Determining intraocular lens power within the eye

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ABSTRACT

A method is described for determining the power of an intraocular lens (IOL) within the eye by measuring the horizontal dimension of the corneal reflected image (Purkinje-Sanson I) and the anterior IOL reflected image (Purkinje-Sanson III) as seen through a standard slitlamp with a target positioned 68 mm anterior to the focal plane of the biomicroscope. The horizontal K-reading (at 180°) and the anterior chamber depth are the two other parameters necessary to calculate the exact power of the IOL. Seven tables that use these four measurements have been provided, eliminating the need for complex calculations. To determine the accuracy of this technique, ten implanted IOLs ranging from 9 diopters (D) to 27 D were chosen and their powers calculated; these calculated values were then compared to the actual IOL powers. The largest error was 0.5 D and the average error was 0.17 D.

Key Words: anterior chamber depth, intraocular lens, intraocular lens power calculation, K-reading, Purkinje-Sanson image

Although various methods for confirming the power of an intraocular lens (IOL) prior to implantation exist,[1-4] few clinicians perform this step because of the improved quality control by manufacturers,[5,6,7] the risk of contamination, and the increased surgical time.

After the lens has been implanted, there has been no method described for directly measuring the power,[8,9,10] although it can be indirectly calculated from the ultrasonic axial length, anterior chamber depth, K-readings, and postoperative refractions.[11] We present a method using slitlamp photography that measures the IOL power within the eye with an average error of only 0.17 diopters (D).

MATERIALS AND METHODS

Ten patients who had clear corneas, measurable K-readings (corneal power), and intraocular lenses (IOLs) were selected as subjects for this experiment. The actual IOL powers ranged from +9 D to +27 D as verified by the manufacturer to the nearest 0.25 D prior to implantation. The horizontal K-reading was measured with a standard Bausch & Lomb keratometer. The anterior chamber depth, defined as the axial distance from the anterior corneal vertex to the anterior IOL vertex, was measured with the standard optical attachment for the Haag-Streit slitlamp. A 5 mm × 10 mm rectangular diffusing target (Figure 1) was mounted 10 mm anterior to the center of the reflecting mirror, such that the target was 68 mm from the biomicroscope's focal plane. This distance was chosen so the tables would also be applicable to the Zeiss biomicroscope. With the slitlamp beam illuminating the diffusing target, Purkinje-Sanson images I, III, and IV (anterior corneal, anterior IOL, and posterior IOL, respectively) could be visualized through the biomicroscope.

The right 10X eyepiece was replaced with a 35 mm SLR camera and a 10X adapter lens. The biomicroscope was set at 1.6X magnification for a total image magnification of 16X. Photographs of Purkinje-Sanson

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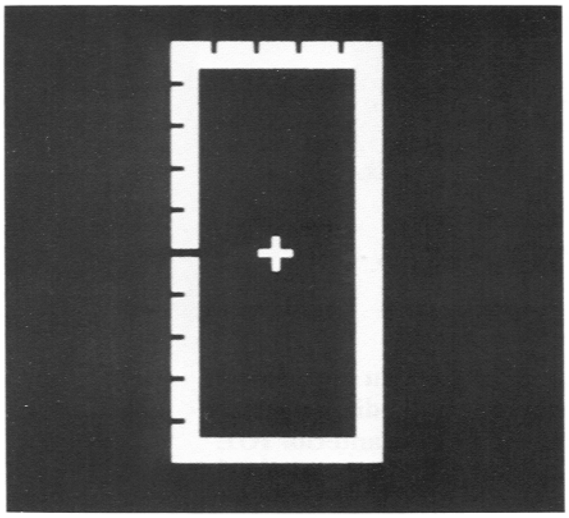

Fig. 1. (Holladay) The object used to produce the Purkinje-Sanson images was a 5 mm × 10 mm rectangular diffusing target. The target was always 68 mm anterior to the focal plane of the biomicroscope.

images I and III were taken individually and developed into 5 × 7 prints. The horizontal dimension of both images was measured. The ratio of the anterior IOL image (Purkinje-Sanson III) to corneal image (Purkinje-Sanson I) was then calculated, yielding the magnification ratio.

Vergence formulas were derived using the cornea as a refractor for incoming rays, the anterior IOL surface as a convex mirror, and the cornea as a refractor for exiting rays. The indices of refraction used in the formulas are as follows: air, n = 1.0000; Standardized Keratometric Index, n = 1.3375; aqueous, n = 1.3360; polymethylmethacrylate (PMMA), n = 1.4917.* The formulas were then placed in a Digital Equipment Corporation computer to generate Tables 2 to 8. These tables allow easy determination of the power of the implanted IOL after measuring the anterior chamber depth, the horizontal K-reading, and the magnification ratio of the anterior IOL image (Purkinje-Sanson III) to the corneal image (Purkinje-Sanson I). The value of the lens power was interpolated from the tables to the nearest 0.1 D. All measured and computed values are shown in Table 1.

RESULTS

A comparison of the computed IOL power, the actual IOL power, and all measured values are shown in Table 1. The average difference between the actual and computed IOL power was + 0.17 D. No error was greater than 0.5 D. The mean and standard deviation for the manufacturer-verified IOLs were 19.45 D (±5.86 D) and 19.62 D (±6.01 D) for our estimated IOL values. A repeated measure analysis of variance showed no significant difference between groups (F = 3.02, P = 0.1162). A Pearson product-moment coefficient was calculated for these data and showed a correlation of +0.9990.

DISCUSSION

Purkinje, a Bohemian physiologist, first described lenticular reflexes in 1823,[12] and Sanson, a French ophthalmologist, first used them clinically for evaluating cataracts in 1837.[13] Other investigators have used these images to measure lenticular curvatures, accommodation,[14] and eye movement.[15]

Purkinje-Sanson I, the corneal image, represents approximately 2.1% of the incident light and is very bright when viewed through a standard slitlamp. This light reflex, which is often near the anterior lens surface, is approximately 3.6 mm behind the vertex of the cornea for a target 64 mm anterior to the cornea (the distance from the target to the focused image is always 68 mm). Visualizing Purkinje-Sanson III and IV images for the first time may be difficult. Purkinje-Sanson III, the anterior IOL image, is 7.2 times less intense than the corneal reflex and appears more yellow because of the relative absorption of blue light. This image is approximately 1 mm to 2 mm posterior to the corneal image. Purkinje-Sanson IV, the IOL image from the posterior surface, is approximately the same intensity as Purkinje-Sanson III. Although image IV is not necessary for determining the power of convexoplano lenses, it is necessary for calculating the power of biconvex lenses. For IOLs with anterior surface power over +12 D, in which the posterior surface is plano, the reflected image from the posterior surface is much larger than either of the previous two images (I or III). The image from the plano posterior surface is from 10 mm to 12 mm anterior to the cornea, but becomes smaller and moves nearer the cornea as the posterior surface power of the IOL increases in convexity, as with biconvex lenses. If the images are not readily seen, it usually is due to a tilt in the IOL with respect to the optical axis. To bring the reflexes into view, simply change the patient's fixation horizontally or vertically until the images are found.

When measuring the power of an IOL within the eye using the reflected image from the anterior surface, one must take into account the magnifying effect of the cornea.[8,9,10] The cornea acts as a simple magnifier enlarging the reflected IOL image. The amount of magnification depends on the refractive power of the cornea and the cornea's distance from the IOL. The greater the corneal power and the greater the anterior

* *There are two sources of PMMA used for IOLs: Perspex CQ, n = 1.4907, and Rohm and Haas, n = 1.4934. Some manufacturers, however, mistakenly use 1.4900 in their lens power calculations. To minimize the effect of these differences on our tables, the median value of 1.4917 was chosen. The maximum error that can result in the computed PMMA IOL power by using this median index of refraction is 1%.*

Table 1. Comparison of computed and actual IOL power with measured values.

Anterior Chamber Depth (mm)	Horizontal K-readings (diopters)	Ratio of Anterior IOL Image to Corneal Image*	Computed IOL Power (diopters)⁺	Actual IOL Power (diopters)	Difference (diopters)
5.00	42.37	6.435	8.6	9.0	−0.4
4.63	42.50	3.126	12.1	12.0	+0.1
3.48	43.00	1.735	16.4	16.0	+0.4
3.07	43.67	1.583	17.4	17.5	−0.1
3.87	43.75	1.396	20.0	19.5	+0.5
3.86	41.00	1.159	21.1	21.0	+0.1
3.91	43.37	1.129	23.2	23.0	+0.2
3.83	41.12	0.935	25.0	24.5	+0.5
3.91	44.75	1.049	25.5	25.0	+0.5
3.90	45.50	1.004	26.9	27.0	−0.1

*Magnification ratio of horizontal dimension of the anterior IOL image (Purkinje-Sanson III) to the horizontal dimension of the corneal image (Purkinje-Sanson I).

⁺The computed IOL power is obtained by interpolating between the appropriate values shown in Tables 2-8.

chamber depth the more the IOL image will be magnified. This simple magnifying effect of the cornea explains why the pupil appears approximately 10% larger than actual size. The effect, although easily visualized, is nonlinear in the case of the virtual IOL image and therefore does not permit a simple conversion factor, but requires tables or a computer to calculate the exact effect of the corneal power on the implanted IOL image.

As can be seen from Tables 2 to 8, the corneal and IOL images are approximately the same size (magnification ratio = 1.00) for a +25 D IOL in a patient with an average cornea (44 D) and anterior chamber depth (3.50 mm). The anterior IOL image is 200% larger (magnification ratio = 2.00) with a +15.5 D IOL and 20% smaller (magnification ratio = 0.80) with a +30 D IOL than the normal corneal reflex (K = 44 D) for a target positioned 68 mm anterior to the focal plane of the biomicroscope. Remembering these magnification ratios will allow estimation of the IOL power to within 2 D by visually comparing the slitlamp mirror images from these two surfaces. A more exact determination to ± 0.50 D requires photography or a micrometer reticule in the eyepiece. Using a micrometer, however, is somewhat difficult because of the movement of the reflected image.

Errors in the measurements have the following approximate effect on the calculated IOL power. A 1-D error in the K-reading results in a 0.50-D error in the computed lens power. A 0.5-mm error in the anterior chamber depth results in a 0.50-D error. A 5% error in the magnification ratio of the reflected images results in a 0.5-D error.

A keratometer may be used to measure the size of the anterior IOL reflex image.[2] The K-reading taken from the anterior surface of the IOL must be divided by the corneal K-reading, resulting in nearly the same magnification ratio as would have been obtained from measuring photographs. The ratio is not exactly the same because the mires of the keratometer are approximately 75 mm from the cornea, not 68 mm as with our slitlamp target. This difference produces a slight error when using our tables. Although this difference in the target distance produces a variation that is nonlinear and varies with corneal curvature, anterior chamber depth, and IOL power, the error never exceeds 1% for IOLs between zero and +30 D. The keratometric technique is difficult because of the dim mires and limited because most standard IOL reflexes are beyond the scale of the normal keratometer.

We have also successfully determined the power of the posterior surface of biconvex IOLs. When determining the posterior surface power of the IOL, both the cornea and the anterior lens surface serve as simple magnifiers, enlarging the reflected posterior IOL image. The anterior surface power should be determined first and this value used in calculating the posterior surface power. Since the anterior IOL surface is another variable, there must be seven tables for every possible IOL power. The number of necessary tables is prohibitive. To eliminate this problem, we have developed a computer routine that will compute the power of both surfaces and the equivalent lens power given the horizontal K-reading, anterior chamber depth, and the horizontal dimension of Purkinje-Sanson images I, III, and IV. This program will allow measurement of biconvex lenses within the eye. The software is limited to PMMA IOLs (n = 1.4917), but modifications in the program reflecting the refraction index of different lenses would accommodate other

Table 2. Magnification ratio for the IOL image size to the corneal image size (anterior chamber depth = 2 mm).*

IOL Power†	Corneal Power (Diopters)																
	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0.00	-3.01	-3.02	-3.03	-3.04	-3.05	-3.06	-3.07	-3.08	-3.09	-3.09	-3.10	-3.11	-3.12	-3.13	-3.13	-3.14	-3.15
1.00	-3.79	-3.78	-3.77	-3.76	-3.75	-3.74	-3.73	-3.73	-3.72	-3.71	-3.71	-3.70	-3.70	-3.69	-3.69	-3.69	-3.68
2.00	-5.04	-4.99	-4.93	-4.88	-4.83	-4.78	-4.74	-4.70	-4.66	-4.63	-4.59	-4.56	-4.53	-4.50	-4.47	-4.45	-4.42
3.00	-7.29	-7.12	-6.95	-6.80	-6.65	-6.52	-6.40	-6.28	-6.17	-6.07	-5.98	-5.89	-5.80	-5.72	-5.65	-5.58	-5.52
4.00	-11.60	-11.20	-10.80	-10.40	-10.10	-9.71	-9.40	-9.11	-8.83	-8.58	-8.35	-8.13	-7.93	-7.74	-7.56	-7.40	-7.25
5.00	10.90	12.00	13.10	14.40	15.80	17.40	19.00	20.80	-13.90	-13.30	-12.80	-12.30	-11.80	-11.40	-11.00	-10.60	-10.30
6.00	6.91	7.51	8.16	8.88	9.68	10.60	11.50	12.60	13.80	15.00	16.40	18.00	19.70	21.50	23.40	-16.60	-15.90
7.00	4.84	5.20	5.58	6.00	6.46	6.96	7.51	8.10	8.76	9.48	10.30	11.10	12.10	13.20	14.30	15.60	17.00
8.00	3.67	3.90	4.16	4.43	4.72	5.03	5.37	5.74	6.13	6.56	7.02	7.53	8.08	8.68	9.34	10.10	10.90
9.00	2.93	3.10	3.28	3.48	3.68	3.90	4.13	4.37	4.64	4.92	5.22	5.54	5.89	6.27	6.67	7.11	7.58
10.00	2.44	2.57	2.71	2.85	3.00	3.17	3.34	3.51	3.70	3.91	4.12	4.34	4.58	4.84	5.11	5.40	5.72
11.00	2.08	2.19	2.30	2.41	2.53	2.66	2.79	2.93	3.07	3.23	3.39	3.56	3.74	3.92	4.12	4.33	4.55
12.00	1.82	1.90	1.99	2.09	2.19	2.29	2.40	2.51	2.62	2.75	2.87	3.01	3.14	3.29	3.44	3.60	3.77
12.50	1.71	1.79	1.87	1.96	2.05	2.14	2.24	2.34	2.44	2.55	2.67	2.79	2.91	3.04	3.18	3.32	3.47
13.00	1.61	1.68	1.76	1.84	1.92	2.01	2.10	2.19	2.29	2.39	2.49	2.60	2.71	2.83	2.95	3.08	3.22
13.50	1.52	1.59	1.66	1.74	1.81	1.89	1.98	2.06	2.15	2.24	2.34	2.43	2.54	2.64	2.76	2.87	2.99
14.00	1.44	1.51	1.58	1.64	1.72	1.79	1.87	1.94	2.03	2.11	2.20	2.29	2.38	2.48	2.58	2.69	2.80
14.50	1.37	1.43	1.50	1.56	1.63	1.70	1.77	1.84	1.92	1.99	2.08	2.16	2.25	2.34	2.43	2.53	2.63
15.00	1.31	1.37	1.43	1.49	1.55	1.61	1.68	1.75	1.82	1.89	1.97	2.04	2.12	2.21	2.29	2.38	2.48
15.50	1.25	1.31	1.36	1.42	1.48	1.54	1.60	1.66	1.73	1.80	1.87	1.94	2.01	2.09	2.17	2.26	2.34
16.00	1.20	1.25	1.30	1.35	1.41	1.47	1.53	1.59	1.65	1.71	1.78	1.85	1.92	1.99	2.06	2.14	2.22
16.50	1.15	1.20	1.25	1.30	1.35	1.40	1.46	1.52	1.57	1.63	1.70	1.76	1.83	1.89	1.96	2.04	2.11
17.00	1.10	1.15	1.20	1.24	1.29	1.35	1.40	1.45	1.51	1.56	1.62	1.68	1.74	1.81	1.87	1.94	2.01
17.50	1.06	1.11	1.15	1.20	1.24	1.29	1.34	1.39	1.44	1.50	1.55	1.61	1.67	1.73	1.79	1.85	1.92
18.00	1.02	1.07	1.11	1.15	1.20	1.24	1.29	1.34	1.39	1.44	1.49	1.54	1.60	1.66	1.72	1.78	1.84
18.50	0.99	1.03	1.07	1.11	1.15	1.20	1.24	1.29	1.33	1.38	1.43	1.48	1.54	1.59	1.65	1.70	1.76
19.00	0.95	0.99	1.03	1.07	1.11	1.15	1.20	1.24	1.29	1.33	1.38	1.43	1.48	1.53	1.58	1.64	1.69
19.50	0.92	0.96	1.00	1.03	1.07	1.11	1.16	1.20	1.24	1.28	1.33	1.38	1.42	1.47	1.52	1.57	1.63
20.00	0.89	0.93	0.96	1.00	1.04	1.08	1.12	1.16	1.20	1.24	1.28	1.33	1.37	1.42	1.47	1.52	1.57
20.50	0.87	0.90	0.93	0.97	1.01	1.04	1.08	1.12	1.16	1.20	1.24	1.28	1.33	1.37	1.42	1.46	1.51
21.00	0.84	0.87	0.91	0.94	0.97	1.01	1.05	1.08	1.12	1.16	1.20	1.24	1.28	1.33	1.37	1.41	1.46
21.50	0.82	0.85	0.88	0.91	0.95	0.98	1.01	1.05	1.09	1.12	1.16	1.20	1.24	1.28	1.32	1.37	1.41
22.00	0.79	0.82	0.85	0.89	0.92	0.95	0.98	1.02	1.05	1.09	1.13	1.16	1.20	1.24	1.28	1.32	1.37
22.50	0.77	0.80	0.83	0.86	0.89	0.92	0.96	0.99	1.02	1.06	1.09	1.13	1.17	1.20	1.24	1.28	1.32
23.00	0.75	0.78	0.81	0.84	0.87	0.90	0.93	0.96	0.99	1.03	1.06	1.10	1.13	1.17	1.21	1.24	1.28
23.50	0.73	0.76	0.79	0.81	0.84	0.87	0.90	0.94	0.97	1.00	1.03	1.07	1.10	1.14	1.17	1.21	1.25
24.00	0.71	0.74	0.77	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.04	1.07	1.10	1.14	1.17	1.21
24.50	0.69	0.72	0.75	0.77	0.80	0.83	0.86	0.89	0.92	0.95	0.98	1.01	1.04	1.07	1.11	1.14	1.18
25.00	0.68	0.70	0.73	0.75	0.78	0.81	0.84	0.86	0.89	0.92	0.95	0.98	1.01	1.05	1.08	1.11	1.15
25.50	0.66	0.69	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.90	0.93	0.96	0.99	1.02	1.05	1.08	1.11
26.00	0.65	0.67	0.69	0.72	0.74	0.77	0.80	0.82	0.85	0.88	0.91	0.93	0.96	0.99	1.02	1.05	1.09
26.50	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.86	0.88	0.91	0.94	0.97	1.00	1.03	1.06
27.00	0.62	0.64	0.66	0.69	0.71	0.73	0.76	0.78	0.81	0.84	0.86	0.89	0.92	0.95	0.97	1.00	1.03
28.00	0.59	0.61	0.63	0.66	0.68	0.70	0.73	0.75	0.77	0.80	0.82	0.85	0.88	0.90	0.93	0.96	0.99
29.00	0.57	0.59	0.61	0.63	0.65	0.67	0.70	0.72	0.74	0.77	0.79	0.81	0.84	0.86	0.89	0.92	0.94
30.00	0.55	0.56	0.58	0.60	0.63	0.65	0.67	0.69	0.71	0.73	0.76	0.78	0.80	0.83	0.85	0.88	0.90

*The values listed are the magnification ratios of Purkinje III (produced by the anterior surface of the IOL) to Purkinje I (produced by the cornea). The magnification ratio is computed assuming a 68-mm axial distance from object target to the focused biomicroscopic image (Purkinje I or III). *Negative values indicate an inverted IOL image.*

†These values are the refracting power in diopters of the anterior surface of the IOL in aqueous (n=1.3360), which for a convexoplano lens (n=1.4917) is also the total power (equivalent power), since the posterior surface is plano.

Table 3. Magnification ratio for the IOL image size to the corneal image size (anterior chamber depth = 2.5 mm).*

IOL Power†	Corneal Power (Diopters)																
	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0.00	-3.05	-3.06	-3.08	-3.09	-3.10	-3.11	-3.12	-3.13	-3.14	-3.15	-3.16	-3.17	-3.18	-3.19	-3.19	-3.20	-3.21
1.00	-3.82	-3.81	-3.81	-3.80	-3.79	-3.78	-3.78	-3.77	-3.77	-3.76	-3.76	-3.76	-3.75	-3.75	-3.75	-3.74	-3.74
2.00	-5.06	-5.00	-4.95	-4.90	-4.85	-4.81	-4.77	-4.73	-4.69	-4.66	-4.63	-4.60	-4.57	-4.54	-4.52	-4.50	-4.47
3.00	-7.23	-7.06	-6.90	-6.75	-6.62	-6.49	-6.37	-6.26	-6.16	-6.06	-5.97	-5.88	-5.81	-5.73	-5.66	-5.60	-5.53
4.00	-11.30	-10.90	-10.50	-10.20	-9.83	-9.51	-9.22	-8.94	-8.68	-8.44	-8.22	-8.02	-7.83	-7.65	-7.48	-7.33	-7.19
5.00	11.30	12.50	13.70	15.00	16.50	18.10	19.80	-13.90	-13.40	-12.80	-12.30	-11.90	-11.40	-11.00	-10.60	-10.30	-9.98
6.00	7.22	7.85	8.56	9.33	10.20	11.10	12.20	13.30	14.50	15.90	17.40	19.00	20.80	22.70	-16.50	-15.70	-15.10
7.00	5.05	5.43	5.85	6.30	6.80	7.34	7.94	8.59	9.31	10.10	11.00	11.90	13.00	14.10	15.40	16.80	18.30
8.00	3.82	4.07	4.35	4.64	4.96	5.30	5.67	6.07	6.50	6.97	7.49	8.05	8.66	9.33	10.10	10.90	11.80
9.00	3.05	3.23	3.43	3.64	3.86	4.09	4.34	4.61	4.90	5.21	5.54	5.90	6.29	6.71	7.16	7.65	8.19
10.00	2.53	2.67	2.82	2.98	3.14	3.32	3.50	3.70	3.90	4.13	4.36	4.61	4.88	5.16	5.47	5.79	6.14
11.00	2.16	2.27	2.39	2.52	2.64	2.78	2.92	3.08	3.23	3.40	3.58	3.76	3.96	4.17	4.39	4.63	4.87
12.00	1.88	1.98	2.07	2.17	2.28	2.39	2.51	2.63	2.76	2.89	3.03	3.17	3.33	3.49	3.66	3.84	4.02
12.50	1.77	1.85	1.94	2.04	2.13	2.23	2.34	2.45	2.56	2.68	2.81	2.94	3.08	3.22	3.37	3.53	3.70
13.00	1.67	1.75	1.83	1.91	2.00	2.10	2.19	2.29	2.40	2.51	2.62	2.74	2.86	2.99	3.13	3.27	3.42
13.50	1.58	1.65	1.73	1.81	1.89	1.97	2.06	2.15	2.25	2.35	2.45	2.56	2.68	2.79	2.92	3.05	3.18
14.00	1.50	1.56	1.64	1.71	1.79	1.86	1.95	2.03	2.12	2.21	2.31	2.41	2.51	2.62	2.73	2.85	2.97
14.50	1.42	1.49	1.55	1.62	1.69	1.77	1.84	1.92	2.01	2.09	2.18	2.27	2.37	2.46	2.57	2.67	2.79
15.00	1.36	1.42	1.48	1.54	1.61	1.68	1.75	1.82	1.90	1.98	2.06	2.15	2.24	2.33	2.42	2.52	2.62
15.50	1.29	1.35	1.41	1.47	1.53	1.60	1.67	1.74	1.81	1.88	1.96	2.04	2.12	2.20	2.29	2.38	2.48
16.00	1.24	1.29	1.35	1.41	1.47	1.53	1.59	1.65	1.72	1.79	1.86	1.94	2.01	2.09	2.18	2.26	2.35
16.50	1.19	1.24	1.29	1.35	1.40	1.46	1.52	1.58	1.64	1.71	1.78	1.85	1.92	1.99	2.07	2.15	2.23
17.00	1.14	1.19	1.24	1.29	1.34	1.40	1.46	1.51	1.57	1.64	1.70	1.76	1.83	1.90	1.97	2.05	2.13
17.50	1.10	1.14	1.19	1.24	1.29	1.34	1.40	1.45	1.51	1.57	1.63	1.69	1.75	1.82	1.89	1.96	2.03
18.00	1.06	1.10	1.15	1.19	1.24	1.29	1.34	1.39	1.45	1.50	1.56	1.62	1.68	1.74	1.81	1.87	1.94
18.50	1.02	1.06	1.11	1.15	1.20	1.24	1.29	1.34	1.39	1.45	1.50	1.56	1.61	1.67	1.73	1.79	1.86
19.00	0.99	1.03	1.07	1.11	1.15	1.20	1.25	1.29	1.34	1.39	1.44	1.50	1.55	1.61	1.66	1.72	1.78
19.50	0.95	0.99	1.03	1.07	1.11	1.16	1.20	1.25	1.29	1.34	1.39	1.44	1.49	1.55	1.60	1.66	1.72
20.00	0.92	0.96	1.00	1.04	1.08	1.12	1.16	1.21	1.25	1.30	1.34	1.39	1.44	1.49	1.54	1.60	1.65
20.50	0.89	0.93	0.97	1.00	1.04	1.08	1.12	1.17	1.21	1.25	1.30	1.34	1.39	1.44	1.49	1.54	1.59
21.00	0.87	0.90	0.94	0.97	1.01	1.05	1.09	1.13	1.17	1.21	1.25	1.30	1.34	1.39	1.44	1.49	1.54
21.50	0.84	0.88	0.91	0.94	0.98	1.02	1.05	1.09	1.13	1.17	1.21	1.26	1.30	1.35	1.39	1.44	1.49
22.00	0.82	0.85	0.88	0.92	0.95	0.99	1.02	1.06	1.10	1.14	1.18	1.22	1.26	1.30	1.35	1.39	1.44
22.50	0.80	0.83	0.86	0.89	0.92	0.96	0.99	1.03	1.07	1.10	1.14	1.18	1.22	1.26	1.31	1.35	1.39
23.00	0.77	0.80	0.84	0.87	0.90	0.93	0.97	1.00	1.04	1.07	1.11	1.15	1.19	1.23	1.27	1.31	1.35
23.50	0.75	0.78	0.81	0.84	0.87	0.91	0.94	0.97	1.01	1.04	1.08	1.11	1.15	1.19	1.23	1.27	1.31
24.00	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.95	0.98	1.01	1.05	1.08	1.12	1.16	1.19	1.23	1.27
24.50	0.72	0.74	0.77	0.80	0.83	0.86	0.89	0.92	0.95	0.99	1.02	1.05	1.09	1.13	1.16	1.20	1.24
25.00	0.70	0.73	0.75	0.78	0.81	0.84	0.87	0.90	0.93	0.96	0.99	1.03	1.06	1.10	1.13	1.17	1.20
25.50	0.68	0.71	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.07	1.10	1.14	1.17
26.00	0.67	0.69	0.72	0.74	0.77	0.80	0.83	0.86	0.88	0.91	0.94	0.98	1.01	1.04	1.07	1.11	1.14
26.50	0.65	0.68	0.70	0.73	0.75	0.78	0.81	0.84	0.86	0.89	0.92	0.95	0.98	1.01	1.05	1.08	1.11
27.00	0.64	0.66	0.69	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.90	0.93	0.96	0.99	1.02	1.05	1.09
28.00	0.61	0.63	0.66	0.68	0.70	0.73	0.75	0.78	0.81	0.83	0.86	0.89	0.92	0.94	0.97	1.00	1.04
29.00	0.59	0.61	0.63	0.65	0.67	0.70	0.72	0.75	0.77	0.80	0.82	0.85	0.88	0.90	0.93	0.96	0.99
30.00	0.56	0.58	0.60	0.63	0.65	0.67	0.69	0.72	0.74	0.76	0.79	0.81	0.84	0.87	0.89	0.92	0.95

*The values listed are the magnification ratios of Purkinje III (produced by the anterior surface of the IOL) to Purkinje I (produced by the cornea). The magnification ratio is computed assuming a 68-mm axial distance from object target to the focused biomicroscopic image (Purkinje I or III). *Negative values indicate an inverted IOL image.*

†These values are the refracting power in diopters of the anterior surface of the IOL in aqueous (n=1.3360), which for a convexoplano lens (n=1.4917) is also the total power (equivalent power), since the posterior surface is plano.

Table 4. Magnification ratio for the IOL image size to the corneal image size (anterior chamber depth = 3 mm).*

IOL Power†	Corneal Power (Diopters) 36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0.00	-3.09	-3.11	-3.12	-3.13	-3.14	-3.16	-3.17	-3.18	-3.19	-3.20	-3.21	-3.23	-3.24	-3.25	-3.26	-3.27	-3.28
1.00	-3.86	-3.85	-3.84	-3.84	-3.83	-3.83	-3.82	-3.82	-3.82	-3.81	-3.81	-3.81	-3.81	-3.81	-3.81	-3.81	-3.81
2.00	-5.07	-5.01	-4.96	-4.92	-4.87	-4.83	-4.80	-4.76	-4.73	-4.70	-4.67	-4.64	-4.61	-4.59	-4.57	-4.55	-4.53
3.00	-7.17	-7.00	-6.85	-6.71	-6.58	-6.46	-6.35	-6.24	-6.14	-6.05	-5.97	-5.89	-5.81	-5.74	-5.68	-5.61	-5.56
4.00	-11.10	-10.70	-10.30	-9.96	-9.63	-9.33	-9.05	-8.79	-8.54	-8.32	-8.11	-7.91	-7.73	-7.57	-7.41	-7.27	-7.13
5.00	11.80	13.00	14.20	15.60	17.20	18.80	20.60	-13.40	-12.90	-12.40	-11.90	-11.50	-11.10	-10.70	-10.40	-10.00	-9.73
6.00	7.54	8.22	8.97	9.80	10.70	11.70	12.80	14.00	15.40	16.80	18.40	20.10	22.00	24.00	-15.60	-15.00	-14.30
7.00	5.27	5.69	6.14	6.63	7.16	7.75	8.40	9.11	9.89	10.80	11.70	12.80	13.90	15.20	16.60	18.10	19.70
8.00	3.98	4.26	4.55	4.87	5.21	5.58	5.99	6.42	6.90	7.42	7.99	8.61	9.29	10.00	10.90	11.80	12.80
9.00	3.17	3.37	3.58	3.81	4.05	4.30	4.58	4.87	5.19	5.53	5.90	6.30	6.73	7.20	7.70	8.26	8.87
10.00	2.63	2.78	2.94	3.11	3.29	3.48	3.68	3.89	4.12	4.36	4.62	4.90	5.20	5.51	5.85	6.22	6.62
11.00	2.24	2.36	2.49	2.62	2.76	2.91	3.07	3.23	3.40	3.59	3.78	3.99	4.21	4.44	4.68	4.95	5.23
12.00	1.95	2.05	2.16	2.27	2.38	2.50	2.63	2.76	2.90	3.04	3.19	3.35	3.52	3.70	3.89	4.09	4.30
12.50	1.83	1.93	2.02	2.12	2.23	2.33	2.45	2.57	2.69	2.82	2.96	3.10	3.26	3.42	3.58	3.76	3.95
13.00	1.73	1.81	1.90	1.99	2.09	2.19	2.29	2.40	2.52	2.63	2.76	2.89	3.03	3.17	3.32	3.48	3.64
13.50	1.63	1.71	1.79	1.88	1.97	2.06	2.16	2.26	2.36	2.47	2.58	2.70	2.83	2.96	3.09	3.24	3.38
14.00	1.55	1.62	1.70	1.78	1.86	1.95	2.03	2.13	2.22	2.32	2.43	2.54	2.65	2.77	2.89	3.02	3.16
14.50	1.47	1.54	1.61	1.69	1.76	1.84	1.93	2.01	2.10	2.19	2.29	2.39	2.49	2.60	2.72	2.84	2.96
15.00	1.40	1.47	1.54	1.60	1.68	1.75	1.83	1.91	1.99	2.08	2.17	2.26	2.36	2.46	2.56	2.67	2.78
15.50	1.34	1.40	1.46	1.53	1.60	1.67	1.74	1.81	1.89	1.97	2.06	2.14	2.23	2.33	2.42	2.52	2.63
16.00	1.28	1.34	1.40	1.46	1.52	1.59	1.66	1.73	1.80	1.88	1.96	2.04	2.12	2.21	2.30	2.39	2.49
16.50	1.23	1.28	1.34	1.40	1.46	1.52	1.59	1.65	1.72	1.79	1.86	1.94	2.02	2.10	2.18	2.27	2.36
17.00	1.18	1.23	1.29	1.34	1.40	1.46	1.52	1.58	1.65	1.71	1.78	1.85	1.93	2.00	2.08	2.16	2.25
17.50	1.14	1.19	1.24	1.29	1.34	1.40	1.46	1.52	1.58	1.64	1.71	1.77	1.84	1.91	1.99	2.07	2.15
18.00	1.09	1.14	1.19	1.24	1.29	1.34	1.40	1.46	1.51	1.57	1.64	1.70	1.77	1.83	1.90	1.98	2.05
18.50	1.06	1.10	1.15	1.19	1.24	1.29	1.35	1.40	1.46	1.51	1.57	1.63	1.69	1.76	1.83	1.89	1.96
19.00	1.02	1.06	1.11	1.15	1.20	1.25	1.30	1.35	1.40	1.46	1.51	1.57	1.63	1.69	1.75	1.82	1.89
19.50	0.99	1.03	1.07	1.11	1.16	1.20	1.25	1.30	1.35	1.40	1.46	1.51	1.57	1.63	1.69	1.75	1.81
20.00	0.95	0.99	1.03	1.08	1.12	1.16	1.21	1.26	1.30	1.35	1.40	1.46	1.51	1.57	1.62	1.68	1.74
20.50	0.92	0.96	1.00	1.04	1.08	1.13	1.17	1.21	1.26	1.31	1.36	1.41	1.46	1.51	1.57	1.62	1.68
21.00	0.90	0.93	0.97	1.01	1.05	1.09	1.13	1.18	1.22	1.27	1.31	1.36	1.41	1.46	1.51	1.57	1.62
21.50	0.87	0.91	0.94	0.98	1.02	1.06	1.10	1.14	1.18	1.23	1.27	1.32	1.36	1.41	1.46	1.51	1.57
22.00	0.85	0.88	0.91	0.95	0.99	1.03	1.06	1.10	1.15	1.19	1.23	1.28	1.32	1.37	1.42	1.47	1.52
22.50	0.82	0.85	0.89	0.92	0.96	1.00	1.03	1.07	1.11	1.15	1.19	1.24	1.28	1.33	1.37	1.42	1.47
23.00	0.80	0.83	0.86	0.90	0.93	0.97	1.00	1.04	1.08	1.12	1.16	1.20	1.24	1.29	1.33	1.38	1.42
23.50	0.78	0.81	0.84	0.87	0.91	0.94	0.98	1.01	1.05	1.09	1.13	1.17	1.21	1.25	1.29	1.34	1.38
24.00	0.76	0.79	0.82	0.85	0.88	0.92	0.95	0.99	1.02	1.06	1.10	1.13	1.17	1.21	1.25	1.30	1.34
24.50	0.74	0.77	0.80	0.83	0.86	0.89	0.93	0.96	0.99	1.03	1.07	1.10	1.14	1.18	1.22	1.26	1.30
25.00	0.72	0.75	0.78	0.81	0.84	0.87	0.90	0.94	0.97	1.00	1.04	1.07	1.11	1.15	1.19	1.23	1.27
25.50	0.70	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.98	1.01	1.05	1.08	1.12	1.16	1.19	1.23
26.00	0.69	0.72	0.74	0.77	0.80	0.83	0.86	0.89	0.92	0.95	0.99	1.02	1.05	1.09	1.13	1.16	1.20
26.50	0.67	0.70	0.73	0.75	0.78	0.81	0.84	0.87	0.90	0.93	0.96	1.00	1.03	1.06	1.10	1.13	1.17
27.00	0.66	0.68	0.71	0.74	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.04	1.07	1.11	1.14
28.00	0.63	0.65	0.68	0.70	0.73	0.76	0.78	0.81	0.84	0.87	0.90	0.93	0.96	0.99	1.02	1.05	1.09
29.00	0.60	0.63	0.65	0.67	0.70	0.72	0.75	0.78	0.80	0.83	0.86	0.89	0.92	0.95	0.98	1.01	1.04
30.00	0.58	0.60	0.63	0.65	0.67	0.70	0.72	0.75	0.77	0.80	0.82	0.85	0.88	0.91	0.94	0.96	0.99

*The values listed are the magnification ratios of Purkinje III (produced by the anterior surface of the IOL) to Purkinje I (produced by the cornea). The magnification ratio is computed assuming a 68-mm axial distance from object target to the focused biomicroscopic image (Purkinje I or III). *Negative values indicate an inverted IOL image.*

†These values are the refracting power in diopters of the anterior surface of the IOL in aqueous (n=1.3360), which for a convexoplano lens (n=1.4917) is also the total power (equivalent power), since the posterior surface is plano.

Table 5. Magnification ratio for the IOL image size to the corneal image size (anterior chamber depth = 3.5 mm).*

IOL Power†	Corneal Power (Diopters)																
	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0.00	-3.13	-3.15	-3.16	-3.18	-3.19	-3.21	-3.22	-3.23	-3.25	-3.26	-3.27	-3.29	-3.30	-3.31	-3.33	-3.34	-3.35
1.00	-3.89	-3.89	-3.88	-3.88	-3.88	-3.87	-3.87	-3.87	-3.87	-3.87	-3.87	-3.87	-3.87	-3.87	-3.87	-3.87	-3.87
2.00	-5.08	-5.03	-4.98	-4.94	-4.90	-4.86	-4.83	-4.79	-4.76	-4.73	-4.71	-4.68	-4.66	-4.64	-4.62	-4.60	-4.58
3.00	-7.11	-6.95	-6.81	-6.68	-6.55	-6.44	-6.33	-6.23	-6.14	-6.05	-5.97	-5.89	-5.82	-5.76	-5.69	-5.64	-5.58
4.00	-10.80	-10.40	-10.10	-9.75	-9.45	-9.16	-8.89	-8.64	-8.42	-8.20	-8.01	-7.82	-7.65	-7.50	-7.35	-7.21	-7.09
5.00	12.20	13.50	14.80	16.20	17.80	19.50	-13.50	-13.00	-12.50	-12.00	-11.50	-11.10	-10.80	-10.40	-10.10	-9.79	-9.51
6.00	7.88	8.60	9.40	10.30	11.30	12.30	13.50	14.80	16.20	17.70	19.40	21.20	23.10	-15.50	-14.90	-14.30	-13.70
7.00	5.51	5.95	6.44	6.97	7.55	8.19	8.89	9.67	10.50	11.50	12.50	13.60	14.90	16.20	17.70	19.40	21.10
8.00	4.15	4.45	4.77	5.11	5.48	5.89	6.33	6.81	7.33	7.91	8.53	9.22	9.98	10.80	11.70	12.70	13.90
9.00	3.31	3.52	3.75	3.99	4.25	4.53	4.83	5.15	5.50	5.87	6.28	6.72	7.20	7.73	8.30	8.93	9.61
10.00	2.74	2.90	3.07	3.25	3.45	3.65	3.87	4.10	4.35	4.62	4.91	5.21	5.54	5.90	6.28	6.70	7.15
11.00	2.33	2.46	2.60	2.74	2.89	3.05	3.22	3.40	3.59	3.79	4.00	4.23	4.47	4.73	5.01	5.30	5.62
12.00	2.03	2.13	2.25	2.36	2.49	2.62	2.75	2.90	3.05	3.21	3.37	3.55	3.74	3.94	4.15	4.37	4.61
12.50	1.90	2.00	2.10	2.21	2.32	2.44	2.57	2.69	2.83	2.97	3.12	3.28	3.45	3.63	3.81	4.01	4.22
13.00	1.79	1.88	1.98	2.08	2.18	2.29	2.40	2.52	2.64	2.77	2.91	3.05	3.20	3.36	3.53	3.71	3.89
13.50	1.69	1.78	1.87	1.96	2.05	2.15	2.26	2.36	2.48	2.60	2.72	2.85	2.99	3.13	3.28	3.44	3.61
14.00	1.61	1.68	1.77	1.85	1.94	2.03	2.13	2.23	2.33	2.44	2.56	2.68	2.80	2.93	3.07	3.21	3.37
14.50	1.53	1.60	1.68	1.76	1.84	1.92	2.01	2.11	2.20	2.30	2.41	2.52	2.63	2.75	2.88	3.01	3.15
15.00	1.45	1.52	1.59	1.67	1.75	1.83	1.91	2.00	2.09	2.18	2.28	2.38	2.49	2.60	2.71	2.83	2.96
15.50	1.39	1.45	1.52	1.59	1.66	1.74	1.82	1.90	1.98	2.07	2.16	2.26	2.35	2.46	2.56	2.68	2.79
16.00	1.33	1.39	1.45	1.52	1.59	1.66	1.73	1.81	1.89	1.97	2.05	2.14	2.23	2.33	2.43	2.53	2.64
16.50	1.27	1.33	1.39	1.45	1.52	1.59	1.65	1.73	1.80	1.88	1.96	2.04	2.13	2.22	2.31	2.41	2.51
17.00	1.22	1.28	1.34	1.39	1.46	1.52	1.58	1.65	1.72	1.79	1.87	1.95	2.03	2.11	2.20	2.29	2.38
17.50	1.18	1.23	1.28	1.34	1.40	1.46	1.52	1.58	1.65	1.72	1.79	1.86	1.94	2.02	2.10	2.19	2.27
18.00	1.13	1.18	1.23	1.29	1.34	1.40	1.46	1.52	1.58	1.65	1.72	1.78	1.86	1.93	2.01	2.09	2.17
18.50	1.09	1.14	1.19	1.24	1.29	1.35	1.40	1.46	1.52	1.58	1.65	1.71	1.78	1.85	1.93	2.00	2.08
19.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.41	1.46	1.52	1.58	1.65	1.71	1.78	1.85	1.92	1.99
19.50	1.02	1.06	1.11	1.16	1.20	1.25	1.30	1.36	1.41	1.47	1.53	1.59	1.65	1.71	1.78	1.85	1.92
20.00	0.99	1.03	1.07	1.12	1.16	1.21	1.26	1.31	1.36	1.42	1.47	1.53	1.59	1.65	1.71	1.78	1.84
20.50	0.96	1.00	1.04	1.08	1.13	1.17	1.22	1.27	1.32	1.37	1.42	1.48	1.53	1.59	1.65	1.71	1.78
21.00	0.93	0.97	1.01	1.05	1.09	1.13	1.18	1.23	1.27	1.32	1.37	1.43	1.48	1.54	1.59	1.65	1.71
21.50	0.90	0.94	0.98	1.02	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.49	1.54	1.60	1.66
22.00	0.87	0.91	0.95	0.99	1.03	1.07	1.11	1.15	1.20	1.24	1.29	1.34	1.39	1.44	1.49	1.54	1.60
22.50	0.85	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.16	1.20	1.25	1.30	1.34	1.39	1.44	1.50	1.55
23.00	0.83	0.86	0.90	0.93	0.97	1.01	1.05	1.09	1.13	1.17	1.21	1.26	1.30	1.35	1.40	1.45	1.50
23.50	0.80	0.84	0.87	0.91	0.94	0.98	1.02	1.06	1.10	1.14	1.18	1.22	1.27	1.31	1.36	1.41	1.46
24.00	0.78	0.82	0.85	0.88	0.92	0.95	0.99	1.03	1.07	1.11	1.15	1.19	1.23	1.27	1.32	1.37	1.41
24.50	0.76	0.80	0.83	0.86	0.89	0.93	0.96	1.00	1.04	1.08	1.11	1.16	1.20	1.24	1.28	1.33	1.37
25.00	0.75	0.78	0.81	0.84	0.87	0.91	0.94	0.97	1.01	1.05	1.09	1.12	1.16	1.21	1.25	1.29	1.34
25.50	0.73	0.76	0.79	0.82	0.85	0.88	0.92	0.95	0.99	1.02	1.06	1.10	1.13	1.17	1.22	1.26	1.30
26.00	0.71	0.74	0.77	0.80	0.83	0.86	0.89	0.93	0.96	1.00	1.03	1.07	1.11	1.14	1.18	1.22	1.27
26.50	0.69	0.72	0.75	0.78	0.81	0.84	0.87	0.90	0.94	0.97	1.01	1.04	1.08	1.12	1.15	1.19	1.23
27.00	0.68	0.71	0.73	0.76	0.79	0.82	0.85	0.88	0.92	0.95	0.98	1.02	1.05	1.09	1.13	1.16	1.20
28.00	0.65	0.68	0.70	0.73	0.76	0.79	0.81	0.84	0.87	0.91	0.94	0.97	1.00	1.04	1.07	1.11	1.15
29.00	0.62	0.65	0.67	0.70	0.73	0.75	0.78	0.81	0.84	0.87	0.90	0.93	0.96	0.99	1.03	1.06	1.09
30.00	0.60	0.62	0.65	0.67	0.70	0.72	0.75	0.78	0.80	0.83	0.86	0.89	0.92	0.95	0.98	1.01	1.05

*The values listed are the magnification ratios of Purkinje III (produced by the anterior surface of the IOL) to Purkinje I (produced by the cornea). The magnification ratio is computed assuming a 68-mm axial distance from object target to the focused biomicroscopic image (Purkinje I or III). *Negative values indicate an inverted IOL image.*

†These values are the refracting power in diopters of the anterior surface of the IOL in aqueous (n=1.3360), which for a convexoplano lens (n=1.4917) is also the total power (equivalent power), since the posterior surface is plano.

Table 6. Magnification ratio for the IOL image size to the corneal image size (anterior chamber depth = 4 mm).*

IOL	Corneal Power (Diopters)																
Power†	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0.00	-3.18	-3.19	-3.21	-3.23	-3.24	-3.26	-3.27	-3.29	-3.31	-3.32	-3.34	-3.35	-3.37	-3.38	-3.39	-3.41	-3.42
1.00	-3.93	-3.93	-3.92	-3.92	-3.92	-3.92	-3.92	-3.92	-3.92	-3.92	-3.92	-3.93	-3.93	-3.93	-3.93	-3.94	-3.94
2.00	-5.10	-5.05	-5.01	-4.96	-4.93	-4.89	-4.86	-4.83	-4.80	-4.77	-4.75	-4.73	-4.71	-4.69	-4.67	-4.65	-4.64
3.00	-7.06	-6.91	-6.77	-6.64	-6.53	-6.42	-6.31	-6.22	-6.13	-6.05	-5.97	-5.90	-5.83	-5.77	-5.72	-5.66	-5.61
4.00	-10.60	-10.20	-9.88	-9.57	-9.27	-9.00	-8.75	-8.52	-8.30	-8.10	-7.91	-7.74	-7.58	-7.43	-7.30	-7.17	-7.05
5.00	12.70	14.00	15.40	16.90	18.50	-13.60	-13.00	-12.50	-12.10	-11.60	-11.20	-10.80	-10.50	-10.10	-9.85	-9.57	-9.31
6.00	8.23	9.00	9.86	10.80	11.80	13.00	14.20	15.60	17.10	18.70	20.40	22.30	-15.50	-14.80	-14.20	-13.60	-13.10
7.00	5.76	6.24	6.76	7.33	7.96	8.65	9.41	10.30	11.20	12.20	13.30	14.60	15.90	17.40	19.00	20.70	22.60
8.00	4.34	4.65	5.00	5.37	5.77	6.22	6.70	7.22	7.80	8.43	9.12	9.89	10.70	11.60	12.70	13.80	15.00
9.00	3.45	3.67	3.92	4.18	4.46	4.77	5.09	5.45	5.83	6.25	6.70	7.19	7.73	8.31	8.96	9.66	10.40
10.00	2.85	3.02	3.21	3.40	3.61	3.84	4.08	4.33	4.61	4.90	5.22	5.56	5.93	6.32	6.76	7.22	7.73
11.00	2.42	2.56	2.71	2.86	3.03	3.20	3.39	3.58	3.79	4.01	4.25	4.50	4.77	5.06	5.37	5.70	6.06
12.00	2.11	2.22	2.34	2.47	2.60	2.74	2.89	3.04	3.21	3.38	3.57	3.76	3.97	4.19	4.43	4.68	4.94
12.50	1.98	2.08	2.19	2.31	2.43	2.56	2.69	2.83	2.98	3.14	3.30	3.48	3.66	3.86	4.07	4.29	4.52
13.00	1.86	1.96	2.06	2.17	2.28	2.39	2.52	2.64	2.78	2.92	3.07	3.23	3.40	3.57	3.76	3.96	4.17
13.50	1.76	1.85	1.94	2.04	2.14	2.25	2.36	2.48	2.61	2.74	2.87	3.02	3.17	3.33	3.49	3.67	3.86
14.00	1.67	1.75	1.84	1.93	2.02	2.12	2.23	2.34	2.45	2.57	2.70	2.83	2.96	3.11	3.26	3.42	3.59
14.50	1.58	1.66	1.74	1.83	1.92	2.01	2.11	2.21	2.31	2.42	2.54	2.66	2.79	2.92	3.06	3.21	3.36
15.00	1.51	1.58	1.66	1.74	1.82	1.91	2.00	2.09	2.19	2.29	2.40	2.51	2.63	2.75	2.88	3.01	3.15
15.50	1.44	1.51	1.58	1.66	1.73	1.81	1.90	1.99	2.08	2.17	2.27	2.38	2.49	2.60	2.72	2.84	2.97
16.00	1.38	1.44	1.51	1.58	1.65	1.73	1.81	1.89	1.98	2.07	2.16	2.26	2.36	2.46	2.57	2.69	2.81
16.50	1.32	1.38	1.45	1.51	1.58	1.65	1.73	1.81	1.89	1.97	2.06	2.15	2.24	2.34	2.45	2.55	2.66
17.00	1.27	1.33	1.39	1.45	1.52	1.58	1.65	1.73	1.80	1.88	1.96	2.05	2.14	2.23	2.33	2.43	2.53
17.50	1.22	1.27	1.33	1.39	1.45	1.52	1.59	1.66	1.73	1.80	1.88	1.96	2.04	2.13	2.22	2.32	2.41
18.00	1.17	1.23	1.28	1.34	1.40	1.46	1.52	1.59	1.66	1.73	1.80	1.88	1.96	2.04	2.12	2.21	2.30
18.50	1.13	1.18	1.23	1.29	1.35	1.40	1.46	1.53	1.59	1.66	1.73	1.80	1.88	1.95	2.03	2.12	2.21
19.00	1.09	1.14	1.19	1.24	1.30	1.35	1.41	1.47	1.53	1.60	1.66	1.73	1.80	1.88	1.95	2.03	2.11
19.50	1.05	1.10	1.15	1.20	1.25	1.31	1.36	1.42	1.48	1.54	1.60	1.67	1.73	1.80	1.88	1.95	2.03
20.00	1.02	1.07	1.11	1.16	1.21	1.26	1.31	1.37	1.43	1.48	1.54	1.61	1.67	1.74	1.81	1.88	1.95
20.50	0.99	1.03	1.08	1.12	1.17	1.22	1.27	1.32	1.38	1.43	1.49	1.55	1.61	1.68	1.74	1.81	1.88
21.00	0.96	1.00	1.04	1.09	1.13	1.18	1.23	1.28	1.33	1.39	1.44	1.50	1.56	1.62	1.68	1.75	1.81
21.50	0.93	0.97	1.01	1.06	1.10	1.14	1.19	1.24	1.29	1.34	1.39	1.45	1.51	1.56	1.62	1.69	1.75
22.00	0.90	0.94	0.98	1.02	1.07	1.11	1.16	1.20	1.25	1.30	1.35	1.40	1.46	1.51	1.57	1.63	1.69
22.50	0.88	0.92	0.95	0.99	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.36	1.41	1.47	1.52	1.58	1.64
23.00	0.85	0.89	0.93	0.97	1.01	1.05	1.09	1.13	1.18	1.22	1.27	1.32	1.37	1.42	1.47	1.53	1.59
23.50	0.83	0.87	0.90	0.94	0.98	1.02	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.48	1.54
24.00	0.81	0.84	0.88	0.92	0.95	0.99	1.03	1.07	1.11	1.16	1.20	1.25	1.29	1.34	1.39	1.44	1.49
24.50	0.79	0.82	0.86	0.89	0.93	0.97	1.00	1.04	1.08	1.12	1.17	1.21	1.26	1.30	1.35	1.40	1.45
25.00	0.77	0.80	0.84	0.87	0.91	0.94	0.98	1.02	1.06	1.10	1.14	1.18	1.22	1.27	1.31	1.36	1.41
25.50	0.75	0.78	0.82	0.85	0.88	0.92	0.95	0.99	1.03	1.07	1.11	1.15	1.19	1.23	1.28	1.32	1.37
26.00	0.73	0.77	0.80	0.83	0.86	0.90	0.93	0.97	1.00	1.04	1.08	1.12	1.16	1.20	1.25	1.29	1.34
26.50	0.72	0.75	0.78	0.81	0.84	0.87	0.91	0.94	0.98	1.02	1.05	1.09	1.13	1.17	1.21	1.26	1.30
27.00	0.70	0.73	0.76	0.79	0.82	0.85	0.89	0.92	0.96	0.99	1.03	1.07	1.10	1.14	1.18	1.23	1.27
28.00	0.67	0.70	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.95	0.98	1.02	1.05	1.09	1.13	1.17	1.21
29.00	0.64	0.67	0.70	0.73	0.75	0.78	0.81	0.84	0.87	0.91	0.94	0.97	1.01	1.04	1.08	1.12	1.15
30.00	0.62	0.64	0.67	0.70	0.72	0.75	0.78	0.81	0.84	0.87	0.90	0.93	0.96	1.00	1.03	1.07	1.10

*The values listed are the magnification ratios of Purkinje III (produced by the anterior surface of the IOL) to Purkinje I (produced by the cornea). The magnification ratio is computed assuming a 68-mm axial distance from object target to the focused biomicroscopic image (Purkinje I or III). *Negative values indicate an inverted IOL image.*

†These values are the refracting power in diopters of the anterior surface of the IOL in aqueous (n=1.3360), which for a convexoplano lens (n=1.4917) is also the total power (equivalent power), since the posterior surface is plano.

Table 7. Magnification ratio for the IOL image size to the corneal image size (anterior chamber depth = 4.5 mm).*

IOL Power†	Corneal Power (Diopters)																
	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0.00	-3.22	-3.24	-3.26	-3.28	-3.29	-3.31	-3.33	-3.35	-3.36	-3.38	-3.40	-3.42	-3.43	-3.45	-3.47	-3.48	-3.50
1.00	-3.97	-3.97	-3.97	-3.97	-3.97	-3.97	-3.97	-3.97	-3.98	-3.98	-3.98	-3.99	-3.99	-4.00	-4.00	-4.01	-4.02
2.00	-5.11	-5.07	-5.03	-4.99	-4.95	-4.92	-4.89	-4.86	-4.84	-4.82	-4.79	-4.77	-4.76	-4.74	-4.72	-4.71	-4.70
3.00	-7.01	-6.87	-6.74	-6.62	-6.50	-6.40	-6.30	-6.21	-6.13	-6.05	-5.98	-5.91	-5.85	-5.79	-5.74	-5.69	-5.65
4.00	-10.40	-10.00	-9.69	-9.39	-9.11	-8.86	-8.62	-8.40	-8.19	-8.00	-7.83	-7.67	-7.52	-7.38	-7.25	-7.13	-7.02
5.00	13.20	14.50	15.90	17.50	19.10	-13.10	-12.60	-12.10	-11.70	-11.30	-10.90	-10.50	-10.20	-9.91	-9.63	-9.38	-9.14
6.00	8.60	9.42	10.30	11.30	12.40	13.60	14.90	16.40	17.90	19.60	21.40	-15.40	-14.80	-14.20	-13.60	-13.10	-12.60
7.00	6.03	6.54	7.10	7.71	8.39	9.14	9.97	10.90	11.90	13.00	14.20	15.50	17.00	18.50	20.30	22.10	24.10
8.00	4.53	4.87	5.24	5.65	6.09	6.57	7.09	7.67	8.30	8.99	9.76	10.60	11.50	12.50	13.70	14.90	16.30
9.00	3.59	3.84	4.10	4.39	4.69	5.03	5.38	5.77	6.19	6.65	7.15	7.70	8.30	8.96	9.68	10.50	11.30
10.00	2.97	3.15	3.35	3.57	3.79	4.04	4.30	4.58	4.88	5.21	5.56	5.94	6.35	6.79	7.28	7.81	8.38
11.00	2.52	2.67	2.83	3.00	3.17	3.36	3.56	3.78	4.00	4.25	4.51	4.79	5.09	5.41	5.76	6.13	6.54
12.00	2.19	2.31	2.44	2.58	2.72	2.87	3.03	3.21	3.39	3.58	3.78	4.00	4.23	4.47	4.74	5.02	5.32
12.50	2.05	2.17	2.28	2.41	2.54	2.68	2.82	2.98	3.14	3.31	3.50	3.69	3.89	4.11	4.35	4.59	4.86
13.00	1.93	2.04	2.15	2.26	2.38	2.51	2.64	2.78	2.93	3.08	3.25	3.42	3.61	3.80	4.01	4.23	4.47
13.50	1.82	1.92	2.02	2.13	2.24	2.36	2.48	2.61	2.74	2.88	3.03	3.19	3.36	3.54	3.72	3.92	4.13
14.00	1.73	1.82	1.91	2.01	2.11	2.22	2.33	2.45	2.58	2.71	2.85	2.99	3.14	3.30	3.47	3.65	3.84
14.50	1.64	1.73	1.81	1.91	2.00	2.10	2.21	2.32	2.43	2.55	2.68	2.81	2.95	3.10	3.25	3.42	3.59
15.00	1.56	1.64	1.72	1.81	1.90	1.99	2.09	2.19	2.30	2.41	2.53	2.65	2.78	2.92	3.06	3.21	3.37
15.50	1.49	1.57	1.64	1.72	1.81	1.90	1.99	2.08	2.18	2.29	2.40	2.51	2.63	2.76	2.89	3.03	3.17
16.00	1.43	1.50	1.57	1.65	1.73	1.81	1.89	1.98	2.08	2.17	2.28	2.38	2.49	2.61	2.73	2.86	2.99
16.50	1.37	1.43	1.50	1.57	1.65	1.73	1.81	1.89	1.98	2.07	2.17	2.27	2.37	2.48	2.59	2.71	2.84
17.00	1.31	1.38	1.44	1.51	1.58	1.65	1.73	1.81	1.89	1.98	2.07	2.16	2.26	2.36	2.47	2.58	2.70
17.50	1.26	1.32	1.38	1.45	1.52	1.59	1.66	1.73	1.81	1.89	1.98	2.07	2.16	2.25	2.35	2.46	2.57
18.00	1.21	1.27	1.33	1.39	1.46	1.52	1.59	1.66	1.74	1.81	1.89	1.98	2.06	2.15	2.25	2.35	2.45
18.50	1.17	1.23	1.28	1.34	1.40	1.46	1.53	1.60	1.67	1.74	1.82	1.90	1.98	2.06	2.15	2.25	2.34
19.00	1.13	1.18	1.24	1.29	1.35	1.41	1.47	1.54	1.61	1.67	1.75	1.82	1.90	1.98	2.07	2.15	2.24
19.50	1.09	1.14	1.19	1.25	1.30	1.36	1.42	1.48	1.55	1.61	1.68	1.75	1.83	1.90	1.98	2.07	2.15
20.00	1.06	1.10	1.15	1.21	1.26	1.31	1.37	1.43	1.49	1.56	1.62	1.69	1.76	1.83	1.91	1.99	2.07
20.50	1.02	1.07	1.12	1.17	1.22	1.27	1.33	1.38	1.44	1.50	1.56	1.63	1.70	1.77	1.84	1.91	1.99
21.00	0.99	1.04	1.08	1.13	1.18	1.23	1.28	1.34	1.39	1.45	1.51	1.57	1.64	1.71	1.77	1.85	1.92
21.50	0.96	1.01	1.05	1.10	1.14	1.19	1.24	1.30	1.35	1.41	1.46	1.52	1.58	1.65	1.71	1.78	1.85
22.00	0.94	0.98	1.02	1.06	1.11	1.16	1.21	1.26	1.31	1.36	1.42	1.47	1.53	1.59	1.66	1.72	1.79
22.50	0.91	0.95	0.99	1.03	1.08	1.12	1.17	1.22	1.27	1.32	1.37	1.43	1.49	1.54	1.61	1.67	1.73
23.00	0.88	0.92	0.96	1.00	1.05	1.09	1.14	1.18	1.23	1.28	1.33	1.39	1.44	1.50	1.56	1.62	1.68
23.50	0.86	0.90	0.94	0.98	1.02	1.06	1.10	1.15	1.20	1.24	1.29	1.35	1.40	1.45	1.51	1.57	1.63
24.00	0.84	0.88	0.91	0.95	0.99	1.03	1.07	1.12	1.16	1.21	1.26	1.31	1.36	1.41	1.47	1.52	1.58
24.50	0.82	0.85	0.89	0.93	0.97	1.01	1.05	1.09	1.13	1.18	1.22	1.27	1.32	1.37	1.42	1.48	1.53
25.00	0.80	0.83	0.87	0.90	0.94	0.98	1.02	1.06	1.10	1.15	1.19	1.24	1.28	1.33	1.38	1.44	1.49
25.50	0.78	0.81	0.85	0.88	0.92	0.96	0.99	1.03	1.07	1.12	1.16	1.20	1.25	1.30	1.35	1.40	1.45
26.00	0.76	0.79	0.83	0.86	0.90	0.93	0.97	1.01	1.05	1.09	1.13	1.17	1.22	1.26	1.31	1.36	1.41
26.50	0.74	0.77	0.81	0.84	0.87	0.91	0.95	0.98	1.02	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38
27.00	0.73	0.76	0.79	0.82	0.85	0.89	0.92	0.96	1.00	1.04	1.08	1.12	1.16	1.20	1.25	1.29	1.34
28.00	0.69	0.72	0.75	0.79	0.82	0.85	0.88	0.92	0.95	0.99	1.03	1.07	1.11	1.15	1.19	1.23	1.28
29.00	0.67	0.69	0.72	0.75	0.78	0.81	0.85	0.88	0.91	0.95	0.98	1.02	1.06	1.09	1.13	1.18	1.22
30.00	0.64	0.67	0.69	0.72	0.75	0.78	0.81	0.84	0.87	0.91	0.94	0.98	1.01	1.05	1.09	1.12	1.16

*The values listed are the magnification ratios of Purkinje III (produced by the anterior surface of the IOL) to Purkinje I (produced by the cornea). The magnification ratio is computed assuming a 68-mm axial distance from object target to the focused biomicroscopic image (Purkinje I or III). *Negative values indicate an inverted IOL image.*

†These values are the refracting power in diopters of the anterior surface of the IOL in aqueous (n=1.3360), which for a convexoplano lens (n=1.4917) is also the total power (equivalent power), since the posterior surface is plano.

Table 8. Magnification ratio for the IOL image size to the corneal image size (anterior chamber depth = 5 mm).*

IOL Power†	Corneal Power (Diopters) 36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0.00	-3.27	-3.29	-3.31	-3.33	-3.35	-3.37	-3.39	-3.41	-3.43	-3.45	-3.46	-3.48	-3.50	-3.52	-3.54	-3.56	-3.58
1.00	-4.01	-4.01	-4.01	-4.01	-4.01	-4.02	-4.02	-4.03	-4.03	-4.04	-4.04	-4.05	-4.06	-4.07	-4.07	-4.08	-4.09
2.00	-5.13	-5.09	-5.05	-5.02	-4.98	-4.95	-4.93	-4.90	-4.88	-4.86	-4.84	-4.82	-4.81	-4.80	-4.78	-4.77	-4.76
3.00	-6.96	-6.83	-6.71	-6.59	-6.48	-6.39	-6.29	-6.21	-6.13	-6.06	-5.99	-5.93	-5.87	-5.82	-5.77	-5.73	-5.68
4.00	-10.10	-9.81	-9.51	-9.23	-8.97	-8.72	-8.50	-8.29	-8.10	-7.92	-7.76	-7.60	-7.46	-7.33	-7.21	-7.10	-7.00
5.00	13.60	15.00	16.50	18.10	-13.20	-12.70	-12.20	-11.80	-11.40	-11.00	-10.60	-10.30	-9.98	-9.70	-9.44	-9.20	-8.98
6.00	8.98	9.85	10.80	11.90	13.00	14.30	15.70	17.20	18.80	20.60	22.50	-14.70	-14.10	-13.60	-13.10	-12.60	-12.10
7.00	6.30	6.85	7.46	8.12	8.85	9.66	10.60	11.50	12.60	13.80	15.10	16.50	18.10	19.70	21.60	23.50	-17.20
8.00	4.74	5.10	5.50	5.94	6.42	6.94	7.52	8.15	8.84	9.60	10.40	11.40	12.40	13.50	14.70	16.10	17.60
9.00	3.75	4.02	4.30	4.61	4.94	5.30	5.70	6.12	6.59	7.09	7.65	8.26	8.92	9.66	10.50	11.40	12.30
10.00	3.09	3.29	3.51	3.74	3.99	4.25	4.54	4.85	5.18	5.54	5.93	6.35	6.81	7.31	7.85	8.45	9.10
11.00	2.62	2.78	2.95	3.14	3.33	3.53	3.75	3.99	4.24	4.51	4.80	5.11	5.44	5.80	6.19	6.62	7.08
12.00	2.28	2.41	2.55	2.69	2.85	3.02	3.19	3.38	3.58	3.79	4.01	4.25	4.51	4.78	5.08	5.40	5.74
12.50	2.13	2.25	2.38	2.52	2.66	2.81	2.97	3.14	3.31	3.50	3.71	3.92	4.15	4.39	4.65	4.93	5.23
13.00	2.01	2.12	2.24	2.36	2.49	2.63	2.77	2.93	3.09	3.26	3.44	3.63	3.84	4.06	4.29	4.54	4.80
13.50	1.90	2.00	2.11	2.22	2.34	2.47	2.60	2.74	2.89	3.05	3.21	3.39	3.57	3.77	3.98	4.20	4.44
14.00	1.80	1.89	1.99	2.10	2.21	2.33	2.45	2.58	2.71	2.86	3.01	3.17	3.34	3.52	3.71	3.91	4.12
14.50	1.70	1.79	1.89	1.99	2.09	2.20	2.31	2.43	2.56	2.69	2.83	2.98	3.13	3.29	3.47	3.65	3.84
15.00	1.62	1.71	1.80	1.89	1.98	2.09	2.19	2.30	2.42	2.54	2.67	2.81	2.95	3.10	3.26	3.43	3.60
15.50	1.55	1.63	1.71	1.80	1.89	1.98	2.08	2.19	2.29	2.41	2.53	2.65	2.79	2.92	3.07	3.23	3.39
16.00	1.48	1.56	1.63	1.72	1.80	1.89	1.98	2.08	2.18	2.29	2.40	2.52	2.64	2.77	2.90	3.05	3.20
16.50	1.42	1.49	1.56	1.64	1.72	1.80	1.89	1.98	2.08	2.18	2.28	2.39	2.51	2.63	2.75	2.89	3.03
17.00	1.36	1.43	1.50	1.57	1.65	1.73	1.81	1.90	1.99	2.08	2.18	2.28	2.39	2.50	2.62	2.74	2.87
17.50	1.31	1.37	1.44	1.51	1.58	1.66	1.73	1.82	1.90	1.99	2.08	2.18	2.28	2.39	2.50	2.61	2.73
18.00	1.26	1.32	1.38	1.45	1.52	1.59	1.66	1.74	1.82	1.91	1.99	2.09	2.18	2.28	2.38	2.49	2.61
18.50	1.21	1.27	1.33	1.40	1.46	1.53	1.60	1.67	1.75	1.83	1.91	2.00	2.09	2.18	2.28	2.38	2.49
19.00	1.17	1.23	1.29	1.35	1.41	1.47	1.54	1.61	1.68	1.76	1.84	1.92	2.01	2.09	2.19	2.29	2.39
19.50	1.13	1.19	1.24	1.30	1.36	1.42	1.48	1.55	1.62	1.69	1.77	1.85	1.93	2.01	2.10	2.19	2.29
20.00	1.09	1.15	1.20	1.25	1.31	1.37	1.43	1.50	1.56	1.63	1.70	1.78	1.86	1.94	2.02	2.11	2.20
20.50	1.06	1.11	1.16	1.21	1.27	1.33	1.39	1.45	1.51	1.58	1.64	1.72	1.79	1.87	1.95	2.03	2.12
21.00	1.03	1.08	1.12	1.18	1.23	1.28	1.34	1.40	1.46	1.52	1.59	1.66	1.73	1.80	1.88	1.96	2.04
21.50	1.00	1.04	1.09	1.14	1.19	1.24	1.30	1.35	1.41	1.47	1.54	1.60	1.67	1.74	1.81	1.89	1.97
22.00	0.97	1.01	1.06	1.11	1.16	1.21	1.26	1.31	1.37	1.43	1.49	1.55	1.62	1.68	1.75	1.83	1.90
22.50	0.94	0.98	1.03	1.07	1.12	1.17	1.22	1.27	1.33	1.38	1.44	1.50	1.56	1.63	1.70	1.77	1.84
23.00	0.92	0.96	1.00	1.04	1.09	1.14	1.19	1.24	1.29	1.34	1.40	1.46	1.52	1.58	1.64	1.71	1.78
23.50	0.89	0.93	0.97	1.02	1.06	1.11	1.15	1.20	1.25	1.30	1.36	1.41	1.47	1.53	1.59	1.66	1.73
24.00	0.87	0.91	0.95	0.99	1.03	1.08	1.12	1.17	1.22	1.27	1.32	1.37	1.43	1.49	1.55	1.61	1.67
24.50	0.85	0.88	0.92	0.96	1.00	1.05	1.09	1.14	1.18	1.23	1.28	1.34	1.39	1.45	1.50	1.56	1.62
25.00	0.83	0.86	0.90	0.94	0.98	1.02	1.06	1.11	1.15	1.20	1.25	1.30	1.35	1.41	1.46	1.52	1.58
25.50	0.81	0.84	0.88	0.92	0.95	0.99	1.04	1.08	1.12	1.17	1.22	1.27	1.32	1.37	1.42	1.48	1.54
26.00	0.79	0.82	0.86	0.89	0.93	0.97	1.01	1.05	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.44	1.49
26.50	0.77	0.80	0.84	0.87	0.91	0.95	0.99	1.03	1.07	1.11	1.16	1.20	1.25	1.30	1.35	1.40	1.46
27.00	0.75	0.78	0.82	0.85	0.89	0.93	0.96	1.00	1.04	1.09	1.13	1.17	1.22	1.27	1.32	1.37	1.42
28.00	0.72	0.75	0.78	0.82	0.85	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.16	1.21	1.25	1.30	1.35
29.00	0.69	0.72	0.75	0.78	0.81	0.85	0.88	0.92	0.95	0.99	1.03	1.07	1.11	1.15	1.20	1.24	1.29
30.00	0.66	0.69	0.72	0.75	0.78	0.81	0.84	0.88	0.91	0.95	0.99	1.02	1.06	1.10	1.14	1.19	1.23

*The values listed are the magnification ratios of Purkinje III (produced by the anterior surface of the IOL) to Purkinje I (produced by the cornea). The magnification ratio is computed assuming a 68-mm axial distance from object target to the focused biomicroscopic image (Purkinje I or III). *Negative values indicate an inverted IOL image.*

†These values are the refracting power in diopters of the anterior surface of the IOL in aqueous (n=1.3360), which for a convexoplano lens (n=1.4917) is also the total power (equivalent power), since the posterior surface is plano.

materials such as glass, silicone, or the crystalline lens.

When refractive surprises occur following IOL implantation, the IOL power can be directly checked without lens removal. Knowing the exact power of the implanted lens will assist in making a more accurate selection of the lens power for the second eye. When a lens exchange is being contemplated because of an intolerable postoperative refractive error, the power of a lens within the eye can be determined prior to surgery, assuring that the appropriate exchange is made.

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