The SRK regression formula in calculating the dioptric power of intraocular lenses

JOSE L. MENEZO, VICENTE CHAQUES, AND MIGUEL HARTO

From the Department of Ophthalmology, Postgraduate Medical School, La Fe Medical Centre, Valencia, Spain

SUMMARY One hundred and seventy one eyes with intraocular lenses were studied to compare the predictive accuracy of the Fyodorov and Van der Heijde theoretical formulae of the Sanders-Retzlaff-Kraff (SRK) regression formula. The SRK regression formula was the most accurate. Our personal calculations of the A constants of this formula are given for several types of implants and manufacturers.

Calculation of the dioptric power of intraocular lenses (IOL) started with Ridley,¹ who, on implanting an IOL for the first time, committed an error and left the patient highly myopic (-18 sph, -6 cyl × 120°).

Fyodorov and Kolinko² presented a theoretical formula based on geometrical optics, using keratometry and ecography. Colenbrander,³ Thijssen,⁴ Van der Heijde,⁵ and Binkhorst⁶ also developed theoretical formulae based on geometrical optics, using theoretical constants in reference to schematic eyes.

Although apparently different, all these formulae are in fact identical and differ only in terms of small correctional factors. They may all be algebraically transformed thus⁷:

$$P = \frac{N}{L-C} - \frac{N K}{N-KC}$$

where: P=dioptric power of the IOL for assuring emmetropia, N=refractive index of vitreous and aqueous humour, C=estimated postoperative anterior chamber (AC) depth in mm, L=antero-posterior length of eye in mm, K=corneal dioptric power.

Recently Sanders, Retzlaff, and Kraff⁸⁻¹⁰ studied a series of more than 2500 by means of a regression analysis involving the search for a mathematical function that best interrelates a number of variables. They found that the dioptric power of the IOL for assuring emmetropia fundamentally depends on the axial length of the eye and the corneal dioptric power. On the other hand the postoperative depth of the AC and the refractive indices of the aqueous and vitreous humours bear no significant influence. In this way

Correspondence to Dr J. L. Menezo, Departamento de Oftalmología, Ciudad Sanitaria La Fe, Av Campanar 21, Valencia-9, Spain.

they developed and perfected a simplified regression formula, coming to the same conclusions from completely different sources of data. This gave rise to the SRK formula.

We have studied 171 patients with intraocular implants from a large variety of models and manufacturers. The final visual acuity (VA) was equal or greater than 20/40 in all cases. All implants were carried out by the same surgeon. The axial length of the eye was measured prior to the operation with a Systems Inc. Ophthalmoscan model 100 sonometric echograph. The corneal dioptric power and its curvature radii were registered in its principal meridians with a carefully calibrated Haag-Streit ophthalmometer. The anterior chamber depth and the corneal thickness were measured with the pachymeter of the Haag-Streit slit-lamp. The post-operative ophthalmometric data as well as the final VA were recorded on average 9 months after surgery.

The dioptric power of the IOL was calculated according to the following formulae:

$$\text{Fyodorov: } P = \frac{N-LK}{(L-C) \left(1 - \frac{CK}{N}\right)}$$

Van der Heijde (VDH):

$$P = \frac{N}{L-C} - \frac{1}{\left(\frac{1}{K} - \frac{C}{N}\right)}$$

$$\text{SRK: } P = A - 2.5 L - 0.9 K$$

where P, N, L, K, and C are the parameters mentioned above and A is a constant derived for each type of lens and manufacturer.

In the first calculation we considered the constant A as indicated by Sanders, Retzlaff, and Kraff in their

Fig. 1 Percentage distribution of the number of cases according to residual error (e) and calculation formula.

manual.⁷ In the event of any of them not having been published, we made use of an assumed constant A.

After the operation, and knowing the dioptric power of the actual implanted lens as well as the additional postoperative correction by which the maximum VA is obtained, we calculated the dioptric power of the ideal lens that should have been implanted in order to assure emmetropia. This calculation was carried out with the following formula:

$$P_c = P_{\text{real}} + 1.5 R$$

where: P_c = power of the ideal lens that would have assured emmetropia, P_{real} = power of the implanted lens, and R = spherical equivalent of the additional postoperative refraction.

Subsequently we found the difference or error existing in each case between the power of the ideal IOL for

Fig. 2 Percentage distribution of the number of cases according to residual error (e) and calculation formula.

assuring emmetropia and that calculated for each one of the formulas.

The results obtained on analysing these differences or errors were as follows:

	Mean	SD
Fyodorov formula	2.84	1.80
VDH formula	3.21	1.91
SRK formula	2.18	1.43

The percentage distribution of the number of cases according to the residual error (e) and the calculation formula for all 171 intraocular lenses was as follows (Figs. 1 and 2):

	$e \leq 1$	$1 < e \leq 2$	$2 < e \leq 3$	$3 < e \leq 4$	$4 < e$
SRK	48.45	28.64	10.90	6.36	5.65
Fyodorov	30.44	21.62	18.36	15.73	13.85
VDH	16.25	22.65	26.48	20.31	14.31

The superiority of the SRK regression formula over the 'classical' theoretical formulae has been shown in different reports by Sanders *et al.*⁸⁻¹¹ We have made the same observation in our own series.

These authors point out that the constant A of the SRK formula must be individualised for each type of lens and manufacturer if we wish to assure maximum precision in calculating the dioptric power of the IOL.

What is more, even for the same type of lens and manufacturer they observed small differences according to the surgeon in charge of implanting a given series of intraocular lenses.⁷ In view of this, Sanders, Retzlaff, and Kraff advise calculating personal A constants and comparing them with those published.

In the 171 eyes considered here we implanted an

Table 1 A constants for each type of lens and manufacturer

Type of lens	Manufacturer	A (published or assumed)	A' (ours)
Choice Mark IX	Rayner	116.0	115.1
Miniflex	Cilco	115.3	114.7
Optiflex	Cilco	115.3	114.8
Fyodorov-Sputnik	Medexport URSS	115.6	114.8
Worst Medallion	Medical Workshop	115.6	113.1
Binkhorst 2-Loop			
Iridocapsular	Morcher	115.0	113.8
Binkhorst 4-Loop			
Irisclip	Morcher	115.0	113.2
Simcoe	Cilco	116.6	115.0
Simcoe II	Cilco	116.6	115.2
Pearce Tripod	Rayner	117.6	116.2
Pearce Tripod	Cilco	117.6	116.1
Kratz J-Loop KR-1	Cilco	116.2	115.0

IOL calculated by the SRK formula and using the constants A (published or assumed) as indicated in Table 1. We then determined P_c and the difference between P_c and P_{SRK} (dioptric power calculated by the SRK formula). Subsequently we tried to calculate the constant A which in each case we would have had to use in order to make P_{SRK} coincide with P_c . This particular constant A was for each case referred as A'.

In order to determine the A' corresponding to each case we algebraically added the value of $(P_c - P_{SRK})$ to A. We then calculated the arithmetical mean of these

A' values for not fewer than 10 cases of a given type of lens and manufacturer. The result was our own constant A for that particular lens and manufacturer (Table 1).

References

- 1 Ridley H. Intra-ocular acrylic lenses. A recent development in the surgery of cataract. *Br J Ophthalmol* 1952; **36**: 113-22.
- 2 Fyodorov SN, Kolinko AI. Estimation of optical power of intra-ocular lens. *Vestn Oftalmol* 1967; **80**: 27-31.
- 3 Colenbrander MD. Calculation of the power of an iris clip lens for distance vision. *Br J Ophthalmol* 1973; **57**: 735-40.
- 4 Thijssen JM. The emmetropic and the isiconic implant lens: computer calculation of the refractive power and its accuracy. *Ophthalmologica* 1975; **171**: 467-86.
- 5 Van der Heijde GL. A nomogram for calculating the power of the prepupillary lens in the aphakic eye. *Bibl Ophthalmol* 1975; **83**: 273-5.
- 6 Binkhorst RD. The optical design of intraocular lens implants. *Ophthalmic Surg* 1975; **6**: 17-31.
- 7 Retzlaff J, Sanders D, Kraff M. *A manual of implant power calculation*. Oregon: Medford, 1982.
- 8 Retzlaff J. A new intraocular lens calculation formula. *Am Intra-Ocular Implant Soc J* 1980; **6**: 148-52.
- 9 Sanders D, Kraff M. Improvement of intraocular lens power calculation using empirical data. *Am Intra-Ocular Implant Soc J* 1980; **6**: 148-52.
- 10 Retzlaff J. Posterior chamber implant power calculation: regression formulas. *Am Intra-Ocular Implant Soc J* 1980; **6**: 268-70.
- 11 Sanders D, Retzlaff J, Kraff M, et al. Comparison of accuracy of Binkhorst, Colenbrander and SRK implant power prediction formulas. *Am Intra-Ocular Implant Soc J* 1981; **7**: 337-40.