Optimization of Intraocular Lens Constant Improves Refractive Outcomes in Combined Endothelial Keratoplasty and Cataract Surgery

Gustavo Bonfadini, MD,[1,2,3] John G. Ladas, MD, PhD,[1,2] Hamilton Moreira, MD, PhD,[4] Mauro Campos, MD, PhD,[3] Mario Matthaei, MD,[1,5] Beatriz Muñoz, MS,[2,6] Kim Pratzer, COT, ROUB,[1,2] Albert S. Jun, MD, PhD[1,2]

Purpose: To evaluate the accuracy of intraocular lens (IOL) power calculations with A-constant optimization in Descemet's stripping automated endothelial keratoplasty (DSAEK) combined with cataract extraction and intraocular lens implantation (DSAEK triple procedure).

Design: Retrospective case series.

Participants: Thirty eyes of 22 patients with Fuchs' endothelial dystrophy who underwent the DSAEK triple procedure performed by a single surgeon.

Methods: Prediction errors were calculated retrospectively for consecutive DSAEK triple procedures. These prediction errors then were used to determine an IOL constant for this cohort of patients. The new optimized IOL constant subsequently was compared with the manufacturer's IOL constant, allowing evaluation and quantification of refractive benefits of optimization.

Main Outcomes Measures: The error in diopters (D) of the predicted refraction with the manufacturer's and optimized IOL constants.

Results: Optimization of the A constant decreased the mean absolute error (MAE) from 1.09±0.63 D (range, 0.12–2.41 D) to 0.61±0.4 D (range, 0–1.58 D; $P = 0.004$). Comparing the intended and final postoperative refractions calculated with the original manufacturer's constant and the optimized constant, 20% versus 43% of all eyes were in the less than 0.5-D range and 50% versus 83% of all eyes were in the less than 1.0-D range of the target refraction. Furthermore, optimization decreased the number of eyes that were more than 1.0 D from the target refraction from 50% to 17%.

Conclusions: Optimization of the IOL constant showed significantly improved accuracy of predicted postoperative refraction compared with the manufacturer's IOL constant, which may help improve the postoperative refractive outcomes in patients undergoing the DSAEK triple procedure.

Financial Disclosure(s): The author(s) have no proprietary or commercial interest in any materials discussed in this article. *Ophthalmology 2013;120:234–239 © 2013 by the American Academy of Ophthalmology.*

Descemet's stripping automated endothelial keratoplasty (DSAEK) has become the preferred endothelial keratoplasty technique worldwide.[1] It has been demonstrated to provide faster visual recovery, better wound stability, minimal induced astigmatism with a smoother anterior corneal surface, and an improved safety profile compared with the traditional penetrating keratoplasty, which has allowed DSAEK to have more consistent refractive outcomes.[2–5]

Although some reports previously advocated that cataract surgery and subsequent endothelial keratoplasty should be performed as a 2-stage surgical procedure,[1] the current predominating opinion suggests that both procedures can be carried out at the same time.[5–7] Because DSAEK can be performed in patients with clinically significant cataract who need concurrent phacoemulsification and intraocular lens (IOL) implantation, it becomes desirable to identify factors that may affect predictability of surgical outcomes to reduce the postoperative deviation from the target refraction.[3,5]

The power of the IOL usually is determined using specific modern generation calculation formulas. This allows for a precise determination of the power of the IOL to be implanted depending on the individual target refraction.[8] However, there is a subset of patients who do not benefit completely from the application of modern IOL formulas. Among these most notably are phakic patients who either have or have not undergone corneal transplantation or the triple procedure. In these patients, the determination of the correct IOL power to be implanted is not trivial, because most modern generation formulas do not consider the new shape and power of the corneal graft. Thus, most current theoretical formulas result in incorrect assumptions and calculation errors. Multiple methods have tried to meet this challenge, but

ISSN 0161-6420/13/$–see front matter
http://dx.doi.org/10.1016/j.ophtha.2012.08.003

many patients still end up with unacceptable deviations from the target refraction.[9,10]

The shift from penetrating keratoplasty to DSAEK now provides surgeons with the opportunity to refine and enhance IOL selection in these particular patients who need cataract surgery. One method to improve the selection process would be to optimize the applied IOL constants. Optimization of IOL constants is the process by which a constant is refined for a particular surgical technique, lens, formula, surgeon, or measurement device based on previous outcomes.[10] This has been shown to improve outcomes significantly and can be done with any formula, lens, or specific situation.[11–13]

This study sought to characterize the error in patients undergoing the DSAEK triple procedure by comparing the theoretical biometry prediction error using the manufacturer's IOL constant with the results that would have been achieved with an optimized IOL constant and to propose a method to determine IOL power in patients undergoing DSAEK triple procedures.

Patients and Methods

Study Population

The Johns Hopkins Institutional Review Board granted approval for this study. All study procedures adhered to the tenets of the Declaration of Helsinki. A retrospective chart review was conducted in 25 consecutive patients. Thirty eyes of 22 patients were included in this study. Inclusion criteria were attendance of the individual case by a single surgeon (A.S.J.) and status of having undergone the DSAEK triple procedure (DSAEK, phacoemulsification, and IOL implantation) between October 2006 and February 2011. Exclusion criteria were preoperative ocular comorbidity that would affect vision, previous intraocular surgery, intraoperative complications, and postoperative best-corrected visual acuity worse than 20/50 by subjective refraction performed 6 months after surgery. Three patients were excluded because of other ocular diseases, including severe glaucoma and diabetic retinopathy.

Protocol

Retrospective data collection was performed over a period comprising surgery and a postoperative follow-up of at least 6 months. The main measures recorded were axial length (AL), keratometry, preoperative and postoperative best spectacle-corrected visual acuity in logarithm of the minimum angle of resolution units, preoperative and postoperative refractive spherical equivalent (SE) in diopters (D), preoperative and postoperative mean keratometry (K), preoperative AL, preoperative anterior chamber depth, preoperative and postoperative corneal thickness of the recipient (in micrometers), corneal thickness of the graft (in micrometers), and time since the DSAEK triple procedure.

The predicted postoperative refraction using the IOL power implanted was calculated for each eye using the third-generation formula (SRK/T) and the manufacturer's IOL constant (119.4) for the Alcon 3-piece model MA50BM acrylic lenses (Alcon Laboratories, Fort Worth, TX). Using data from the deviation of the target refraction, a new optimized constant was calculated using the Holladay IOL Consultant software (version 1.0; Consulting, Inc., Houston, TX).[14] The new optimized IOL constants for the surgeon and the IOL power subsequently were entered into the SRK/T formula. Using the newly optimized IOL constant and the SRK/T formula, the new optimized predicted refraction for the IOL power was calculated.

An error of prediction was derived for each eye to show the tendency of prediction performance by the SRK/T formula in optimized IOL constants. The error of prediction is the actual postoperative SE minus the predicted postoperative SE and demonstrates how close the actual postoperative refraction in each eye is to the target postoperative refraction. The sign of the error of prediction denotes the direction of the departure from the target. That is, a negative error of prediction value means that the patient had a postoperative refraction that was more myopic than intended, whereas a positive error of prediction value means that the patient had a more hyperopic refraction than intended. An absolute error also was derived for each eye. The absolute error is the absolute value of the error of prediction in each eye and denotes the distance of the refraction from 0, without taking into account whether the departure from 0 was in the myopic or hyperopic direction.[15]

Surgical Protocol

All eyes underwent DSAEK to manage Fuchs' endothelial dystrophy. All operations were performed by a single surgeon (A.S.J.) using sub-tenon anesthesia. No dislocation of the graft occurred in this series of eyes, and no patient underwent reoperation for donor graft failure.

A 4.5-mm scleral tunnel incision was created in the supertemporal quadrant of the right or left eye. A 2.75-mm entry into the anterior chamber was made through the scleral tunnel incision with a keratome. Two limbal paracenteses were created 90 degrees to either side of the scleral tunnel incision. Standard phacoemulsification was followed by implantation of an acrylic foldable IOL (Alcon 3-piece model MA50BM; Alcon Laboratories) in the capsular bag. The host epithelium was marked with an 8.5-mm trephine. Using sodium hyaluronate 1% (Abbott Medical Optics, Santa Ana, CA) to maintain the anterior chamber, a reverse-bent Sinskey hook was used to score 360° and strip Descemet's membrane along this mark. The exposed stromal surface in the peripheral 2 mm of the defect in Descemet's membrane was disrupted using the Terry scraper (Bausch & Lomb, Rochester, NY). The entry into the anterior chamber was widened up to 4.5 mm with a keratome, and all viscoelastic material was removed with the irrigation-and-aspiration handpiece.

The presectioned corneal scleral donor tissue was trephined at 8.5 mm in diameter. The donor disc was folded with a 60:40 asymmetric overlap using sodium hyaluronate 1% to protect the apposed endothelial surfaces, was inserted into the anterior chamber using Charley forceps (Bausch & Lomb) under saline without anterior segment infusion, and was unfolded using a combination of air and saline injections. The scleral incision was secured with 2 interrupted 9-0 monofilament nylon sutures. The anterior chamber was filled completely with air for 10 minutes, during a portion of which sweeping of the epithelial surface was performed to remove residual fluid in the host–donor interface. At the conclusion of the 10 minutes, the air bubble was reduced to approximately 6.5 mm in diameter, with a tactile estimate of physiologic intraocular pressure. The patient maintained a supine position for 90 minutes in the postoperative area and was instructed to remain supine for an additional 24 hours after discharge.

Statistical Analysis

A paired *t* test was used to compare the mean difference between manufacturer's IOL constant (119.4) and the new constant. The mean arithmetic error and mean absolute error were calculated in all eyes. The percentage of eyes with <0.5 D, <1.0 D, and >1.0

D of target refraction were compared between the original constant (119.4) and the optimized constant. The McNemar's test was performed for correlated proportions of eyes out of the predicted postoperative SE; the Pearson correlation was used to evaluate the relationships between the best-corrected visual acuity after surgery, refractive changes from before to after surgery (SE), patient preoperative and postoperative corneal thickness (in micrometers), and corneal donor graft thickness (in micrometers). *P* values <0.05 were considered statistically significant, and 95% confidence intervals (CI) were calculated.

Results

The characteristics of the 30 eyes included in the study are summarized in Table 1. This study included eyes with at least a 6-month follow-up after the DSAEK triple procedure (mean±standard deviation, 18.4±9.8 months; range, 6–42 months). The mean refractive SE in all 30 eyes that underwent the DSAEK triple procedure was −0.9±3 D (range, –7.13 to 3.5 D) before surgery, and the mean postoperative SE was −0.72±0.7 D (range, –1.88 to 0.88 D). Using these data, the new optimized IOL constant in this cohort of patients was found to be 120.9. Table 2 and Figure 1 show the manufacturer's IOL constant and the new optimized IOL constant, with their respective mean absolute errors (D) and standard deviations.

Table 1. Characteristics of the 30 Eyes Included in the Study

Characteristic	Mean (Standard Deviation)	Minimum–Maximum
Demographics		
Age (yrs)	69.9 (6.0)	61–81
Months after surgery	18.4 (9.8)	6–42
Best-corrected visual acuity (logMAR)		
Preoperative	0.48 (0.09)	0.301–0.796
Postoperative	0.17 (0.12)	0.0–0.398
Refraction (D)		
Preoperative refractive spherical equivalent	−0.90 (3.0)	−7.13 to 3.5
Preoperative spherical refractive error	−1.5 (3.1)	−7.5 to 4.5
Preoperative cylindrical refractive error	1.3 (0.56)	0.25–2.5
Hyperopic shift	0.066 (2.8)	−5.0 to 6.1
Postoperative refractive spherical equivalent	−0.72 (0.72)	−1.88 to 0.88
Postoperative spherical refractive error	−1.26 (0.77)	−2.5 to 0.25
Postoperative cylindrical refractive error	1.0 (0.63)	0.0–2.5
Biometric data		
Preoperative mean keratometry	43.0 (1.7)	39.87–45.66
Postoperative mean keratometry	42.26 (1.7)	39.0–44.8
Preoperative axial length	24.7 (1.7)	21.69–28.34
Preoperative anterior chamber depth	3.19 (0.46)	2.33–4.54
Cornea (μm)		
Preoperative corneal thickness	628.8 (45.1)	560.0–723.0
Corneal donor graft thickness	138.9 (25.0)	100.0–182.0
Postoperative corneal thickness	619 (38)	626–692

D = diopters; logMAR = logarithm of the minimum angle of resolution.

Table 2. Arithmetic and Absolute Errors of Postoperative Refraction by Intraocular Lens Constant Used

Metric	Manufacturer's Intraocular Lens Constant (119.4)	Optimized Intraocular Lens Constant (120.9)	*P* Value
Mean arithmetic error (SD)	1.09 (0.62)	−0.22 (0.70)	<0.001
Mean absolute error (SD)	1.09 (0.62)	0.61 (0.40)	0.004
Distance from target			
% <0.5 D	20.0	43.3	0.11*
% ≤1.0 D	50.0	83.3	
% >1.0 D	50.0	16.7	0.012†

D = diopters; SD = standard deviation.
*Comparing proportion with <0.5 D.
†Comparing proportion with >1 D.

The original SRK/T IOL constant for the 3-piece model MA50BM acrylic lens (119.4) produced a mean absolute error of 1.09±0.63 D (range, 0.12–2.41 D) and a mean arithmetic IOL error of 1.09±0.63 D (range, 0.12–2.41 D). When using the optimized SRK/T IOL constant for the same lens (120.9), the mean absolute error was 0.61±0.4 D (range, 0.00–1.58 D), and the mean arithmetic IOL error was −0.22±0.7 D (range, –1.58 to 1.09 D).

The percentage of eyes with a deviation of <0.5 D, <1.0 D, and >1.0 D from the target refraction with the manufacturer's constant and the new personalized constant were calculated: 20% versus 43% ($P = 0.11$) for <0.5 D and 50% versus 17% ($P = 0.012$) for >1.0 D. The percentage of eyes out of the target refraction are displayed in Table 2 and Figure 2.

The mean difference between the mean arithmetic error with manufacturer's IOL constant (119.4) and the new personalized constant (120.9) was 1.32 D (95% CI, 1.18–1.45; $P<0.0001$). The mean difference between the mean absolute error with the manufacturer's IOL constant (119.4) and with the new personalized constant (120.9) was 0.481 D (95% CI, 0.17–0.79; $P = 0.0036$).

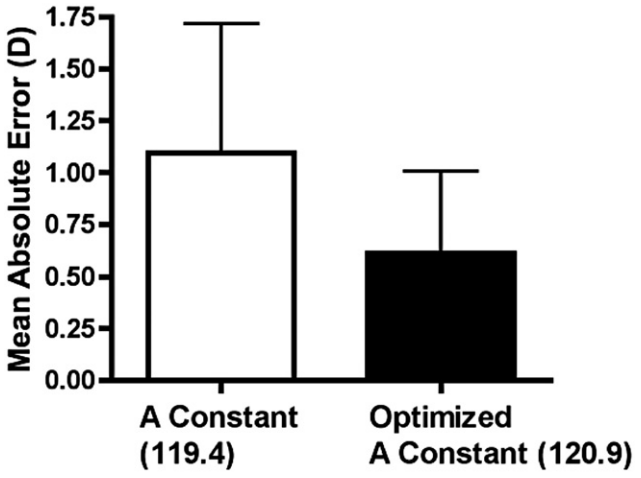

Figure 1. Graph showing mean absolute error and standard deviation (in diopters [D]) of final refraction using the manufacturer's intraocular lens constant (119.4) and optimized intraocular lens constant (120.9).

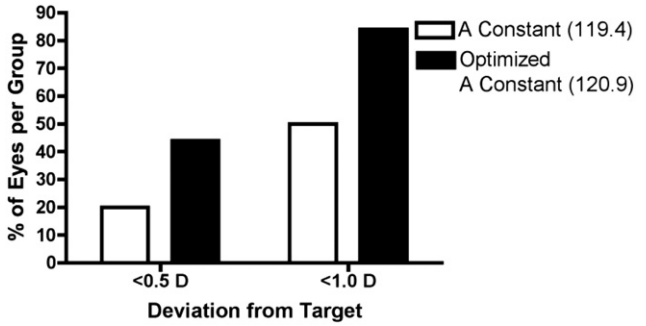

Figure 2. Graph showing percentage of eyes out of the target refraction (in diopters [D]) for the manufacturer's intraocular lens constant (119.4) and optimized intraocular lens constant (120.9).

The biometric data are presented in Table 1. The mean difference between the mean preoperative K and the postoperative K was 0.8 D (95% CI, 0.074–1.688; $P = 0.0721$). The mean±standard deviation AL in this study was 24.7±1.7 mm (range, 21.69–28.34 mm), and there was no statistical correlation with the Pearson analysis between the preoperative AL and the postoperative K (–0.42; $P = 0.01$).

The Pearson correlation showed that there was no correlation between the refractive shift (preoperative to postoperative SE) and the mean preoperative K (–0.11; $P = 0.54$), the mean postoperative K (–0.13; $P = 0.47$), the preoperative anterior chamber depth (0.20; $P = 0.29$), or the preoperative AL (0.541; $P = 0.002$).

All patients enrolled in this study received an 8.5-mm graft diameter. The mean corneal graft thickness used in those surgeries was 138.8±24.9 μm (range, 100–180 μm); the mean corneal recipient corneal pachymetry of the patients before surgery was 628±45 μm (range, 560–723 μm), and the mean postoperative corneal thickness was 619±38 μm (range, 626–692 μm). The Pearson correlation showed that there was no correlation between the refractive shift (preoperative to postoperative SE), and the graft thickness (0.219; $P = 0.25$), the patients' preoperative corneal thickness (–0.296; $P = 0.11$), or the patients' postoperative corneal thickness (0.08; $P = 0.1$).

Discussion

This study evaluated the accuracy of refractive prediction using a personalized constant for IOL power calculation with the SRK/T formula in DSAEK triple procedure eyes. Based on these results, a new method to improve the refractive prediction accuracy in this patient population is evident.

Hyperopic outcomes tend to occur after DSAEK surgery. In general, a hyperopic shift of 0.7 to 1.5 D is described in the literature, and many surgeons empirically aim for a more myopic postoperative outcome by targeting a postoperative refraction of –1.00 to –2.00 D to reduce the chance for unintended hyperopic results.[3,5,8]

Benchmarks for refractive success after routine cataract surgery have been reported in the literature[16] as 85% within 1 D and 55% within 0.5 D of the intended refraction. The present study shows that this level of accuracy would be nearly achieved by customizing the IOL constant in DSAEK triple procedures. With the IOL constant optimization described herein, 84% of patients were within 1 D of the predicted value and 44% of patients were within 0.5 D.

Several approaches to improve refractive outcomes in routine cataract surgery include optimization of the IOL constant, better formulae, and use of modern instrumentation. The optimization of the IOL constant similarly has been performed successfully in some specific circumstances such as high myopia, postrefractive surgery, and other types of surgeries.[8,10–13,17]

The disadvantage of any empirical approach is that the formula in principle works properly only for the data set from which it is derived. Furthermore, the formula also may be sensitive to differences in surgical technique, such as in phacoemulsification and DSAEK surgery, and also whether the donor graft thickness, graft diameter, or thickness of the patient cornea before surgery may play a significant role.

Previously, a positive correlation between refractive hyperopic shift and graft diameter has been reported, and large graft diameters (8.75–9.0 mm) have been associated with a refractive hyperopic shift as high as +1.50 D.[18] In this study, all eyes received 8.5-mm corneal grafts. A hyperopic shift was noted, but showed statistically no significant correlation with the patient's preoperative and postoperative corneal thickness or with the corneal graft thickness.

The mean AL in this study was 24.7±1.7 mm (range, 21.69–28.34 mm). The IOL constant by nature depends on the population AL average and the surgical technique performed. In this study, there was no statistical correlation between the AL and postoperative refractive outcomes. Because this study included eyes with at least a 6-month follow-up after the DSAEK triple procedure, the effects of residual corneal edema should be minimal. A previous study found that 95% of the corneal graft changes after DSAEK occur within the first 6 postoperative months.[19]

The 4 potential sources of error in IOL calculations are corneal curvature measurement, AL measurement, effective lens position estimation, and the IOL calculation formula.[17] Corneal power accounts for approximately two-thirds of the total dioptric power of the eye and is an important component of the ocular refractive system. If the calculation of corneal power is inaccurate, it will induce error propagation and will have profound consequences on the remaining steps in the calculation of IOL power. Unfortunately, calculating corneal power especially in endothelial (DSAEK) transplantation is not a straightforward process.

The cornea has 2 refracting surfaces, and to calculate the total corneal refractive power, it is necessary to know the curvature of not only the front, but also the back of the cornea. Modern optical biometers such as the IOLMaster (Carl Zeiss Meditec, Jena, Germany) do not directly measure the posterior cornea, but instead account for it by using an assumed value for the refractive index of the cornea combined with measurements of the anterior corneal curvature. The anterior corneal surface has been claimed to contribute to refractive changes only in those eyes with advanced corneal decompensation associated with epithelial changes, and thus it is unlikely to explain the hyperopic shift seen in DSAEK triple procedures.[20] In another report, the hyperopic shift was correlated to the differential thickness between the central and peripheral graft, resulting in altered

posterior corneal refractive power.[21] Although this second explanation seems more plausible, the present study was not designed to address the cause of the hyperopic shift seen in DSAEK triple procedures, whether from altered anterior or posterior corneal refractive power or change in refractive index of the cornea.

In this cohort, all surgeries were performed with a scleral tunnel incision, which already is known to induce minimal astigmatism.[7] In this study, the difference between the mean preoperative K and the postoperative K was 0.8 D. The posterior corneal astigmatism after DSAEK previously was attributed to graft decentration,[22] off-center donor cutting with the microkeratome, or off-center punching.[23] A recent report shows that alteration in the posterior astigmatism at least in part may be intrinsic to microkeratome donor preparation.[24]

To the authors' knowledge, this is the first report of an optimization of the IOL constant formula to improve the final postoperative refraction in DSAEK triple procedures. Despite the constraints of the small numbers of patients enrolled, it still was possible to show a significant change in the unexpected errors between the before and after IOL constant optimization and a significant reduction in the standard deviation between the 2 groups. Some potential limitations of this study are posed by the small size of the cohort (30 eyes) investigated, the performance of all surgeries by a single surgeon, and the retrospective nature of the study. Future studies including a prospective design, a larger cohort of patients, and multiple surgeons are needed to address these limitations.

With increasing patient expectations, the first step to obtain an accurate IOL power calculation is to be able to identify the patient's visual goals, especially if they have specific needs. In addition, optimization of the IOL constant should improve the postoperative refractive outcomes in patients undergoing DSAEK triple procedures.

References

1. Gorovoy MS. Descemet-stripping automated endothelial keratoplasty. Cornea 2006;25:886–9.
2. Bahar I, Kaiserman I, McAllum P, et al. Comparison of posterior lamellar keratoplasty techniques to penetrating keratoplasty. Ophthalmology 2008;115:1525–33.
3. Lee WB, Jacobs DS, Musch DC, et al. Descemet's stripping endothelial keratoplasty: safety and outcomes. A report by the American Academy of Ophthalmology. Ophthalmology 2009; 116:1818–30.
4. Eye Bank Association of America. 2008 Eye banking statistical report. Washington, DC: Eye Bank Association of America; April 2009.
5. Terry MA, Shamie N, Chen ES, et al. Endothelial keratoplasty for Fuchs' dystrophy with cataract: complications and clinical results with the new triple procedure. Ophthalmology 2009; 116:631–9.
6. Covert DJ, Koenig SB. New triple procedure: Descemet's stripping and automated endothelial keratoplasty combined with phacoemulsification and intraocular lens implantation. Ophthalmology 2007;114:1272–7.
7. Chen ES, Shamie N, Hoar KL, Terry MA. The new triple procedure: Descemet's stripping automated endothelial keratoplasty with concurrent phacoemulsification cataract extraction and intraocular lens placement. Tech Ophthalmol 2007;5:143–9.
8. Kalyani SD, Kim A, Ladas JG. Intraocular lens power calculation after corneal refractive surgery. Curr Opin Ophthalmol 2008;19:357–62.
9. Viestenz A, Seitz B, Langenbacher A. Intraocular lens power prediction for triple procedure in Fuchs' dystrophy using multiple regression analysis. Acta Ophthal Scand 2005;83: 312–5.
10. Ladas JG, Stark WJ. Improving cataract surgery refractive outcomes. Ophthalmology 2011;118:1699–700.
11. Madge SN, Khong CH, Lamont M, et al. Optimization of biometry for intraocular lens implantation using the Zeiss IOLMaster. Acta Ophthalmol Scand 2005;83:436–8.
12. Aristiodemou P, Cartwright NE, Sparrow JM, Johnston RL. Intraocular lens formula constant optimization and partial coherence interferometry biometry: refractive outcomes in 8108 eyes after cataract surgery. J Cataract Refract Surg 2011;37:50–62.
13. Conrad-Hengerer I, Dick HB, Hütz WW, et al. Optimized constants for an ultraviolet light-adjustable intraocular lens. Cataract Refract Surg 2011;37:2101–4.
14. Holladay JT. Holladay IOL Consultant User's Guide and Reference Manual. Houston TX: Holladay Lasik Institute; 1999.
15. Charalampidou S, Cassidy L, Ng E, et al. Effect on refractive outcomes after cataract surgery of intraocular lens constant personalization using the Haigis formula. J Cataract Refract Surg 2010;36:1081–9.
16. Gale RP, Saldana M, Johnston RL, et al. Benchmark standards for refractive outcomes after NHS cataract surgery. Eye 2009; 23:149–52.
17. Wang L, Shirayama M, Ma XJ, et al. Optimizing intraocular lens power calculations in eyes with axial lengths above 25.0 mm. J Cataract Refract Surg 2011;37:2018–27.
18. Jun B, Kuo AN, Afshari NA, et al. Refractive change after Descemet stripping automated endothelial keratoplasty surgery and its correlation with graft thickness and diameter. Cornea 2009;28:19–23.
19. Di Pascuale MA, Prasher P, Schlecte C, et al. Corneal deturgescence after Descemet stripping automated endothelial keratoplasty evaluated by Visante anterior segment optical coherence tomography. Am J Ophthalmol 2009;148:32–7.
20. Lombardo M, Terry MA, Lombardo G, et al. Analysis of posterior donor corneal parameters 1 year after Descemet stripping automated endothelial keratoplasty (DSAEK) triple procedure. Graefes Arch Clin Exp Ophthalmol 2010;248: 421–7.
21. Yoo SH, Kymionis GD, Deobhakta AA, et al. One-year results and anterior segment optical coherence tomography findings of Descemet stripping automated endothelial keratoplasty combined with phacoemulsification. Arch Ophthalmol 2008; 126:1052–5.
22. Prasher P, Muftuoglu O, Bowman RW, et al. Corneal power measurement with a rotating Scheimpflug imaging system after Descemet stripping automated endothelial keratoplasty. J Cataract Refract Surg 2010;36:1358–64.
23. Bahar I, Kaiserman I, Livny E, et al. Changes in corneal curvatures and anterior segment parameters after Descemet stripping automated endothelial keratoplasty. Curr Eye Res 2010;35:961–6.
24. Bhogal MS, Allan BD. Graft profile and thickness as a function of cut transition speed in Descemet-stripping automated endothelial keratoplasty. J Cataract Refract Surg 2012;38: 690–5.

Footnotes and Financial Disclosures

Originally received: January 23, 2012.
Final revision: July 29, 2012.
Accepted: August 2, 2012.
Available online: October 27, 2012. Manuscript no. 2012-103.

[1] Division of Cornea & Anterior Segment, Wilmer Eye Institute, Johns Hopkins School of Medicine, Baltimore, Maryland.

[2] Wilmer IOL Formula Study Group, Wilmer Eye Institute, Johns Hopkins School of Medicine, Baltimore, Maryland.

[3] Department of Ophthalmology, Federal University of São Paulo/Paulista School of Medicine, São Paulo, Brazil.

[4] Hospital de Olhos do Paraná, Curitiba, Brazil.

[5] Department of Ophthalmology, University Medical Center Hamburg-Eppendorf, Hamburg, Germany.

[6] Department of Ophthalmology, Dana Center for Preventive Ophthalmology, Wilmer Eye Institute, Johns Hopkins School of Medicine, Baltimore, Maryland.

Financial Disclosure(s):
The author(s) have no proprietary or commercial interest in any materials discussed in this article.

Correspondence:
Albert S. Jun, MD, PhD, Wilmer Eye Institute, Johns Hopkins School of Medicine, 400 North Broadway, Smith Building 5011, Baltimore, MD 21231. E-mail: aljun@jhmi.edu.