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Evaluating Refractive Outcomes after Cataract Surgery

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Purpose: To compare methods for evaluating refractive outcomes after cataract surgery to detect outliers.

Design: Case series database study of the evaluation of diagnostic technology.

Participants: Consecutive patients who had uneventful cataract operations over a 5-year period.

Methods: The intended and postoperative refractive outcome and differences between these were analyzed as a spherical equivalent, cylinder, and spherocylinder. The average keratometry and differences between steep and flat keratometric meridians were used to calculate the intended refractive error.

Main Outcome Measures: Outliers were defined as patients for whom the difference between the intended and postoperative refractive errors was more than 3 standard deviations (SDs) away from the mean.

Results: A total of 9000 patients were included. Twelve patients had missing data and were excluded. The mean intended refractive outcome was −0.12+0.12×2 (95% lower confidence limit [LCL], −1.94+1.06×44; 95% upper confidence limit [UCL], +0.77+1.05×140). The actual postoperative refractive error was −0.30+0.47×6 (95% LCL, −2.36+1.31×36; 95% UCL, +1.00+1.18×148) with a difference from the intended of −0.18+0.35×7 (95% LCL, −1.91+1.22×38; 95% UCL, +0.75+1.09×145). Treating the components of the refractive error independently, outliers were observed in 82 eyes (0.91%) based on the sphere, 46 eyes (0.51%) based on the spherical equivalent, 115 eyes (1.28%) based on treating the cylinder as a scalar, and 76 eyes (0.85%) based on treating the cylinder as a vector. When the differences between the intended and postoperative refractive errors were calculated as a compound spherocylinder, outliers were observed for 233 eyes (2.59%).

Conclusions: Treating the intended refractive outcome as a spherocylinder improves the precision for detecting clinically significant refractive outliers. *Ophthalmology 2018;■:1–6 © 2018 by the American Academy of Ophthalmology*

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Cataract surgery with intraocular lens (IOL) implantation is the most frequently undertaken operation with significant patient benefit.[1] In recent years, much effort has been devoted to achieving spectacle independence through improvements in the operative technique, acquisition of biometric data, and refinement of IOL power formulae.[2-4] This has led to a progressive reduction in spherical equivalent prediction errors.[2,3,5] Approaching the intended postoperative spherical equivalent, however, often does not achieve spectacle independence.[6] Uncorrected residual spherocylindrical refractive errors appear to have a far greater adverse effect on unaided visual acuity than may be evident using a spherical equivalent or the individual sphere and cylinder.[6-8] Uncompensated spherocylinder refractive errors, particularly those with oblique astigmatism (e.g., −1+2×135) compared to with-the-rule astigmatism or against-the-rule astigmatism, are more destructive on stereopsis and vision.[9,10]

Presentation of biometric data as spherical equivalents may limit the surgeon's ability to fully appreciate the intended refractive outcome with a potentially missed opportunity to optimize their surgical approach and achieve an improved outcome. Therefore, taking into account the compound refractive error with all of its components, including sphere, cylinder, and axis, is important when planning surgery both for the individual patient and for analyzing outcomes for larger groups, either for audit or research. Providing the target or intended outcome as a spherocylinder rather than as a spherical equivalent, cylinder, or sphere sets a more accurate target with a higher threshold.

To facilitate the treatment or analysis of refractive errors, there have been many attempts to reduce the refractive error into a single or univariate value, for example, the spherical equivalent or power vectors. Reducing the spherocylinder, which is a 3-component number, into a single value makes it impossible to distinguish between different refractive errors. Many different refractive errors will have the same univariate value, for example, −0.50+3.00×90, 0.50+1.00×180, and 0.00+2.00×90 will all have the same "spherical equivalent" value of +1.00. Other examples in relation to power vectors are provided in the Appendix (available at www.aaojournal.org). The spherical equivalent is a univariate approximation of the spherocylinder power. The error associated with the approximation is not constant and varies according to the power of the spherocylinder. Thus, for groups of different refractive powers, the magnitude of the error will differ in each of the groups and may lead to invalid conclusions.[11]

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Other approaches have been to treat the components of the refractive error as independent terms, that is, separation of the sphere and cylinder. They are not, however, independent variables, and a change in one is associated with a change in the other.[12-16] The space of cylinder powers whether treated as a vector or a scalar number is not closed under addition or subtraction, for example, a cylinder of +1.00×90 plus a cylinder of +1.00×180 is a sphere of +1.00 or a cylinder of +1.00×90 plus a cylinder of +2.00×180 is a spherocylinder of +1.00+1.00×180.

Although refractive data are conventionally expressed as spherocylinder, there is a tendency to treat each component independently. For example, consider the following 2 refractive (paraxial) powers: +2+2×90 and +1+1×180. If they were to be added together, what would be the result? There are 3 possibilities depending on whether each component is treated independently or dependently. If they are treated independently as scalar values, this leads to the following situation,

or (+2+2)+(+1+1)=+3+3, which is incorrect.[17] If they are treated independently as vectors, this leads to

$$\left|\begin{array}{c} \textit{Sphere} \\ 2 \\ \underline{1} \\ 3 \end{array}\right| + \left|\begin{array}{c} \textit{Cylinder} \\ 2_{90} \\ \underline{1_{180}} \\ 1^{1}_{90} \end{array}\right| +$$

or (+2+2×90)+(+1+1×180)=+3+1×90, which again is incorrect. If, however, they are treated dependently, then

$$\left|\begin{array}{cc} \textit{Sphere} & \textit{Cylinder} \\ 2^{1} & 2_{90} \\ \underline{1} & \underline{1_{180}} \\ 4 & 1^{1}_{90} \end{array}\right| +$$

or (+2+2×90)+(+1+1×18)=+4+1×90, which is the correct result.[17]

Attempts to treat the components of a refractive power independently, therefore, regardless of whether the cylinder is treated as a vector or a scalar number, will introduce errors and potentially lead to erroneous conclusions.[12-18]

There are informative and established methods to treat the analysis of refractive errors appropriately and that are easily applicable to assessing outcomes after cataract surgery.[16-21] The purpose of this article is to compare methods for analyzing refractive outcomes after cataract surgery for the detection of significant outliers.

Methods

Data on consecutive cataract operations performed at Gloucestershire Hospitals National Health Service (public hospital) Foundation Trust between December 1, 2005, and July 31, 2010, were collected.[22] Data extraction and analysis were performed as part of a research project sponsored by Gloucestershire Hospitals National Health Service Foundation Trust and approved by the Local Research Ethics Committee. The described research adhered to the tenets of the Declaration of Helsinki. Inclusion criteria were consecutive patients who underwent phacoemulsification cataract surgery having had preoperative measurement of both axial length (AL) and keratometry using the IOLMaster 500 (Carl Zeiss Meditec, Jena, Germany, software versions 4.01 and 5.4), uneventful phacoemulsification cataract surgery with implantation of the IOL in the capsular bag, and a postoperative subjective refraction and corrected distance visual acuity of 20/40 or better. Cases with high corneal astigmatism (difference between the steep [keratometry 2] and flat [keratometry 1] meridians >3.00 diopters [D]) or undergoing any concurrent additional ophthalmological surgical procedure or additional refractive procedures, such as a limbal-relaxing incision, were not included. Postoperative subjective refraction was performed 4 to 6 weeks after surgery.

The IOL model used was the Bausch & Lomb (Rochester, NY) LI61AO Sofport, a 3-piece IOL with a silicone aspheric optic, 2 polymethyl methacrylate haptics, and a manufacturer's A constant of 118.0. For the purposes of this study, optimized IOL power constants were used. A standard 2.8-mm corneal incision was used in all cases. For eyes with an AL under 22 mm, the Hoffer Q formula was used; for eyes with an AL between 22 and 26 mm, and for eyes with an AL over 26 mm, the Holladay 1 was used; and for eyes with an AL over 26 mm, the SRK/T was used.[23-25] All formulae had been optimized for a mean arithmetical prediction error of 0. The IOL power constants used were postoperative anterior chamber depth = 5.30, surgeon factor = 1.67, and a constant = 118.8 for the Hoffer Q, Holladay 1, and SRK/T, respectively. (References 26 and 27 are cited in the supplementary data available at www.aaojournal.org.)

Refractive Analyses

The average keratometry and the differences between the steep (K2) and flat (K1) meridians were added to the intended error to give the intended refractive error as a spherical equivalent and a spherocylinder.[16-18] For the intended and postoperative refractive error and difference, the components (sphere and cylinder) were treated as both independent and dependent terms. For the cylinder, this was undertaken treating the cylinder as both a scalar number and a vector. For the dependent analysis, the data were transformed into the components of Long's formalism,[19] and the difference between the intended and postoperative refractions was calculated before transformation back into spherocylinder notation.[20] The detailed methodology and theory are provided in references 12-20 and reviewed in reference 17 (in this article). The website http://OphthaCalc.co.uk/ can be freely accessed and used for all the respective calculations.

Descriptive statistics were computed to give the mean, standard deviation (SD), 95% confidence interval, mean ±3 SD, minimum, and maximum. For the compound analysis, the method of Harris[15] and Kaye and Harris[16] was used to test the differences between the intended and actual postoperative refractive error.

Identification of Outliers

Patients whose refractive outcome was more than 3 SD from the mean difference between the intended and postoperative refractive outcome were identified using the spherical equivalent, sphere, and cylinder independently and the compound refractive error. Based on Chebyshev's theorum, this would guarantee that at least 88.89% of cases would lie within 3 SD of the mean whether or not the data followed a normal or nonparametric distribution. If the data follow a normal distribution, then it would be expected (not guaranteed) that 99.73% of the data would be within 3 SD of the mean (cumulative distribution function of the normal distribution).

Table 1. Intended, Postoperative, and Difference between Intended and Postoperative Refractive Error (n=8988 patients): Flat (K1), Steep (K2), and Meridian (M) of K2, Compound Refractive Error (SC×A), and Spherical Equivalent

	Preoperative Keratometry			Intended Refractive Outcome		Postoperative Refractive Error		Difference between Intended and Postoperative Refractive Error	
	K1	*K2*	*M(K2)*	*SE*	*SC×A*	*SE*	*SC×A*	*SE*	*SC×A*
Mean (SD)	43.77	43.89	2	−0.06 (+0.69)	−0.12+0.12×2	−0.06 (+0.84)	−0.30+0.47×6	−0.01 (+0.66)	−0.18+0.35×7
95% LCL	40.24	41.32	136	−1.41	−1.94+1.06×44	−1.71	−2.36+1.31×36	−1.30	−1.91+1.22×38
95% UCL	46.35	47.39	40	+1.30	+0.77+1.05×140	+1.59	+1.00+1.18×148	+1.29	+0.75+1.09×145
Mean −3 SD	38.35	39.98	41	−2.13	−2.93+1.61×45	−2.59	−3.53+1.89×39	−1.99	−2.89+1.79×41
Mean +3 SD	47.69	49.28	135	+2.01	+1.21+1.61×139	+2.46	+1.58+1.76×144	+1.98	+1.15+1.65×142
Min	37.40	40.04	47	−10.57	−11.96+2.78×40	−10.75	−13.72+5.94×36	−5.59	−8.92+5.55×37
Max	48.86	51.78	131	+5.59	+4.52+2.97×129	+8.25	+6.56+4.50×115	+7.94	+6.05+3.79×117

LCL = lower confidence limit; SD = standard deviation; SE = spherical equivalent; UCL = upper confidence limit.

Results

The data from 9000 cataract operations were available. Twelve eyes had missing data and were excluded, leaving 8988 operation entries. The descriptive statistics for the preoperative keratometry, the intended refractive outcome, the observed postoperative refractive error, and the difference between the intended and observed postoperative refractive error are presented in Tables 1 and 2. The mean preoperative keratometry was K1 43.77 D and K2 43.89 D at 2 degrees, and the intended outcome was −0.12+0.12×2 (spherical equivalent of −0.06 D) (Table 1). The results based on each analytic approach are presented in Tables 1 and 2 and summarized as follows.

a. Sphere as an independent variable. The mean (SD) intended and postoperative refractive error and difference from the intended outcome were −0.51 D (0.59)+0.12 D (0.87) and −0.21 D (0.70), respectively.
b. Cylinder as an independent variable (scalar and vector). The intended, postoperative, and differences from the intended outcome were +0.91 D (0.57), +0.91×41, +0.91 D (0.67), −0.36×109, and +0.51 D (0.42), +0.41×163, respectively.
c. Spherical equivalent. The mean postoperative refractive error was −0.06 D (0.84) with the difference from the intended of −0.01 D (0.66).
d. Spherocylinder (compound number). The mean postoperative refractive error was −0.30+0.47×6 with the difference from the intended outcome of −0.18+0.35×7 (95% lower confidence limit, −1.91+1.22×38 and 95% upper confidence limit, +0.75+1.09×145).

There were 82 patients (0.91%) using the sphere, 115 patients (1.28%) using the cylinder as a scalar, and 76 patients (0.85%) using the cylinder as a vector for whom the difference between the postoperative and intended refractive outcome was more than 3 SD from the mean (Table 3). For the spherical equivalent, there were 46 patients (0.51%) for whom the difference between the intended and postoperative refractive error was more than 3 SD (−1.99 to +1.98) above or below the mean difference. For the compound refractive error, there were 233 patients (2.59%) for whom the differences between the intended and postoperative refractive errors were more than ±3 SD (−2.89+1.79×41 to +1.15+1.65×142) from the mean difference. For comparison, examples of cases in which the differences between the intended and postoperative refractive error were more than 3 SD from the mean using the compound refractive error, but were less than 3 SD from the mean using the spherical equivalent, are presented in Table 4A. Examples of cases in which the difference between the intended and the postoperative refractive error was more than 3 SD from the mean for both the compound refractive error and spherical equivalent are presented in Table 4B.

Table 2. Intended, Postoperative, and Difference between the Intended and Postoperative Refractive Error Treating the Components of the Refractive Error as Independent Variables (n=8988 patients)

	Intended Refractive Outcome			Postoperative Refractive Error			Difference between Intended and Postoperative Refractive Error		
	Sphere	*Vector Cylinder*	*Scalar Cylinder*	*Sphere*	*Vector Cylinder*	*Scalar Cylinder*	*Sphere*	*Vector Cylinder*	*Scalar Cylinder*
Mean	−0.51	+0.91×41	+0.91	+0.12	−0.36×109	+0.91	−0.21	+0.41×163	+0.51
SD	+0.59	+0.58	+0.57	+0.87	+1.07	+0.67	+0.70	+0.94	+0.42
95% LCL	−1.67	+2.04	+2.04	−1.58	−2.47	−0.41	−1.58	−1.44	−0.31
95% UCL	+0.65	−0.22	−0.21	+1.82	+1.74	+2.23	+1.17	+2.25	+1.33
Mean −3 SD	−2.29	−0.82	−0.81	−2.48	−3.58	−1.11	−2.31	−2.42	−0.75
Mean +3 SD	+1.26	+2.64	+2.63	+2.72	+2.85	+2.93	+1.89	+3.23	+1.76
Min	−10.84	−2.43	0.00	−9.75	−6.00	0.00	−6.93	−4.38	0.00
Max	+5.30	+3.00	+3.00	+10.25	+4.00	+6.00	+9.11	+5.77	+5.70

LCL = lower confidence limit; SD = standard deviation; UCL = upper confidence limit.

Table 3. Number of Patients with Refractive Errors More or Less Than the 3 Standard Deviations Away from the Mean: Intended, Difference, and Postoperative Refractive Errors Analyzed Using Spherical Equivalent, Sphere, and Cylinder (Scalar and Vector) Independently and SC×A as a Compound Number

	SE	**Sphere**	**Cylinder (Scalar)**	**Cylinder (Vector)**	**SC×A**
Intended	187	161	105	102	257
Difference	46	82	115	76	233
Postoperative	162	138	117	47	280

SC×A = compound refractive error; SE = spherical equivalent.

Discussion

Cataract surgery provides significant patient benefit. However, there are many variables that may lead to unintended refractive outcome after cataract surgery, such as surgically induced changes in the eye, errors in biometry, and prediction errors of the effective lens position. Surgeons often plan the refractive outcome according to an IOL power calculator, which typically provides the spherical power for a range of IOLs; each IOL power is associated with a spherical equivalent prediction for the intended postoperative refractive outcome. According to the preoperative keratometry, a surgeon may then decide to use a toric IOL, place the incision in the steep meridian or suture the flat meridian, and use additional incisional or ablative corneal techniques or combinations of these to reduce the expected refractive error. Whatever additional technique is used, an important measure of success is the difference between the intended and the actual postoperative refractive outcome. It is necessary to have a method that is sensitive to departures between the intended and the actual outcome. Providing the surgeon and patient with the intended outcome as a spherocylinder in addition to a spherical equivalent provide an opportunity to decide whether the intended outcome is suitable for the patient's postoperative visual tasks. Only using the spherical equivalent or cylinder in isolation limits this option.

This study demonstrates that in cataract surgery, both the intended and actual outcomes, as well as the respective difference, can be represented in the standard spherocylinder form (i.e., a compound number), which is both more sensitive and specific and more informative than either the

Table 4. Differences between the Intended and Postoperative Refractive Error

A. Examples of Patients with Differences of Greater (Hypermetropic) or Less (Myopic) than ±3 Standard Deviations from the Mean Treating the Refractive Error as a Compound Number Who Would Not Have Been Identified Using the Spherical Equivalent

	Preoperative Keratometry			**Intended Refractive Outcome**		**Postoperative Refractive Error**		**Difference between Intended and Postoperative Refractive Error**	
	K1	*K2*	*M(K2)*	*SE*	*SC×A*	*SE*	*SC×A*	*SE*	*SC×A*
1	46.11	46.68	106	−0.07	−0.36+0.57×106	+0.13	−0.75+1.75×30	+0.20	−0.94+2.27×27
2	45.61	46.23	163	0.03	−0.28+0.62×163	−0.38	−1.75+2.75×65	−0.40	−2.08+3.35×66
3	43.44	44.12	147	−0.16	−0.50+0.68×147	+0.25	−0.75+2.00×20	+0.41	−0.73+2.28×28
4	44.00	45.06	97	−0.57	−1.10+1.06×97	−0.13	−1.25+2.25×48	+0.44	−0.88+2.63×36
5	42.35	42.83	68	−0.25	−0.49+0.48×68	−0.75	−1.50+1.50×150	−0.50	−1.49+1.97×152
6	45.67	46.04	122	−0.01	−0.19+0.37×122	+0.50	−1.00+3.00×20	+0.51	−1.16+3.34×21
7	44.47	45.12	114	−0.28	−0.61+0.65×114	+0.25	−1.50+3.50×15	+0.53	−1.53+4.12×16
8	44.64	44.94	55	−0.03	−0.18+0.30×55	+0.50	−2.50+6.00×35	+0.53	−2.35+5.77×34
9	41.26	41.72	90	+0.08	−0.15+0.46×90	−0.75	−2.00+2.50×170	−0.83	−2.30+2.94×172
10	39.34	40.61	87	+0.11	−0.52+1.27×87	+1.00	0.25+1.50×175	+0.89	−0.50+2.77×176

K = keratotomy; M = meridian; SC×A = compound refractive error; SE = spherical equivalent.

B. Examples of Patients with Differences of Greater (Hypermetropic) or Less (Myopic) than ±3 Standard Deviations from the Mean Treating the Refractive Error as a Compound Number or Spherical Equivalent

	Preoperative Keratometry			**Intended Refractive Outcome**		**Postoperative Refractive Error**		**Difference between Intended and Postoperative Refractive Error**	
	K1	*K2*	*M(K2)*	*SE*	*SC×A*	*SE*	*SC×A*	*SE*	*SC×A*
1	42.72	44.12	102	−0.23	−0.93+1.40×102	+1.75	+0.50+2.50×0	+1.98	+0.07+3.82×4
2	42.19	42.88	180	0.00	−0.34+0.69×180	−2.00	−2.25+0.50×150	−2.00	−2.31+0.62×112
3	44.94	46.36	152	+0.08	−0.63+1.42×152	−2.00	−3.00+2.00×162	−2.08	−2.49+0.82×0
4	41.72	42.24	131	+0.27	+0.01+0.52×131	+2.50	+2.00+1.00×5	+2.23	+1.60+1.26×17
5	43.21	44.06	44	−0.39	−0.82+0.85×44	+1.88	+1.25+1.25×25	+2.27	+1.88+0.78×4
6	42.08	42.72	30	+0.19	−0.13+0.64×30	−2.25	−2.75+1.00×110	−2.44	−3.24+1.62×114
7	44.29	44.58	61	+0.18	+0.03+0.29×61	+2.63	+2.50+0.25×20	+2.45	+2.27+0.36×173
8	42.45	45.36	8	−0.03	−1.49+2.91×8	−2.50	−3.50+2.00×0	−2.47	−3.03+1.13×67
9	43.95	44.58	40	+0.40	+0.08+0.63×40	−2.13	−3.00+1.75×22	−2.52	−3.17+1.29×14
10	41.46	43.72	138	+0.43	−0.70+2.26×138	+3.00	+1.00+4.00×170	+2.57	+0.75+3.63×7

K = keratotomy; M = meridian; SC×A = compound refractive error; SE = spherical equivalent.

spherical equivalent or treating the components of the refractive error (sphere and cylinder) as independent variables. These results demonstrated the identification of a significantly greater number of cases in which the difference between the predicted and postoperative refractive error was higher than that identified using the spherical equivalent or the components independently, reaching clinical significance in a number of cases.

Examples of patients with differences of greater (hypermetropic) or less (myopic) than ±3 SD from the mean treating the refractive error as a compound number who would not have been identified using the spherical equivalent are provided in Table 4A. In terms of the difference between the intended and postoperative refractive error, in all of the 10 patients the difference from the intended may be considered as clinically significant as a spherocylinder but not as a spherical equivalent. In addition, the postoperative refractive outcomes of patients 2, 3, 4, and 5 to 9 as a spherocylinder could be considered as clinically significant. Treating the cylinder independently as a vector, patients 1, 3, 4, 5, and 9 in Table 4A would not have been identified as outliers (> or <3 SD, Table 2).

These analyses have demonstrated that by using the compound (S/C×A) refractive error, 233 patients (2.59%) had differences between the intended and postoperative refractive errors of more than 3 SD above or below the mean. In contrast, treating the components of the refractive error independently, there were 0.85% to 1.28% of patients for whom the difference between the postoperative and intended refractive outcome was more than 3 SD above or below the mean difference. There was a 2- to 5-fold increase in patients whose eyes had clinically significant outcomes that differed by more than $-2.89+1.79\times41$ and $+1.15+1.65\times142$ from the mean difference and who would not have been identified as outliers had the analysis depended on the spherical equivalent or on treating the components of the refractive error independently. This article is based on data collected in routinely performed cataract surgery. The analysis was based on the measured preoperative keratometry and postoperative subjective refraction, and therefore the data and extrapolations are subject to measurement error, as well as true changes in the shape of the eye due to the surgery. Parameters such as posterior corneal shape, which will affect corneal astigmatism and postoperative keratometry, were not measured so that details on surgically induced changes in keratometry were not available. There was an option in the data collection for the surgeon to record the incision location, but unfortunately this was seldom recorded. Although the results presented are in relation to the IOL, equipment, and biometric software used, the methodology is generally applicable.

As IOL technology and operative techniques improve, there is opportunity to improve outcomes, and it is expected that the tolerance for the prediction error will decrease. Therefore, it is correspondingly necessary to have methods that provide more precise and clinically informative analysis. It is important to consider the precision (variation) for which the target refractive outcome is reached because the mean on its own provides only limited information. Where to set the threshold for precision will need to be determined by the ophthalmic community. Treating and analyzing the components of the refractive error independently, although useful for the individual case, lead to the introduction of errors when applied to aggregate outcome data. Likewise, the spherical equivalent has been a useful measure, but there is opportunity to apply more sensitive and specific methods to enhance refractive predictions at the level of individual operations, as well as being of use to define benchmark standards and criteria for detection of outliers and refractive surprises. The methodology presented is theoretically established and is suitable for this type of analysis. As newer and potentially better IOL formulae are developed, the proposed methods will be better placed to evaluate their application. It would be straightforward to include the calculations in a biometry machine software or an electronic patient record so that the preoperative and postoperative data are presented in a conventional format to the surgeon. We have included as an example the website http://OphthaCalc.co.uk/, which can be freely accessed for the respective calculations.

We have highlighted the applications of these methods, illustrating an approach that is achievable in clinical practice. In an era when we strive to improve on our outcomes by using increasingly sophisticated biometry machines and IOL power formulae, it is important not to lose sight of the impact of residual or increased refractive errors that may not be apparent using the spherical equivalent or viewing the components of the refractive error in isolation on the patient's vision, and we should use the tools that facilitate surgeons to assess and manage the patient's refractive error in its entirety.

Further work would be needed to examine and compare the influence of uncompensated (uncorrected) and compensated (corrected with spectacles) refractive outcomes with visual acuity in those patients in whom the target and postoperative outcome differ. This would help determine the acceptable thresholds for refractive outcomes.

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Abbreviations and Acronyms:
AL = axial length; **D** = diopters; **IOL** = intraocular lens; **LCL** = lower confidence limit; **SD** = standard deviation; **UCL** = upper confidence limit.

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