Fixation Stability and Refractive Error After Cataract Surgery in Highly Myopic Eyes

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• **PURPOSE:** **To analyze the refractive error in highly myopic eyes after cataract surgery and investigate the possible impact of fixation stability on it.**

• **DESIGN:** **Secondary data analysis from a previous prospective study.**

• **METHODS:** **Clinical data of 98 eyes of 98 consecutive patients with high myopia and 42 eyes of 42 controls, which underwent cataract surgery, were analyzed. Refractive error was calculated 1 month after surgery based on both Sanders-Retzlaff-Kraff theoretic (SRK/T) and Holladay 1 formulas. Fixation stability was evaluated using the Macular Integrity Assessment microperimeter system, which assessed the fixation pattern in terms of 63% and 95% of the bivariate contour ellipse area (BCEA). Multiple linear regression analysis was performed to identify independent predictors of postoperative refractive error.**

• **RESULTS:** **The highly myopic cataract group had greater hyperopic refractive errors ($P < .001$ for both formulas) and larger 63% and 95% BCEA values ($P = .033$ and $P = .034$) than the control group. In the highly myopic group, the factors 63% or 95% BCEA were positively correlated with the postoperative refractive error (SRK/T formula, $r = 0.383$, $P < .001$ and $r = 0.320$, $P = .002$, respectively). Multiple linear regression analysis showed that with the SRK/T formula, postoperative refractive error in highly myopic eyes was significantly correlated with axial length ($\beta = 0.491$, $P < .001$), 63% BCEA ($\beta = 0.181$, $P = .045$), and corneal curvature ($\beta = -0.190$, $P = .024$). The refractive error was no longer associated with corneal curvature after using the Holladay 1 formula.**

• **CONCLUSIONS:** **Highly myopic eyes usually had hyperopic refractive errors after cataract surgery. Fixation stability might serve as an important determinant of postoperative refractive errors in this population. (Am J Ophthalmol 2016;169:89–94. © 2016 Elsevier Inc. All rights reserved.)**

IT IS NOW POSSIBLE TO CONSISTENTLY AND ACCURATELY estimate the intraocular lens (IOL) power required for a wide range of axial lengths (AXL) (22.0–26.0 mm). However, it is still difficult to precisely predict the IOL power in highly myopic eyes, especially in eyes with an extremely long AXL.[1,2] Highly myopic eyes implanted with low or negatively powered IOLs tend to develop postoperative hyperopic refractive errors.[3,4] Therefore, many attempts have been made to minimize such errors in this population, including selecting a better formula for estimating IOL power,[5,6] optimizing the A constant,[7] or using optical biometry instead of ultrasound biometry.[8] However, these attempts have not fully resolved this problem.

To accurately predict the IOL power, it is extremely important to achieve good fixation during AXL measurement. The fundus generally shows a poor condition in highly myopic eyes. With increasing AXL, the appearance of macular vitreoretinal interface abnormalities, rarefication of the Bruch membrane, and many other myopia-related retinopathies all contribute to the reduced fixation stability. However, few studies have investigated the effects of reduced fixation ability on the IOL power calculation.

Microperimetry combines functional and structural measures of the macula. By using an advanced eye tracking technique,[9,10] microperimetry permits precise, real-time monitoring of fixation eye movements during the examination and yields accurate correlations between retinal sensitivity and pathologic findings. Therefore, the purpose of our study was to analyze the refractive error after cataract surgery and evaluate the impact of fixation stability on it in highly myopic eyes using the Macular Integrity Assessment (MAIA) microperimeter system (Centervue, Padova, Italy).

METHODS

THE PRESENT STUDY WAS A SECONDARY ANALYSIS OF DATA recorded for a previous prospective study, which was conducted for a different purpose, so we had the limitation that only variables obtained for that study could be used in the present investigation. The Institutional Review Board of the Eye and Ear, Nose, and Throat (ENT)

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Hospital of Fudan University approved the protocol of this study. All procedures adhered to the tenets of the Declaration of Helsinki. All of the patients provided informed consent for the use of their medical records for research purposes. The study was registered at www.clinicaltrials.gov (accession number NCT02182921).

• **SUBJECTS:** Data of 98 eyes of 98 consecutive highly myopic patients (with an AXL of >26.0 mm) were analyzed. Clinical data of another 42 eyes of 42 patients (22.0 mm < AXL < 24.5 mm) were included as controls. All the selected eyes underwent uneventful cataract surgery at the Eye and ENT Hospital of Fudan University, Shanghai, China, between October 8, 2015 and December 31, 2015. To guarantee adequate fixation during examination, all the selected eyes had a postoperative best-corrected visual acuity (BCVA) of ≥20/60, and eyes with severe fundus pathologies (including shallow retinal detachment, macular hole, foveoschisis, choroidal neovascularization, macular hemorrhage, etc), strabismus (evaluated with Hirschberg test and Cross-Cover test), lid abnormalities, blepharitis, previous trauma, glaucoma, zonular weakness, or diabetes were excluded from the study, as were eyes with questionable biometry and intraoperative or postoperative complications, such as posterior capsule opening, persistent corneal edema, or pupillary capture of the IOL. Patients with dry eye were referred to corneal specialists to treat the dry eye prior to preoperative examinations and cataract surgery. Patients wearing contact lenses were asked to stop wearing them for 2 weeks and then underwent the relevant examinations.

• **PREOPERATIVE EXAMINATIONS:** Routine ophthalmic examinations, including assessment of visual acuity, tonometry, funduscopy, corneal topography, B-scan ultrasonography, and measurement of AXL (IOLMaster; Carl Zeiss AG, Oberkochen, Germany), were conducted preoperatively. The IOL power was primarily estimated using the Sanders-Retzlaff-Kraff theoretic (SRK/T) formula and the lens power that could yield a target refraction closest to −3.5 diopters (D) postoperatively was selected in cases of high myopia. As for the control group, the lowest possible myopic value was chosen as the target refraction. The Holladay 1 formula was also used to further validate the results. Only 1 examiner was involved in each device.

• **SURGICAL TECHNIQUE:** Phacoemulsification with in-bag implantation of a foldable, hydrophilic, acrylic posterior chamber IOL (MC X11 ASP; HumanOptics, Erlangen, Germany) was performed through a temporal clear corneal 2.6 mm incision by the same surgeon on all the eyes. Stitches were not used in any eyes.

• **POSTOPERATIVE EVALUATIONS:** Assessments of visual acuity, manifest refraction, funduscopy, and tonometry were conducted by the same examiner at 1 month postoperatively. The logarithm of the minimal angle of resolution (logMAR) uncorrected visual acuity, logMAR BCVA, and spherical equivalent (SE) were recorded postoperatively. Postoperative refractive error was calculated as the measured postoperative refraction minus the targeted postoperative refraction.

The demographic data of eyes enrolled in the 2 groups are presented in the Table. In the highly myopic cataract group, the AXL was 26.0–28.0 mm in 31.6% (31/98), 28.0–30.0 mm in 38.8% (38/98), and >30.0 mm in 29.6% (29/98) of eyes.

• **FIXATION EVALUATION:** Fixation was evaluated 1 month after surgery using the MAIA microperimeter system. The system could automatically adjust refractive error ranging from +10 D to −15 D during measurement.[11] Fixation with the MAIA microperimeter is controlled by eye trackers that detect fixation losses as misalignments between the directions of the central fixation stimulus and gaze. The eye trackers also control for fixation losses and record the points of fixation during the examination. During the examination, the patient must stare at the fixation stimulus, which consists of a red circle with a diameter of 1 degree. The device yields a parameter characterizing the fixation pattern, the bivariate contour ellipse area (BCEA), which represents the area in degrees squared (deg^2) of the ellipse containing most of the fixation positions registered during the measurement procedure. BCEA is automatically calculated considering 63% and 95% of the fixation points used in the system. One examiner performed all the microperimeter measurements.

• **STATISTICAL ANALYSIS:** All data are expressed as the mean ± standard deviation (SD). The Student *t* test was used to examine the differences between the 2 AXL groups. Relationships between continuous variables were assessed using the Pearson correlation coefficient. Possible associations between clinically relevant variables, including baseline age, operated eye, sex, AXL, corneal curvature, corneal astigmatism, and 63% BCEA, and postoperative refractive error were determined using backward, stepwise multiple linear regression. P values of <.05 were considered statistically significant. All analyses were performed using SPSS version 11.0 (SPSS, Chicago, Illinois, USA).

RESULTS

• **POSTOPERATIVE REFRACTIVE ERROR:** Figure 1 shows the distribution of the postoperative refractive errors in different AXL groups with 2 formulas. The mean refractive error with the SRK/T formula was 0.57 ± 0.73 (range, −1.40 to 2.44) D in the highly myopic cataract group and 0.10 ± 0.38 (range, −0.89 to 0.61) D in the control group, and with the Holladay 1 formula was 1.13 ± 0.76 (range, −0.68 to 2.99) D and 0.09 ± 0.40