Trial for New Intraocular Lens Power Calculation Following Phototherapeutic Keratectomy

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Purpose: To determine an equation to calculate the intraocular lens (IOL) power for eyes that have undergone laser phototherapeutic keratectomy (PTK).

Methods: The Gullstrand series was used to determine the power and radius of curvature of a convex-plane IOL, which will alter the focal point from the cornea to the conjugate point on the retina using the ray tracing method.

Results: The radius of curvature of the anterior corneal surface (R), axial length (AXL), the predicted postoperative anterior chamber depth (ACD), and lens thickness (LT) were used in the following formula to calculate the refractive power of the IOL to be used: $K = R/7.7$, $DC = 337.5/R$, $VC = lOOO/DC \cdot 1.336$ where VC is the posterior vertex focal length, $A_1 = -(VC - ACD)$, $B_1 = AXL - 0.5 \cdot K - ACD - 0.103LT$, $S = l/A_1 + l/B_1$, K is the proportional expression for anterior corneal curvature, DC = anterior corneal refractive power, A_1 = distance from anterior surface of IOL to posterior vertex focal point, B_1 = distance from the second principal point of IOL to the retina, S = 1/focal length of IOL in air. Using this equation, the power (in diopters) of the IOL in liquid was determined to be $1000/(l/S) \cdot 1.336$. In eyes that have undergone PTK, the keratometric value prior to cataract surgery is not used. Instead a value, R', is introduced. R' is defined as $(R - 376/1376 \cdot dT)$, where R is the radius of corneal curvature prior to PTK and dT the amount of corneal tissue removed. The corneal thickness after cataract surgery, CT', was defined as $CT - dT$, where CT is the corneal thickness prior to PTK.

Conclusion: The new equation appears to be useful for determining the IOL power, although it is important to select a lens that has the accurate predicted anterior chamber depth. **Jpn J Ophthalmol 2000;44:400–406** © 2000 Japanese Ophthalmological Society

Key Words: Anterior chamber depth, intraocular lens, phototherapeutic keratectomy, ray tracing, SRK-II formula.

Introduction

Clinical studies on corneal photorefractive keratectomy (PRK) and phototherapeutic keratectomy (PTK) using excimer lasers have recently been completed in Japan. The PRK procedure was approved this year from the Japanese Ministry of Health and Welfare. At present, only a few ophthalmic surgeons and doctors who are not ophthalmologists in private practice are engaged in PRK and PTK. It is predicted that once the techniques are approved, the number of such practitioners will increase significantly.

Because the radius of curvature is drastically altered following either of these procedures, it is highly likely that the conventional method (such as the SRK-II formula) will not accurately calculate the power of the intraocular lens (IOL) to be implanted. In certain cases, cataract surgery becomes necessary after PTK or PRK.

Some eyes that have undergone PRK are reported to have become hyperopic following the IOL implantation.[1] We have encountered the hyperopic shift in some eyes undergoing IOL implantation af-

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ter PTK. Based on these findings, we reviewed the conventional method of calculating the power of the IOL and we now introduce a new equation for determining the IOL power in eyes treated by laser PTK.

Materials and Methods

Gullstrand Series

The Gullstrand eye model was used as reference for the corneal data, where R_1 is the radius of curvature of the anterior corneal surface, R_2 is the radius of curvature of the posterior corneal surface and T is the corneal thickness. In this schematic eye model, R_1, R_2, and T are 7.7 mm, 6.8 mm, and 0.5 mm, respectively. When R_1 was increased from 6.5 to 9.5 mm at 0.2-mm intervals, new T and R_2 values were calculated while the reciprocal ratio remained constant ($R_2 = R_1/7.7 \cdot 6.8$ and $T = R_1/7.7 \cdot 0.5$). These three constants were then employed in the ray tracing method using Abbe's zero invariant to obtain the posterior vertex focal length (VC) in air. The 1000/VC values revealed refractive powers differing from those of the Gullstrand eye by only about 0.0003 diopters (D) (Table 1) We will temporarily call this "the Gullstrand series" and make these values our basic corneal data.

From the readings of the keratometer, we obtained the focal point of the cornea. The keratometric reading reveals the refractive power of the corneal posterior vertex focal point for the anterior corneal surface (facing air) and for the posterior corneal surface (facing the aqueous humor). The refractive power of the IOL in liquid, which alters the focal length from the cornea to the conjugate point on the retina, was calculated based on the corneal posterior vertex focal length and the length of the optic axis. The power and the radius of curvature of the IOL were calculated using the predicted anterior chamber depth and a tentative determination of the lens thickness. In addition, we made the final calculations by including the lens power and lens curvature obtained from the ray tracing system. By changing the conditions (eg, changes in the anterior chamber depth or the radius of curvature of the posterior corneal surface), various models can be simulated and the calculations adjusted accordingly.

Table 1. Comparison of Gullstrand Series of Basic Corneal Data and Readings with Keratometer

	Refractive Power (D)	
Radius (mm)	Keratometer	Gullstrand Series
6.5	51.9231	51.9228
6.7	50.3737	50.3729
6.9	48.9130	48.9128
7.1	47.5352	47.5349
7.3	46.2329	46.2326
7.5	45.0000	44.9998
7.7	43.8312	43.8309
7.9	42.7215	42.7213
8.1	41.6667	41.6664
8.3	40.6627	40.6624
8.5	39.7059	39.7057
8.7	38.7931	38.7929
8.9	37.9214	37.9211
9.1	37.0879	37.0877
9.3	36.2903	36.2901
9.5	35.5263	35.5261

The phacoemulsification technique was employed in all patients and the IOL was fixed in the capsular bag. The patient data were examined more than 2 months postoperatively.

Calculation Method

In order to obtain the image point from two optical components, we used the ray tracing method (Figure 1). First, we obtained the image point from the first lens system (cornea), then calculated the final image point on the retina using the first image point as the object point. In the first lens system, the front is air ($n = 1.000$) and the back is anterior chamber fluid ($n = 1.336$). In visual optics, the cornea's image point is calculated in the same medium as the anterior chamber regardless of the value. Therefore, even if the focal point is beyond the retina, the focal point is assumed to be in liquid with $n = 1.336$. In the second lens system (lens), the front is the anterior chamber, and the back is the vitreous. Both liquids have index of refraction values of $n = 1.336$. In the case of IOL implantation, we first calculate the focal point (C) of the cornea, then from the focal point and the position of the implanted IOL, we calculate the object distance "a." The image point is calculated from the IOL and retinal positions (F) obtained from axial length, and applied to the basic lens calculation, $1/a + 1/b = 1/f$.

In the actual IOL calculations, the principal points are necessary when considering the lens thickness. The important point is that a is the distance from the first principal point (H_1) to the image point of the corneal system, and b is the distance from the second principal point (H_2) to the retina. As for the conjugate points previously mentioned in the relationship between the object and the image points of the lens, a difference in the distance of the object point a results from the keratometer reading. In addition, an error in the image position occurs from measurement errors of the axial length. It is necessary to take these and an error in the predicted anterior chamber

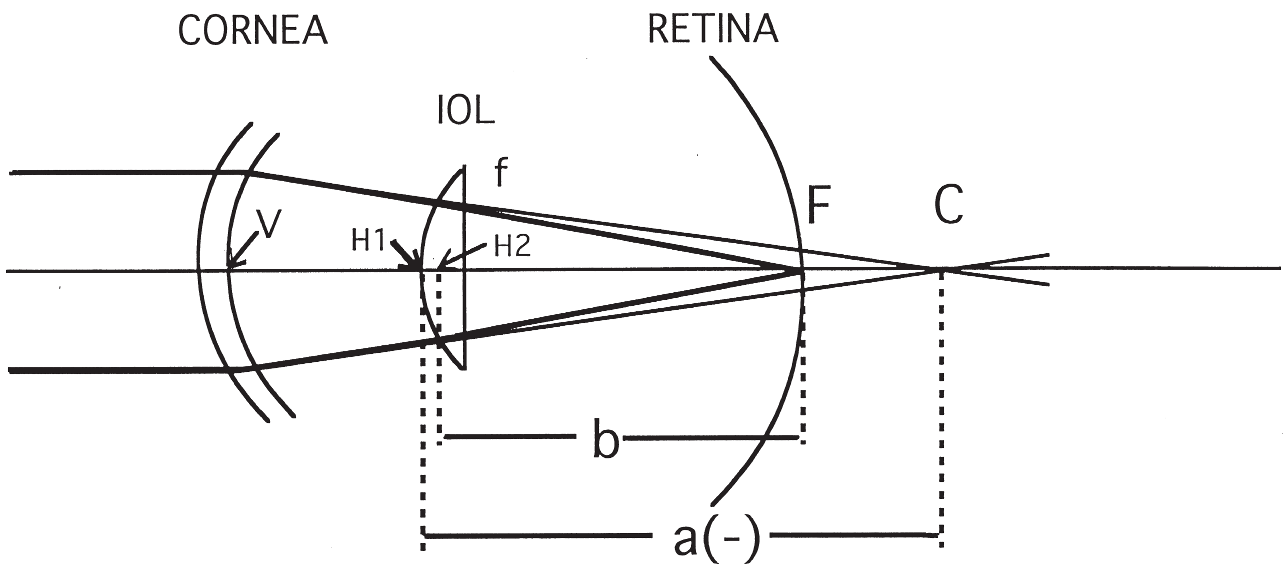

Figure 1. Conjugate points. H_1, H_2: first and second principal points of convex-plane intraocular lens (IOL). See text (Materials and Methods, Calculation Method) for details.

depth (predicted ACD) into consideration because these errors affect the postoperative refraction.

For calculation of a convex-plane IOL (Table 2):

$$a = -(CF - ACD)$$
$$b = AXL - 0.5 * K - ACD - LT + 0.897 * LT$$
$$S = 1/a + 1/b$$
$$NF = 1/S$$
$$DC = 337.5/R$$
$$CF = 1000/(DC) * 1.336$$
$$K = R/7.7.$$

The IOL refractive power is calculated using these values obtained for the radius of curvature of the anterior corneal surface (R), axial length (AXL), predicted ACD, and lens thickness (LT).

In eyes that have undergone PTK, the keratometric value prior to cataract surgery is not used. Instead a value R' is used. R' is defined as R = 376/1376 · dT, where R is the radius of corneal curvature prior to PTK and dT the amount of corneal tissue removed. AXL' is defined as AXL − dT where AXL is the axial length before PTK. The corneal thickness before cataract surgery (CT') is defined as CT − dT where CT is the corneal thickness prior to PTK.

For cataract surgery, in general, our new calculations should be theoretically the same as the SRK-II value calculated for the implanted IOL. In order to verify this, we examined 10 cases with the Nidek (NP74-A) implant and 10 cases with implanted Pharmacia (821T) IOLs. Although both types of IOL are biconvex, we compared the difference in the final refractive values with that obtained with the SRK-II formula, using a calculation method for a convex-plane IOL.

For each IOL, the predicted ACD is listed. It is

Table 2. New Equation for Convex-Plane Intraocular Lens (IOL)

Equation	Variables
$R_1 = 337.5/DC$	ACD: predicted anterior chamber depth (mm)
$ACD' = ACD - 0.5 * K - LT/2$	AXL: axial length (mm)
$CF = 1000/DC * 1.336$	LT: lens thickness (mm)
$A_1 = -(CF - ACD')$	DC: corneal refracting power
$B_1 = AXL - 0.5K - ACD' - 0.103LT$	R_1: radius of anterior corneal curvature (mm)
$S = 1/A_1 + 1/B_1$	$K = R_1/7.7$
$NF = 1/S$	R_2: radius of posterior corneal curvature (mm)
$DL = 1000/NF$	CF: posterior vertex focal length (mm)
IOL power = DL × 1.336	A_1: first principal point of IOL to posterior vertex focal point
	B_1: second principal point of IOL to retina

Table 3. New Formula and SRK-II Formula Compared by Errors of Refraction and Anterior Chamber Depth (ACD) Prediction in 10 Cases*

	Case No.									
	1	2	3	4	5	6	7	8	9	10
IOL power (SRK-II)(D)†	19.95	17.49	16.32	26.1	26.05	18.88	10.9	9.66	22.1	17.86
Attempted refraction (D)	−0.88	−0.8	−0.94	−0.75	−0.76	−0.91	−2.6	−2.7	−1.1	−0.74
Final refraction (D)	−4	−1.25	−2.5	−0.5	−2	−1.25	−3	−3.5	−1.75	−1.26
Refractive error (SRK-II)(D)	−3.12	−0.45	1.56	0.25	−1.24	−0.34	−0.4	−0.8	−0.65	−0.52
IOL power (New formula)(D)	20.41	16.76	16.07	28.85	28.78	16.92	10.13	6.19	23.8	17.25
Refractive error (New)(D)	−3.58	0.28	−1.31	−2.50	−3.97	−0.38	0.37	0.67	−2.35	0.35
Predicted ACD (mm)	4.355	4.41	4.41	4.255	4.255	4.38	4.45	4.47	4.32	4.32
Postoperative ACD (mm)	3.4	4.66	4.1	3.77	3.1	4.1	3.89	3.76	3.32	3.54
Error of ACD (mm)	0.955	−0.25	0.31	0.485	1.155	0.28	0.56	0.71	1	0.78
Refractive Error after corrected ACD (D)	−1.9	−0.11	−0.88	−1.19	−1.01	0.08	0.81	1.13	−0.27	1.53

*Nidek 3-piece convex-plane intraocular lens was used.
†IOL: Intraocular lens, D: Diopter.

important to point out that the predicted ACD is different from the value measured from the posterior cornea to the anterior surface of the lens, which we usually use clinically. Depending on the type of IOL, the measurements and references used to predict the ACD differ. For the Nidek (NP-74A) IOL, the ACD is measured from the anterior surface of the cornea to the center of the first and the second principal points of the IOL. On the other hand, measurement of the ACD for the Pharmacia IOL (821T) is made from the anterior surface of the cornea to the anterior surface of the IOL. Furthermore, the depth appearing on the Nidek ultrasound device (A mode) is actually the distance from the anterior surface of the cornea (precisely from the top of the chip) to the anterior surface of the lens (or IOL). The ACD we used in this calculation is the depth from the posterior surface of the cornea to the anterior surface of the lens (or IOL).

Results

Determination of Refractive Power of IOLs for Cataract Patients Without PTK

For the Nidek IOL patients (Table 3), the new calculations showed a difference of −3.58 D in case 1, −2.50 D in case 4, −3.97 D in case 5, and −2.35 D in case 9 between the attempted refraction and the final refraction. This difference is greater than that with the SRK-II calculation. In order to investigate these results further, we compared the predicted ACD to the postoperative one. We initially set the ACD as the distance from the anterior surface of the cornea to the anterior surface of the lens (or IOL). In 4 cases, the values of the ACD were less than the predicted ACD value by 0.96, 0.485, 1.16 and 1.00 mm. Using these values of the actual ACD, the differences in the final refraction in the four cases were −1.9 D, −1.19 D, −1.01 D, and −0.27 D. These values are similar to the values obtained using the SRK-II calculation. In examining the 10 cases, we found that the Nidek IOL had a greater difference in the postoperative ACD than the predicted preoperative ACD values; however, all the final refraction data were negative values.

In the Pharmacia (821T) IOL implant cases (Table 4), all except case 12 showed a difference greater than +1.17 D between the attempted and the final refractive values. There was a tendency to develop hyperopia. By applying the new calculation method, the results turned out to be more ideal than with the SRK-II formula except for case 11. Compared with the Nidek lens, there was very little difference in the postoperative ACD. The values obtained, which ranged from 4.41 to 4.60 mm, were very close to the predicted ACD of 4.60 mm. In case 16, however the postoperative ACD was especially low with a value of 3.31 mm. Using the new equation with a value of 3.31 mm, the final difference in the refraction was 0.99 D.

The differences in the refractive values of the two lenses and the comparison of SRK-II values with the values obtained using the new equation are shown in Figure 2. It can be seen that in cases implanted with the Nidek three-piece IOL, the mean difference was 0.93 ± 0.87 D with the SRK-II formula, 1.57 ± 1.42 D with the new equation without ACD correction, and 0.89 ± 0.599 D with the new equation after ACD correction. The refractive values show no significant difference in all three groups despite an increase of 1.6 times the SRK-II formula for the cor-

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Table 4. Comparison of New Formula and SRK II Formula in Measurement of Errors of Refraction and Anterior Chamber Depth (ACD) Prediction in 10 Cases*

	Case No.									
	11	12	13	14	15	16	17	18	19	20
IOL power (SRK-II)(D)†	12.31	11.95	16.98	19.9	20.08	22.03	21.43	19.19	20.96	19.44
Attempted refraction (D)	−1.19	−2.06	−2.02	−0.87	−1.12	−1.17	−1.03	−1.06	−0.83	−1.02
Final refraction (D)	0	−2.56	−0.5	0.75	0.25	0	0.5	0	0.75	1.5
Refractive error (SRK-II)(D)	1.19	−0.5	1.52	1.62	1.37	1.17	1.53	1.06	1.58	2.52
IOL power (New formula)(D)	12.01	11.39	17.82	21.28	21.54	24.81	23.96	20.37	23.18	20.79
Refractive error (New)(D)	1.49	0.06	0.675	0.24	−0.09	−1.6	−1	−0.12	−0.64	1.17
Predicted ACD (mm)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Postoperative ACD (mm)	4.51	4.54	4.41	4.45	4.45	3.31	4.65	4.1	3.87	3.81
Error of ACD (mm)	−0.01	−0.04	0.09	0.05	0.05	1.19	−0.15	0.4	0.63	0.69
Refractive error after corrected ACD (D)	1.48	0.02	0.81	0.24	0.00	0.99	−1.35	0.65	−0.31	1.60

*Pharmacia single-piece convex plane intraocular lens was used.
†IOL: Intraocular lens, D: diopter.

rected equation (non-paired *t*-test). A comparison of the postoperative ACD and the predicted one showed that the value of postoperative ACD was significantly lower ($P < .05$ non-paired *t*-test). The average decrease was 0.65 mm.

On the other hand, when the Pharmacia single piece IOLs were implanted, the difference obtained was 1.41 ± 0.52 D using the SRK-II formula, 0.70 ± 0.59 D with the new equation, and 0.59 ± 0.75 D with the new equation after ACD correction. There was a significant difference ($P < .005$) in the final refraction values between the three calculations. The new equation gave a 50% reduction in the refractive value (non-paired *t*-test, $P < .005$). In addition, the Pharmacia IOLs showed very little difference in the predicted and postoperative ACD, and the average

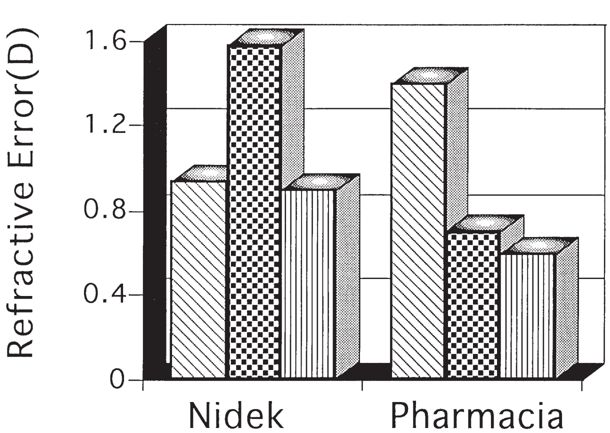

Figure 2. Refractive errors after intraocular lens (IOL) (Nidek and Pharmacia) implantation in three groups. (oblique, SRK-II; reticular, new formula; longitudinal, new formula using corrected anterior chamber depth.)

was half the Nidek value at 0.33 mm. Therefore, the IOL power after recalculation using postoperative ACD showed little difference compared with the value obtained from the new equation.

IOL Power Calculation for 2 PTK Patients

The first patient (KS) was a 73-year-old man who had bilateral band keratopathy. His first visit was in May 1994. Visual acuity in his right eye was SL (−) and in the left, 10 cm/nd (nc). Corneal refractive power was K_1 = 33.5 D, K_2 = 37.25 D. In August 1994, PTK was done on his left eye; cutting rate 160 μm. Three months after PTK, visual acuity in his left eye was 0.05 (0.08 x +2.00 D). In January 1995, he had a planned extracapusular cataract extraction with IOL implantation (+13.0 D) in his left eye (SRK-II method was used). The corneal refractive power before cataract surgery was K_1 = 33.5 D, K_2 = 37.25 D, axial length was 29.64 mm, predicted ACD of IOL was 4.8 mm. Nine months after cataract surgery, visual acuity in his left eye had improved to 0.3 (0.4 x +2.25 D = cyl −1.50 D Ax 20°). Postoperative refractive power was K_1 = 33.50 D, K_2 = 35.75 D.

The second patient (HT) was a 78-year-old man who also had bilateral band keratopathy. His first visit was in July 1994. Visual acuity in his right eye was 0.08 (0.2 x +2.50 D) and in the left, 0.3 (0.43 x +1.75 = cyl −3.00 D Ax 90°). Corneal refractive power was K_1 = 41.75 D, K_2 = 44.37 D. In September 1995, PTK was done on his left eye; cutting rate 110 μm. One month after PTK, visual acuity in his left eye was 0.4 (0.6 x +2.00 D = cyl −2.00 D Ax 90°). In March 1996, he had phacoemulsification with IOL implantation (+21.5 D) in his left eye

Table 5. Difference in Intraocular Lens Power Calculation After Phototherapeutic Keratectomy New Formula and SRK-II Formula (Two Cases)

	Case KS	Case HT
SRK-II (D)	11.48	20.5
New formula (D)	13.87	21.72
Attempted refraction (D)	−1.50	−1.00
Final refraction (D)	2.25	−1.00
Refractive error (SRK-II)	3.75	0
Refractive error (New)	1.35	−1.20
Predicted ACD (mm)*	4.79	4.60
Postoperative ACD (mm)	4.38	4.07
Error of ACD (mm)	0.41	0.53
Refractive error after corrected ACD (D)	1.73	−0.18

*ACD: Anterior chamber depth.

(SRK-II method was used). The corneal refractive power before cataract surgery was $K_1 = 43.0$ D, $K_2 = 43.5$ D, axial length was 23.37 mm, predicted ACD of IOL was 4.8 mm. Nine months after cataract surgery, visual acuity in his left eye was 0.07 (0.2 x −1.00 D = cyl −2.50 D Ax 180°). Postoperative refractive power was $K_1 = 42.0$ D, $K_2 = 45.5$ D (Table 5).

Discussion

The refractive power of the IOL to be implanted is usually calculated using the SRK-II formula which is:

$$P = A - 2.5\ AXL - 0.9K,$$

where A is a constant associated with the IOL, AXL is the axial length, and K is the corneal refractive power. When using the SRK-II formula, one does not have freedom to predict the ACD. Thus, changes in the A-constant have to be made according to the experience of the surgeon. Inadequate lens data from the manufacturers about this A-constant also causes uncertainty.

It has been shown that the effective power of the IOL is dependent on the implanted position. Variations in the predicted ACD for IOLs are all included in the value A.

In addition, the K value is measured by an ophthalmometer and this value is converted to the radius of the anterior corneal surface from a calculation chart. Because the corneal index of refraction (n) used is 1.336, 1.337, 1.3375, and 1.332, the correlation between millimeter graduation and the D graduation of the ophthalmometer does not always agree on different instruments. It was originally used mainly to measure corneal astigmatism. The most widely used keratometer (manufactured by Bausch and Lomb) only indicates the corneal curvature values in diopters.[3] The usual relationship between the radius of curvature and the refractive power of a surface is calculated by $D = 1000(n - 1)/R$.

In 1924, Helmholtz stated in Gullstrand that the corneal index of refraction, n, is 1.376. Hence, the refractive power of keratometer includes not only the refractive power of the anterior surface of the cornea but the relationship between the radius of the posterior corneal curvature, the thickness of the cornea and ACD.[2] In Japan, keratometers made by Bausch and Lomb are generally used and the value n = 1.3375 is used to indicate the relationship between the radius of the anterior corneal curvature (R mm) and its refractive power (K value).

Because of refractive problems encountered postoperatively, we decided to examine the value n more closely by using traditional methods. We examined the height of incidence and the angle of refraction by ray tracing. We found that the refractive power of the cornea as measured by the keratometer indicates the corneal posterior vertex focal length gained in liquid (Figure 1, VC). When this refractive power was converted to the equivalent in air, it turned out to be the same value as obtained by the keratometer reading.

Once we have implanted an IOL after PRK or PTK, there is a change in the corneal thickness and the radius of curvature. Errors were found in the refractive power of the IOL when we used the SRK-II formula. In our calculations, it is necessary to have data for the axial length, corneal thickness, predicted ACD, corneal refractive power (or the radius of corneal curvature), and the thickness of the IOL. An error in axial measurement can cause a significant change. In the SRK-II formula, an error of 0.5 mm in the axial length always becomes an error of 1.25 D. On the other hand, according to our calculations, shorter axial lengths are associated with greater differences. Thus, when the axial length is 20 mm, an error of 0.5 mm results in a difference in refractive power of 2.4 D, and with a 27 mm AXL, an error of 1.3 D. Therefore, an accurate measurement of axial length is necessary. In addition, selection of the proper IOL type also is necessary for an ideal calculation.

When the postoperative ACD varies widely from the predicted ACD using the SRK-II formula, as with the Nidek three-piece lens, the ACD does not have an influence on the power of the implanted lens. However with the new calculations, an error occurs in the refractive power of the lens that needs to be implanted. Retzlaff et al[4] recommended an SRK/T formula, and they are currently reexamining the SRK-II formula by combining the theoretical method with the distance from vitreous membrane to the retina, corneal width, recalculated predicted ACD, and corneal refractive index. Olsen et al[5,6] stated that the error in using the predicted ACD is 38% of the total refraction and stressed the necessity of using a calculation that includes the ACD. Olsen et al[6] and Hoffer[7] emphasized the importance of the predicted ACD and improved it with their new equations. We have also observed the difference between the postoperative and the attempted refractive values. To account for these differences, we paid attention to the ACD and compared the postoperative ACD to the predicted ACD because the postoperative ACD is more reliable than the predicted ACD. We first needed to investigate the accuracy of our equation. Depending on the experience of the surgeons and the existence of narrow-angle glaucoma, the predicted ACD may not agree with the postoperative ACD even if the IOL is fixed in the intracapsular position. The Intermedics of Interocular Company recommends developing a personal A-constant and predicting ACD from the results of surgical experience, equipment, and technique. We recommend that the A-constant in both lenses must be changed and that it is necessary for us to choose an IOL with an accurate predicted ACD.

We performed IOL implantation on 2 patients who underwent PTK. Calculations using the SRK-11 formula and using the keratometer value before cataract surgery were used in both cases. For case KS, the new calculation method gave an error of refraction of about +1.4 D. The reasons for the discrepancy could have been a measurement error in the axial length or the predicted ACD, which is most likely to happen with measurements in normal eyes. Because the shape of the corneal surface is irregular, it is to be expected that the keratometer value (refractive power) or measurements of the corneal radius will not always be accurate. In this case, the axial length was 29.64 mm but the measurements of the axial length were variable, so it was necessary to minimize these measurement errors by measuring several times to obtain an average value.

There seems to be a problem with changes in the radius of the posterior corneal curvature, recurring from not following the Gullstrand method after PTK. However, even if the radius of the posterior corneal curvature changes, we found that there is no difference in the final IOL power from our ray tracing calculations. It is important to remember that there is very little change in the postoperative corneal refractive power with PTK a year after surgery, while it increases by 2–3% of the preoperative level after PRK. The corneal thickness increases 2–3% one year after surgery in both PTK and PRK patients. All these factors must be taken into consideration in IOL implantation in order to avoid adverse postoperative effects. In addition, we also need to have a continuing follow-up period of least 1 year after surgery until the cornea is more stable.

Even though we experienced some errors with our calculation method, we feel that the new equation appears to be useful for determination of IOL power. However, this is only an initial study to modify calculations for IOL implant cases.

Kashiwagi[8] stated that using the SRK-II formula only the convex-plane IOL is more accurate, based on his regression formula of lens location method. On the other hand, calculations for the biconvex IOL and convex-plane lens need to be revised. We also intend to extend our study on IOL refractive power with the biconvex IOL.

We hope that the knowledge we gained in this study will become part of a process to establish an ideal calculation method, and we intend to continue trying to solve postoperative and other problems we encounter.

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