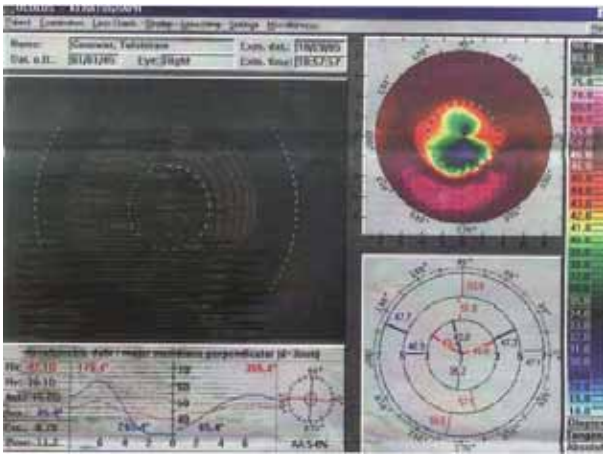
But to make patient myopic and to give him better unaided near vision it was decided to implant +5.0 D intraocular lens. Clear corneal phacoemulsification was done using a temporal incision. Surgery was eventful for inadvertent opening of 2 RK cuts. Foldable +5.0 D lens was implanted in capsular bag. No sutures were taken.

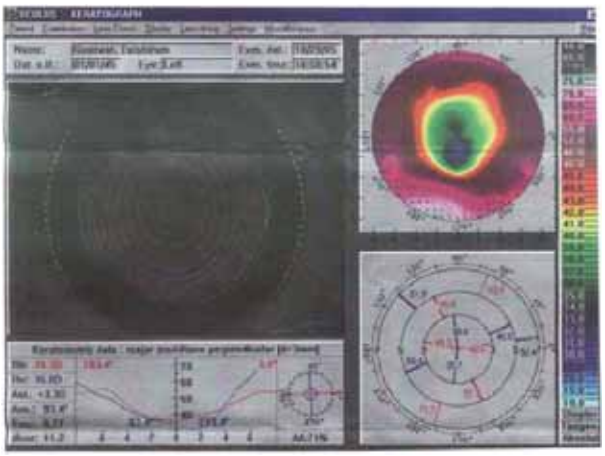
Post operative recovery was unremarkable. However there was a significant refractive surprise. Refractive error 4 weeks later was

+12.0DS and -2.00D cylindrical at 90* improving to 6/9; and N6 with addition of +3.0D Spherical.

After one month of surgery topography of both eyes was carried out and the findings are-----

Avg central corneal curvature in right eye is





42+45+35.2+43 D divided by 4 i.e.4130D and in central 1 mm it is 36 and in left eye it is38.4+40.6+35.7+40.3 D divided by 4 i.e.38.80D and in central 1 mm it is 34.

Discussion-----

This case illustrates the challenge of IOL power calculation for post RK cataract surgery leading to hypermetropic surprises. Here we will try to deal with this dilemma by evaluation of various methods and circumstances for preventing the same.

After the refractive surgery for myopia the central cornea becomes flatter and peripheral becomes steeper[10] and for hypermetropia, it is exactly the opposite. Routine keratometer evaluates the curvature of the central 3 mm. As the cornea becomes flatter after RK the routine keratometer will read for peripheral steep cornea as well as the mires will now spread over central 4.5 mm area. [10]. So it will overestimate the curvature and underestimate the IOL power for myopic patients and the opposite happens overestimate the same for hypermetropics. [10] [13]. There is linear relationship between underestimation of IOL power and degree of myopia. [2] [13]

The average of the anterior-posterior corneal power ratio varied from 7.27 in the smallest analyzed area to 7.63 in the 5-mm-diameter area.[10]

If only anterior surface of cornea with keratometric refractive index[5] is used for measurement of the corneal power will be +1.5D more than when it is deduced using all refractive components and using physiologic refractive index . Study confirms that the total corneal power is more positive when deduced from the anterior surface radius using a keratometric refractive index. As a consequence of changes on corneal surfaces, these findings are more remarkable after myopic LASIK, suggesting that traditional methods to calculate the corneal power may be inappropriate in these cases. [10]

Aramberri points out that the corneal power values are used in 2 ways for IOL calculation formulas: [2] [3] [11]

(1) In a vergence formula that calculates the refractive power of the eye.

(2) For calculation of the effective lens position (ELP). [2][3][11]

In eyes that have had refractive surgery for the correction of myopia, use of the corneal power to calculate the ELP results in underestimation of the anterior chamber depth and selection of an IOL of insufficient power.[2][4]Aramberri proposes the "double-K method," in which the corneal power before refractive surgery is used to calculate the ELP, whereas corneal power after refractive surgery is used in the vergence formula.[2][3][4]

Routinely used IOL calculation formulas are 3RD Generation formula like SRK-1, SRK T, HOFFER'S, and HOLLADAY.[2] 4th generation formula like Holladay 2 considers 7 factors including corneal power, preoperative white-to-white measurement, anterior chamber depth, and lens thickness are taken into account in calculating ELP.[2] In this formula, we can enter the corneal power before refractive surgery for calculation of the ELP.[2] With all 3rd generation formulas, the ELP-related prediction error increased with increasing amounts of refractive correction; standard formulas underestimated IOL power in eyes after myopic surgery and overestimated IOL power in eyes after hyperopic surgery.[2] [11]

The discussion up till now clearly asks for new formula for IOL calculation which will consider the changes in corneal curvature and effective lens position. There is continuous research going on for this. Following are some ways which can be used for IOL calculation

A]If topography can be done pre op-----

1] Modified Maloney method ---------- [2] [3] [4] [10] (CCP x 1.114) - 6.0 D =

CCP = the corneal power with the cursor in the center of the topographic map. An assumed posterior corneal power is 6.0 D. [3][4]

This formula is useful when no history is available as pre RK Keratometry, IOL POWER.

The use of the 2-mm total-mean power and/or the 4-mm total-optical power, as assessed by the Orbscan II statistical analysis device, are taken as accurate values to be applied for IOL calculation in patients who underwent myopic LASIK i.4] [10]Mandell argued that only the change induced by PRK in the front surface of the cornea should be considered; therefore the refractive index of corneal stroma (ie, 1.376) (refractive index of the front corneal surface, air to corneal stroma is 1.376.) should be used instead of the currently used index of 1.3375 for front and back

curvature combined.[11][10]Therefore use of a correcting factor of 1.114, or adding 11.4% to the difference in regular or computerized keratometer readings that are taken with an instrument using the keratometer index of 1.3375 before and after PRK is advocated.[10]spherical equivalent of the refractive change at the corneal plane, divided by Change in K values before and after PRK gives the approx. value 1.114 [11]

2] Postoperative regression method ---------- [3] (CCP x 1.23) - 10.41 D =Post-LASIK adjusted corneal power Where...

CCP = the averaged values of the 0 mm, 1 mm and 2 mm annular rings.

3] Topographic central corneal power adjustment method [4]

CCP - (?D x 0.19) = Post-LASIK adjusted corneal power

Where.CCP = the Effective Refractive Power of the cornea, or the averaged Zeiss Atlas central corneal power,

?D = the refractive change after LASIK at the spectacle plane.

Alternatively CCP is - the adjusted effective refractive power (EffRPadj) of the Holladay Diagnostic Summary of the EyeSys Corneal Analysis System.

Mean spherical error by this method is -- +0.98+/-0.72D [RANGE-- -2.09---+0.01D] [4]

B]If no access to topography but pre RK keratometry readings available

1 Clinical history method ---- [2] [3] [4][5] [8][10][13] Jack Holladay[3]

Kp + Rp - Ra = Ka

Kp = the average keratometry power before keratorefractive surgery,

Rp = the spherical equivalent before keratorefractive surgery,

Ra = the stable spherical equivalent after keratorefractive surgery,

Ka = the estimate of the central corneal power after keratorefractive surgery.

Mean spherical error--- +1.02+/-1.13D [RANGE-- -3.25---+0.97][4]

K values measured before RK are either manual or automated.

The change in refraction is at the spectacle plane.[11]

2] Feiz and Mannis IOL power adjustment method---[2] [3][4]

IOLpre + (?D / 0.7) = IOLpost

IOLpre = the power of the IOL as if no refractive surgery had been performed, using pre lasik K and...

?D = the refractive change after LASIK at the spectacle plane, then...

IOLpost = the estimated power of the IOL to be implanted following LASIK

Mean spherical error-- +0.45+/-0.51 [RANGE-- -0.45---+1.13D] [4]

C]IF no history is available as pre RADIAL KERATOTOMY keratometry or pre refractive surgery IOL POWER and also there is no access to topography.

1] Shammas no history method [3]

K= 1.143 x Ko - 6.8 where...Ko-- manual average keratometry reading.

This formula is very useful but has not been tested on a large scale [4]

2] Hard contact lens method [3][4][5][8][10] [Frederick Ridley, Joseph Soper, Dr. Holladay] [3]

K=B+P+Rc-Rb where...

B- Base curve of contact lens

P- Power of the lens

Rc- over refraction with lens

Rb- refraction without contact lens.

This requires media clear enough for effective refraction or at least retinoscopy

D]If no history, access to topography, and newer IOL formulas are available

1]The use of an average between the Binkhorst and Holladay formulas[7] [12] or Hoffer FORMULA[2] [11], aiming for -0.75 D with an adjusted K (calculated keratometry reading -1 dioptre) seems to be a more accurate and predictable method. [7] Unintentional hyperopia can be significantly decreased but not eliminated with guarantee as a complication of post-radial keratotomy cataract surgery. The accuracy of

the IOL power determination can be improved if myopia is targeted as the post cataract surgery refractive error and the **flatter calculated K reading is used in the IOL determination.(1) (5)**

2]The rule of thumb---- [11]

It can be described as follows: a normal emmetropic eye will usually need an IOL with an A constant of 118.0 and a power of 21 D, so in an eye that achieved emmetropia after PRK, an IOL of 21 D was used. A correction was made for residual myopia after PRK.

3] Ianchulev aphakic/refraction method [3] [6] [9] [11]

Removal of CATARACT/ IOL

Reinflate eye with BSS

Perform hand held autorefraction

Obtain refraction [Rx]

Know A constant of IOL [A]

Calculate IOL power [P]

P= 2.02 X Rx + [A - 118.4] ..... [3]

With this method of IOL calculation, some limitations of conventional biometry can be avoided The clinical applicability of this method may be limited because autorefractometry is less reliable after PRK than in normal eyes[11] This Method has not been tested for accuracy on a large, reported series. [4]

3] Other factors to consider in post RK patient are--- [7]

Patients with previous 8-incision RADIAL KERATOTOMY show variable amounts of transient hyperopia in the immediate post-operative period. This is felt to be due to stromal edema around the radial incisions, producing a temporary central corneal flattening. It is accentuated by greater than 8 incisions. These will gradually resolve over 12 wks. [7]

RULE OF TWO

If the final post-operative refractive objective remains elusive, an IOL exchange, or a piggyback IOL, should not be planned until at least two months have passed and two consecutive refractions, two weeks apart (at the same time of the day), are stable (the "rule of twos.")

COMMENT--- Now using this discussion we will try to solve our problem. What is the best suitable IOL power now that we know the inaccuracy that came up is due to wrong keratometry?

Using the post op topographic K value we can derive following values.

Modified Maloney method ---- (CCP x 1.114) - 6.1 D =

= [34 x 1.114] - 6.1 D =31.78

With this value IOL power calculated is SRK T- +16.5; HOLLADAY-+15.5.0

Postoperative regression method ----- (CCP x 1.23) - 10.41 D =

= [34 X 1.23] - 10.41D =31.41

With this value IOL power calculated is SRK T-+16.5; HOLLADAY-+15.5.0

Topographic central corneal power adjustment method --- CCP - (?D x 0.19)

= 34 - [8 X 0.19] =32.48

With this value IOL power calculated is SRK T-+15.5; HOLLADAY-+14.5.0

With all this formulas - the power of the lens ranges from +14.5 to +16.5 but still not explain the post op spherical equivalent of +11.0 after implanting a lens of + 5.0 power.

One explanation is that as topography was done after cataract surgery, there are chances that pre op topography may have been different considering surgically induced keratometry changes and due to opened RK flaps.

By Shammas no history method [3]-------

Ko= [52+ 38.5]/2 =45.25

Ko x1.143 - 6.8= 51.72 - 6.8= 44.92

Iol calculated using this K value is =+1.5 USING SRK II AND -0.5 USING HOLLADAY. If we use topographic K i.e. 34, then [34 x1.143]- 6.8=32.06 using this value IOL CALCULATED is SRK T--- +16; SRK II-----+ 13; HOLLADAY---- +15 . The manual keratometry cannot be relied on as the mires were not clear and approximate readings were taken.

By the rule of thumb---- according to this rule routinely IOL power is 21 D and we have to deduct -4.25D at spectacle plane which will be approx. -8 D AT lens

position. So IOL of 13 D should have been implanted.

But all these applicable formulae are not answering the hypermetropia of + 11D. As research is going on in these problems to find out accurate formula we may get the missing part of puzzle in future. Now at this stage what we can do is

1] IOL exchange with maximum IOL power we have calculated. [2][3] [7] [13]

2] Piggyback IOL for the residual refractive error [2] [3] [7] [14]

3] Hypermetropic lasik for the residual hypermetropia [12][2]

In general if we look for acceptability and accuracy of the above said formulae; classic history method appears most acceptable and accurate [2][4][10][13]. Then topographic method, if access to topography is possible, appears accurate [2]. And if nothing is available hard contact lens will work best [10]. Also we have to keep in mind that we should wait for 3 months in case of RK patient. Last thing is we should take flatter K and aim for myopia.

What care should we take ----

1. Warn your patients that none of these methods can guarantee the desired, healed refractive result and that they may need to undergo a lens exchange, implantation of a piggy-back lens, or some other surgical adjustment. in case there is a permanent refractive surprise

2. Before any refractive surgery is planned, patient's pre operative keratometry, pre operative intraocular lens power should be given to him for future reference. Details of surgery should also be written on it. The patient should be made aware of the importance of the given data and stress should be given to proper storage/filing of the data.

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Contact Details :

Dr. Devdutt and Dr. Charuta Mandke Desai - Residents in Ophthalmology- MGM Hospital, Kamothe , Navi Mumbai

Dr. Suresh Ramchandani- Private Practice - Nerul, Navi Mumbai

Dr. P Kumthekar- Private Practice- Alibag- Raigad Maharashtra

Address for Communication :

Dr. Suresh Ramchandani

Shivam Eye Clinic

Plot No. 29, Snehal CHS, Sector 17, Nerul , Navi Mumbai

E mail Address- Shivamey2003@Yahoo.co.in

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Dr. Kumar J. Doctor

Doctor Eye Institute, Spenta Mansion,

S.V.Road,Andheri(w),, Mumbai-400058

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