

Comparison of Intraocular Lens Power Calculation Using the Binkhorst and SRK Formulae: A Clinical Study

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Abstract

Comparison of results of intraocular lens implants with IOL powers obtained by Binkhorst and SRK Linear Regression formulae was done using various models and brands of intraocular lenses. Of 887 pseudophakic patients. 415 patients received IOL's with their powers calculated for planned emmetropia, by means of theoretic formula devised by R.D. Binkhorst and in the remaining 472 eyes the IOL power was calculated with the SRK Linear Regression method. No significant difference ($P < 0.05$) was found between visual acuities, obtained with IOL's alone or after postoperative overcorrection of residual refractive errors between the two groups (JPMA 45:38, 1995).

Introduction

Cataract is an important cause of visual impairment and blindness worldwide, Cataract surgery is effective and widely available in most industrialized countries. The removal of the patient's lens creates such formidable obstacles that it has been stated that the "first complication of cataract surgery is aphakia". These cataractous lenses, thus, must be replaced with a prosthetic optical device before useful vision can be restored to the operated eye. Spectacles have been the classic and the most common method of correcting aphakia. Unfortunately, they cause visual problems that reduce patients satisfaction¹. Hard and soft contact lenses may also be used after cataract extraction. They cause fewer visual problems, but many aphakic patients cannot or will not wear them².

Recently, in a rapidly increasing number of extractions, a prosthetic acrylic intraocular lens (IOL) is being surgically implanted inside the eye. These lenses provide many advantages over spectacles and contact lenses³. To calculate the power of IOL to be implanted there are theoretical as well as mathematical formulae available.

The Binkhorst theoretical formula⁴ in which P indicates implant power for emmetropia; N, refractive index of aqueous and vitreous; C, estimated postoperative anterior chamber depth; L, axial length of the globe in millimeters; and K, average corneal refractive power in diopters.

The mathematical SRK Linear Regression formula⁵ is: $IOL = A - 2.5L - 0.9K$, where IOL= emmetropic IOL power; A= the "A-constant" of the specific IOL being used; AL= axial length of the globe in mm and K= average corneal refractive power in diopters.

The aim of this study was to evaluate the accuracy and reliability of the two commonly employed formulae for intraocular lens power calculation (i.e. Binkhorst and Linear Regression).

Patients and Methods

We reviewed a consecutive series of 887 extracapsular cataract extractions with intra-ocular lens implantation performed between May, 1987 and July, 1992 at Shaikh Zayed Postgraduate Medical Institute, Lahore, Pakistan. The history of Ophthalmic problems was recorded along with evaluation for any systemic disease. Visual acuity was tested, cover test performed and extraocular movements were checked. Slit lamp biomicroscopy, applanation tonometry and funduscopy were carried out. Calculation

of IOL power was done by feeding the average "K reading" and axial length obtained by A-scan ultrasonography using the Biophysic or the Hondex Biometer, into the latter's built in computer. The computer had been pre-programmed for "A-constant" and anticipated A.C. depth of several models of IOLs used in the study. Binkhorst and SRK formulae were used for computations and students "t" test applied to see the difference. Extracapsular cataract extraction was carried out in a standard way. Intraocular lens was inserted using either air or methylcellulose as a cushion. Both modified J-loop and C-loop lenses were used manufactured by Cilco, Surgidev, Domilens and AMO. Patients were discharged on the first or second post-operative day on antibiotic and steroid eye drops. The postoperative follow up was 1,2,4 and 8 weeks. Visual acuity with IOL and with pinhole was recorded at each visit. Refraction was done at 8 - 10 weeks after surgery. Sutures were cut if astigmatism measured more than 2.50 diopters.

Results

The patients were divided into two groups. Group I comprised of 415 patients receiving IOLs with their powers calculated by Binkhorst formula. Group II comprised of 472 patients receiving IOLs with their powers calculated according to SRK Linear Regression formula. The two groups were studied as regards the outcome in terms of visual acuity (VA) achieved with IOLs alone as well as the best corrected VA. The refraction needed to achieve the best corrected VA was also compared in the two groups. Visual acuity was measured at one time or another after IOL implantation in 321 patients in group I (77.3%) and 305 in group II (64.6%). Visual acuities achieved on stabilization of VA were compared. Visual acuity of 6/6 - 6/12 was achieved in 92 patients (28.6%) in group I and in 72 (23.6%) in group II; while 6/18 to 6/60 vision was achieved in 204 patients (63.5%) in group I and in 194 (63.6%) in group II. Visual acuity between CF and perception of light was present in 25 patients (7.7%) in group I and in 39 (12.7%) in group II (Table I).

Table I. Comparison of uncorrected VA with IOL BK VS LR

Visual acuity	BK		LR	
	No. of cases	%age	No. of cases	%age
6/6 - 6/12	92	28.6	72	23.6
6/18 - 6/60	204	63.5	194	63.6
CF - PL	25	7.7	39	12.7
Total	321	100	305	100

BK= Binkhorst, LR= Linear Regression, VA= Visual acuity

There was, thus no significant statistical difference between the visual acuities obtained by the Binkhorst and Linear Regression formulae (P value >0.05). The postoperative refractions were compared for each group in terms of spherical equivalent (Table II).

Table II. Comparison of overcorrection prescribed BK Vs LR

Visual acuity	BK		LR	
	No. of cases	%age	No. of cases	%age
-2.25 to -6.25	41	18.9	25	14.3
± 0.25 to ± 2.00	167	77.2	142	81.6
+2.25 to +5.00	8	3.7	7	4.0
Total	216	100	174	100

Refraction was done in 216 patients in group I and 174 patients in group II. The over correction prescribed was ± 2.0 in 167 patients (77.2%) in group I and 142 patients (81.6%) in group II. Over correction above ± 2.00 was required in 49 patients (22.6%) in group I and in 32 patients (18.3%) in group II. There was no significant statistical difference between the two groups (P value >0.05). Final visual results showed that visual acuity between 6/6 and 6/12 was achieved in 196 patients (89.9%) in group I and in 155 patients (85.6%) in group II. Visual acuity between 6/18 and 6/60 was achieved in 21 patients (9.6%) in group I and in 24 patients (13.2%) in group II. Visual acuity between CF and PL was present in 1 patient (0.45%) in group I and in 2 patients (1.10%) in group II (Table III)

Table III. Comparison of corrected VA with IOL BK Vs LR

Visual acuity	BK		LR	
	No. of cases	%age	No. of cases	%age
6/6 - 6/12	196	89.9	155	85.6
6/18 - 6/60	21	9.6	24	13.2
CF - PL	1	0.4	2	1.1
Total	218	100	181	100

(Not significant).

Table IV. Causes of post-operative visual acuity less than 6/12 in group I and II.

No. of eyes	Cause of poor vision
Group I. 22 eyes (10.08%)	
07	Age related macular degeneration
01	Branch retinal artery occlusion
01	Branch retinal vein-occlusion
02	Optic atrophy
01	Cystoid macular edema
02	Diabetic retinopathy
01	Persistent uveitis
02	Corneal decompensation
05	After cataract
Group II. 26 eyes (14.35%)	
05	Age related macular degeneration
01	Central retinal artery occlusion
04	Optic atrophy
03	Cystoid macular edema
01	Retinal detachment
01	Diabetic retinopathy
09	After cataract
02	Records not traceable

Table IV lists the causes for poor visual acuity in the 22 patients (10%) in group I who did not improve to 6/12 and persistent poor visual acuity in 26 patients (14.3%) in group II whose vision remained below 6/12.

Discussion

Intraocular lens implantation is at present the commonest method of visual rehabilitation after cataract extraction in the developed countries. In the past five years this has also become the commonest method for this purpose at our Institute. Successful results of IOL implantation depend partly on the ability to predict postoperative refraction with accuracy. There is increasing evidence of the value of preoperative biometry to calculate the power of an intraocular lens implant used during cataract surgery to avoid the possibility of large postoperative refractive errors associated with the use of a standard power lens as is often done when biometry is not available¹⁵. Because the power of an intraocular lens implant cannot be altered postoperatively without further surgical intervention, a reliable procedure is needed for predicting and achieving the final chosen refractive status. Calculation of the intraocular

lens implant power is still a relatively controversial subject. Despite the availability of numerous formulae none has proven superior in all clinical situations¹⁰. This is mainly due to the presence of various specific variables, like the type of keratometer or ultrasound equipment used and the surgical technique adopted. These formulae are either mathematical, based on theoretical optics^{6,7}, empirical, based on statistical regression analysis of a large number of implant patients⁸, or a combination of the theoretical and empirical approaches⁹. Some authors have recommended that the ideal solution to this problem for the individual surgeon is to develop his own formula. However, not all ophthalmologists have the time or the resources to do this and hence have to depend on one of the readily available IOL calculation formulae. The purpose of this study was to evaluate the results in our patients using two different formulae (i.e. Binkhorst and SRK Linear Regression) and compare the accuracy and reliability of these two commonly employed formulae. The accuracy of IOL calculation may be evaluated in terms of symmetrical errors and in terms of random errors. A symmetrical type of error is found when the average refraction deviates from the expected and may be due to symmetrical errors in the measurement system or in the formula. A random error, on the other hand, results from the inevitable errors in any measurement system. Dang and Sunder¹¹ reported a high degree of predictive accuracy to the users of the SRK-II Linear Regression formula than the original SRK and Binkhorst II formulae. The constants used can be easily modified for the surgeon's specific variables and thus improve its ability to predict IOL power. Retzlaff and Medford¹² reported more accurate results with Regression Formula than with Theoretic Formulae. Similar results have been quoted by Tutton¹³. Binkhorst and Linear Regression formulae are less accurate in axial myopes¹⁴. Armstrong and Lichtenstein¹⁶ reported that the Binkhorst formula is more accurate than Linear Regression formula in eyes with high myopia. In our study data from 887 eyes with intraocular lens implants were used to compare the prediction accuracy of two different lens power formulae: Binkhorst and SRK Linear Regression formulae. No significant statistical difference was found in the postoperative visual acuities without over correction and in the residual postoperative refractive error while using the two formulae (P value >0.05 by 't' test). After testing the accuracy and reliability of the two formulae it is then optional to use any of these two formulae it is then optional to use any of these two formulae for IOL power calculation. We hope that more studies in which the IOL power is recalculated using postoperative measurements will demonstrate that previously unexplained differences between these formulae are due to poor techniques and inadequacies in current instrumentation and that these findings will require manufacturers to upgrade the quality of the instruments to their full potential.

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