ARTICLE

Comparison of ocular wavefront aberrations in subluxated lenses before and after lens extraction with intraocular lens implantation

Samaresh Srivastava, DNB, Vaishali Vasavada, MS, Viraj Vasavada, MS, Shail Vasavada, DO, DNB, FRCS, FICO, Mamidipudi R. Praveen, DOMS, Rajendra Reddy, MS, Abhay R. Vasavada, MS, FRCS

Purpose: To compare the change in ocular higher-order wavefront aberrations (HOAs), visual acuity, and modulation transfer function (MTF) after lens extraction with intraocular lens (IOL) implantation in patients with subluxated lenses.

Setting: Iladevi Cataract & IOL Research Centre, Ahmedabad, India.

Design: Prospective case series.

Methods: Eyes with subluxated lenses having lens extraction with IOL implantation were included. Capsular bag fixation with in-the-bag IOL implantation or sutured or sutureless scleral fixation of the IOL was performed. Aberrometry was performed preoperatively and 6 months postoperatively. The following were compared: root-mean-square (RMS) value for total ocular HOAs, coma aberration, spherical aberration, MTF, and corrected distance visual acuity (CDVA).

Results: Of the 39 eyes with subluxated lenses, 26 eyes had Cionni ring fixation, 9 had sutured scleral fixation, and 4 had intrascleral fixation of the IOL. The mean preoperative and postoperative values, respectively, were as follows: RMS HOAs, 10.5 μm ± 9.5 (SD) and 4.73 ± 4.6 μm ($P < .001$); coma aberration, 2.46 ± 2.4 μm and 0.11 ± 0.1 μm ($P = .03$); and spherical aberration, 0.37 ± 0.9 μm and 0.02 ± 0.06 μm ($P = .02$). The MTF improved significantly in all eyes (mean 0.05 ± 0.02 preoperatively and 0.32 ± 0.16 postoperatively) ($P = .005$). The CDVA was statistically significant improved 6 months postoperatively.

Conclusion: Lens extraction with IOL fixation in eyes with subluxated lenses significantly reduced ocular HOAs and improved the MTF.

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With the evolution of cataract surgery, microsurgical techniques, new technology, and better surgeon understanding have resulted in improved intraoperative performance in patients with subluxated lenses. Several studies[1–6] have reported good long-term visual and anatomic results with an acceptable rate of complications in eyes with subluxated lenses in adults and children.

In cases of gross subluxation with partial aphakia in the pupil, or when there is a cataractous lens, the decision to perform surgery is straightforward. However, a dilemma arises in cases of mild to moderate subluxation because the crystalline lens is clear and centered within the photopic pupil and the patient appears to have a reasonably good Snellen visual acuity. In these cases, some surgeons prefer to wait and watch until the extent of subluxation increases or there is a further reduction in visual acuity. On the other hand, other surgeons advocate early surgery in these cases.

When deciding the timing for surgery, an important factor to consider is that a large majority of patients with nontraumatic subluxated lenses are children or young adults and the subluxated lens might affect their visual quality. Often, despite good Snellen visual acuity, the tilt and decentration of the lens induces higher-order aberrations (HOAs), which lead to deterioration in the quality of vision. Studies[7,8,A] have reported that HOAs can even cause amblyopia. Today, several diagnostic tools are available that can objectively assess and quantify different aspects of optical quality. These include HOAs and lower-order aberrations (LOAs), the modulation transfer function (MTF), and the point-spread function.

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Corresponding author: Samaresh Srivastava, DNB, Raghudeep Eye Hospital, Gurukul Road, Memnagar, Ahmedabad, India. E-mail: samaresh@raghudeepeyeclinic.com.

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There is a paucity of literature on ocular wavefront aberrations in eyes with subluxated lenses and the impact of surgery with intraocular lens (IOL) implantation in these cases. We therefore performed this study to evaluate and compare the ocular wavefront aberrations, visual acuity, and MTF in patients with subluxated lenses between before and after surgery with in-the-bag IOL implantation.

PATIENTS AND METHODS

This prospective interventional case series included consecutive eyes with nontraumatic subluxation of the lens having lens removal with IOL implantation between January 2016 and March 2017. The study protocol was approved and monitored by the institutional ethics committee, and all patients provided written informed consent before enrollment. All procedures adhered to the principles outlined in the tenets of the Declaration of Helsinki for research involving human subjects.

Eyes with traumatic subluxation or a gross anterior or posterior dislocation were excluded from the study. Children who could not cooperate during an aberrometry examination were also excluded.

Preoperative Evaluation

Preoperatively, a slitlamp examination was performed to determine the anterior chamber depth, presence of vitreous in the anterior chamber, extent (clock hours) of subluxation, presence and degree of associated cataract, and documentation of maximum mydriasis. The corrected distance visual acuity (CDVA) was recorded on the Snellen chart and converted to logarithm of the minimum angle of resolution (logMAR) values for analysis. Goldmann applanation intraocular pressure (IOP), fundus examination, and optical biometry, or immersion ultrasound A-scan when optical biometry was not possible, were performed.

Ray-Tracing Aberrometry

A wavefront aberrometry scan was performed with a ray-tracing aberrometer (iTrace, Tracey Technologies) preoperatively and at the final follow-up. The scan was performed at every visit before mydriatic drops were instilled under mesopic room lighting conditions with the patient's physiologic pupil size and the patient fixating on the machine's internal fixation target. This was done to ensure that the aberrations were measured on the patient's visual axis. The total eye aberrations were automatically captured. Subsequently, the same ophthalmologist performed corneal topography. Two hundred fifty-six sequential points were measured within the patient's mesopic pupil. The aberrometer provides an aberration profile of the entire eye, including the root mean square (RMS) value for total aberrations, HOAs, and LOAs. The corneal topography map provided the corneal aberration profile. The machine's software calculates the corneal aberrations from the total eye aberrations to provide a separate display of the internal aberrations. Although internal aberrations can arise from the corneal stroma right to the retina, the lens is usually a major contributor.[9] The MTF at 10 cycles per degree (cpd), displayed by the ray-tracing aberrometer, was recorded preoperatively and 6 months postoperatively. For standardization and analysis, a scan size of 3.0 mm was used to compare values in all eyes.

Surgical Technique

Preoperatively, mydriasis was achieved with cyclopentolate 1.0% eyedrops and phenylephrine 10% eyedrops. All surgeries were performed by the same surgeon (A.R.V.) using the Centurion Vision System (Alcon Laboratories, Inc.) and peribulbar or general anesthesia, depending on the patient's age and level of cooperation. A standardized technique of lens removal was used as described elsewhere.[1,10–12] If had prolapsed into the anterior chamber, bimanual pars plana anterior vitrectomy was performed. The vitrector was introduced through the pars plana region and the irrigation probe through the limbal paracentesis.

Once the lens material was removed, capsular bag support was assessed. If the capsular bag was intact, a single-eyelet Cionni modified capsular tension ring (CTR) and/or an Ahmed capsular tension segment (CTS) were used to fixate the capsular bag to the sclera, depending on the extent of subluxation. A double-armed 9-0 polypropylene suture (Prolene) or a 7-0 polytetrafluoroethylene suture (Gore-Tex.) was used to fixate the modified CTR or CTS to the scleral wall. A 1-piece hydrophobic acrylic IOL (Acrysof SA60AT, Alcon Laboratories, Inc.) was implanted in the bag in eyes in which the capsular bag could be preserved. Sutured scleral fixation of a 1-piece poly(methyl methacrylate) (PMMA) IOL or sutureless intrascleral glued fixation of a 3-piece hydrophobic acrylic IOL (Acrysof MA60AC, Alcon Laboratories, Inc.) was performed in eyes in which the capsular bag could not be preserved.

Postoperative Follow-up

Postoperative examinations were performed at 1 day and 6 months. A margin of 1 week before or after the date of the scheduled 6-month follow-up was allowed. The CDVA was measured and a slitlamp examination, aberrometry, applanation IOP, and a dilated fundus examination were performed. The IOL was considered clinically and geometrically centered when no optic edge was visible through undilated pupils. A clinically well-centered but geometrically decentered IOL was defined by the difference in the distance between the optic edge to the limbus on both sides of the IOL seen through a dilated pupil.

Outcome Measures

The RMS of the total ocular HOAs, coma aberration, spherical aberration, MTF at 10 cpd with a 3.0 mm pupil and the CDVA were compared between preoperatively and 6 months postoperatively. Clinical and/or geometric decentration of the IOL was noted.

Statistical Analysis

Statistical analysis was performed using SPSS software (version 13, SPSS, Inc.). The Wilcoxon signed-rank test was used to calculate *P* values for comparisons of the outcome measures between preoperatively and postoperatively. A *P* value less than 0.05 was considered statistically significant.

RESULTS

The study comprised 39 eyes (22 right, 17 left) of 31 patients. The mean age of the 24 women and 15 men was 27.0 years $\pm$ 20.0 (SD) (range 6 to 55 years). Eleven eyes (28.2%) were of patients younger than 15 years and 28 (71.8%) were patients 15 years old at the time of surgery. Bilateral surgery was performed in 8 patients (16 eyes) and unilateral surgery in 23 eyes of 23 patients. The mean extent of subluxation was 6 clock hours (range 3 to 7 clock hours).

Intraoperative

In 13 eyes (33.3%), the capsular bag could not be preserved and scleral fixation of a PMMA IOL (9 eyes) or intrascleral glued IOL fixation (4 eyes) was performed. In-the-bag implantation was performed in the remaining 26 eyes (66.7%). The capsular bag was fixated using the modified CTR or CTS in 26 eyes.