

Zonular Instability

BY TANIA PAUL, BSc, AND ROSA BRAGA-MELE, MD, MEd, FRCSC

CASE PRESENTATION

A 76-year-old white female with pseudoexfoliation (PXF) was referred to us for cataract surgery on her left eye. She had previously undergone surgery for glaucoma in 1985 and cataract extraction in 1986, both procedures in her right eye. Unfortunately, unspecified intraoperative complications occurred during the latter procedure, and the patient remained aphakic after surgery with retained lens fragments. Postoperatively, she experienced recurrent uveitis. In 1998, she underwent a vitrectomy and removal of a retained lens fragment in her right eye. Thereafter, she experienced severe glaucoma-tous damage that reduced her vision to 20/200 OD.

The patient had developed a posterior subcapsular cataract and nuclear sclerosis in her left eye. Upon examination at our center, she had a manifest refraction of $-0.75 + 100 \times 39$ and a BCVA of 20/80 OS. Her IOP was controlled by a single medication at 24mmHg OD and 22mmHg OS, and the optic nerve and visual field of her left eye were normal. This eye exhibited significant PXF and 2+ nuclear sclerosis but no phacodonesis.

HOW WOULD YOU PROCEED?

1. What treatment options are available for this patient?
2. What difficulties would you expect when attempting cataract extraction in this patient?
3. If you noted zonular instability, would you change your approach? If so, how?

SURGICAL COURSE

We elected to perform microincisional cataract surgery. After administering topical anesthesia with tetracaine, we prepared the eye in the usual manner using two clear corneal tunnel incisions that were 1.4mm wide and 1.2mm long. We injected a cohesive viscoelastic into the anterior chamber. During creation of the continuous curvilinear capsulorhexis, we noticed wrinkling of the anterior capsule and assumed zonular weakness. After gentle hydrodissection, a capsular tension ring (CTR; type 10; Morcher GmbH, Stuttgart, Germany) was inserted under the edge of the capsulorhexis with a forceps. To facilitate the insertion of the device, we injected viscoelastic under the capsular edge

to lift it slightly, and we inserted a Kuglan hook (Storz, St. Louis, MO) through the sideport incision to guide the CTR under the capsule while helping to move it forward with a forceps.

Next, we inserted a dual-port irrigating chopper (Storz) through the sideport incision and a bare phaco needle through the main incision. Nuclear removal involved a quick chop technique using low flow and vacuum as well as parameters to minimize bouncing and instability of the anterior chamber (20% power, 80 milliseconds of burst, 145 to 300mmHg of vacuum, a bottle height of 110cm) on the Millennium microsurgical system (Bausch & Lomb, Rochester, NY).

Upon attempting to remove the last subincisional nuclear segment, we noticed that the piece would not rotate with gentle pressure. Because we felt that continued efforts to rotate it would harm the zonules, we removed the irrigating chopper and phaco handpiece and switched them to the opposite incision sites (Figure 1). The phaco tip entered through the original sideport incision and safely approached the nuclear segment without applying stress to the zonules. We removed the cortex with a bimanual technique employing a gentle, back-and-forth stripping motion. After completing cortical removal, we placed an L161U IOL (Bausch & Lomb) in the capsular bag and performed stromal hydration to close the corneal incisions. No intraoperative complications occurred.

OUTCOME

Postoperatively, the patient achieved a UCVA of 20/25 OS. Her IOP measured 19mmHg OD and 22mmHg OS with no evidence of phacodonesis, retained lens fragments, prolonged inflammation, or corneal edema. One week after surgery, her UCVA was 20/30 OS, her IOP remained 22mmHg, and her left eye was still quiet and asymptomatic. At 1 month postoperatively, the patient's UCVA was 20/20 OS, and the eye was quiet.

DISCUSSION

PXF may be associated with a number of pre-, intra-, and postoperative complications that significantly affect the success of cataract surgery. As a result of the

ALLEGRETTO WAVE

Right. From the Start.

Disclaimer for Myopia:

- Approval of the premarket approval application is for the WaveLight ALLEGRETTO WAVE™ Excimer Laser System to perform LASIK treatments in patients 18 years of age or older for the reduction or elimination of myopic refractive errors up to -12.0 diopters (D) of sphere with and without astigmatic refractive errors up to -6.0 D; and in patients with documented evidence of a stable manifest refraction defined as ≤ 0.50 D of preoperative spherical equivalent shift over one year prior to surgery.
- LASIK is an elective procedure with the alternatives including but not limited to eyeglasses, contact lenses, photorefractive keratectomy (PRK), and other refractive surgeries.
- Approval of the application is based on clinical trials in the United States with 901 eyes treated, of which 813 of 866 eligible eyes were followed for 12 months. Accountability at 3 months was 93.8%, at 6 months was 91.9%, and at 12 months was 93.9%.
- The studies found that of the 844 eyes eligible for the uncorrected visual acuity (UCVA) analysis of effectiveness at the 3-month stability time point, 98.0% were corrected to 20/40 or better, and 84.4% were corrected to 20/20 or better without spectacles or contact lenses.
- The clinical trials showed that the following subjective patient adverse events were reported as "moderate to severe" at a level at least 1% higher than baseline of the subjects at 3 months post-treatment: visual fluctuations (12.8% at baseline versus 28.6% at 3 months).
- Long term risks of LASIK for myopia with and without astigmatism beyond 12 months have not been studied.
- Note that the complete name for this ophthalmic laser is "WaveLight ALLEGRETTO WAVE™ Excimer Laser System for laser assisted in-situ keratomileusis (LASIK) treatments of myopic refractive errors up to -12.0 diopters (D) of sphere with and without astigmatic refractive errors up to -6.0 D at the spectacle plane".

Disclaimer for Hyperopia:

- Approval of the premarket approval application is for the WaveLight ALLEGRETTO WAVE™ Excimer Laser System to perform LASIK treatments in patients 18 years of age or older for the reduction or elimination of hyperopic refractive errors up to +6.0 diopters (D) of sphere with and without astigmatic refractive errors up to 5.0 D at the spectacle plane, with a maximum manifest refraction spherical equivalent (MRSE) of +6.0 D; and in patients with documented evidence of a stable manifest refraction defined as ≤ 0.50 D of preoperative spherical equivalent shift over one year prior to surgery, exclusive of changes due to unmasking latent hyperopia.
- LASIK is an elective procedure with the alternatives including but not limited to eyeglasses, contact lenses, photorefractive keratectomy (PRK), and other refractive surgeries.
- Approval of the application is based on clinical trials in the United States with 290 eyes treated, of which 100 of 290 eligible eyes were followed for 12 months. Accountability at 3 months was 95.2%, at 6 months was 93.9%, and at 12 months was 69.9%.
- The studies found that of the 212 eyes eligible for the uncorrected visual acuity (UCVA) analysis of effectiveness at the 6-month stability time point, 95.3% were corrected to 20/40 or better, and 67.5% were corrected to 20/20 or better without spectacles or contact lenses.
- The study showed that the following subjective patient adverse events were reported as "much worse" by at least 1% of the subjects (in order of increasing frequency) at 6 months post final treatment: glare from bright lights (3.0%); night driving glare (4.2%); light sensitivity (4.9%); visual fluctuations (6.1%); and halos (6.4%).
- Long term risks of LASIK for hyperopia with and without astigmatism beyond 12 months have not been studied.
- Note that the complete name for this ophthalmic laser is "WaveLight ALLEGRETTO WAVE™ Excimer Laser System for laser assisted in-situ keratomileusis (LASIK) treatments of hyperopic refractive errors up to +6.0 diopters (D) of sphere with and without astigmatic refractive errors up to 5.0 D with a maximum manifest refraction spherical equivalent (MRSE) of +6.0 D".



WaveLight Laser Technologie AG

Am Wolfsmantel 5, 91058 Erlangen, Germany
www.wavelight-laser.com

WaveLight, Inc.

46040 Center Oak Plaza, Sterling, VA 20166, USA
www.allegrettowave.com

weakened structures of the anterior segment, numerous complicating factors such as poor pupillary dilatation, zonular friability, posterior synechiae, and delicate capsules can make cataract surgery difficult. Because a variety of forces must be applied during cataract surgery, the smooth performance of phacoemulsification relies on intact, stable zonules that maintain the position of the capsule during nuclear rotation and extraction. If the zonules are weakened as they are in PXF, zonular dialysis or rupture may occur during nuclear rotation and can cause vitreous loss.¹ PXF also complicates postoperative recovery from cataract surgery, because it is associated with glaucoma, phacodonesis, and corneal endothelial decompensation, all of which can cause postoperative complications such as high IOP, corneal edema, and prolonged inflammation.^{2,3}

"PXF may be associated with a number of pre-, intra-, and postoperative complications that significantly affect the success of cataract surgery."

The fragility of the anterior segment in eyes with PXF has stimulated thought on how to stabilize the zonules during phacoemulsification in order to prevent operative complications. The CTR stabilizes the zonular apparatus⁴ by maintaining the contour of the capsule during surgery through stretching of the posterior capsule.⁵ Currently, indications for using the device include zonular instability and rupture during surgery as well as inherent zonular weakness in conditions such as Marfan's syndrome and



Figure 1. The authors switched the irrigating chopper and phaco handpiece to the incision sites opposite the original position in order to access a subincisional nuclear segment, the rotation of which was impeded by zonular instability.

“The weakness of the structures of the anterior segment makes any interruption of irrigation during the aspiration of cortex dangerous.”

PXF.⁵ The CTR is used in cases of PXF to (1) maintain the capsular contour and thereby prevent collapse and aspiration of the capsule, (2) distribute forces equally over all zonules, and (3) prevent vitreous prolapse into the anterior chamber.^{1,5,6} A prospective, randomized study evaluating the use of the CTR in PXF showed that the subjects who received the device had no incidences of zonular separation, whereas 12.8% of the control group did.² The investigators concluded that CTRs reduced intraoperative complications and increased in-the-bag fixation of the IOL.

Compared with traditional cataract surgery, the advantages of microincisional cataract surgery in the setting of capsular or zonular defects include (1) typically lower infusion volumes and pressures with irrigating choppers, (2) generally lower flow and vacuum settings, (3) the ability to direct the fluid stream away from areas of weakness due to the use of an irrigating chopper as opposed to coaxial phacoemulsification, (4) a lower likelihood of fluid misdirection syndrome, which can occur with high infusion volumes as fluid passes through the zonular defect, (5) the ability to approach nuclear material from two different sites or angles, and (6) a more tightly controlled system for all steps of the procedure. The concept of lower flow and vacuum may seem paradoxical, because traditionally higher vacuum will promote the use of lower phaco energies and, theoretically, a more efficient procedure. In the setting of compromised zonules, however, lower flow and vacuum cause less zonular stress by creating less pressure and a more stable anterior chamber. Vacuum is still at levels that promote efficient nuclear removal, and, with newer power modulations such as microburst and hyperpulse, phaco times are still minimal.

Microincisional cataract surgery also helps to reduce the difficulty in aspirating cortex beneath the incision site. When traditional I/A is used to aspirate cortex beneath the injection site, the tip usually retracts slightly, which interrupts the irrigation of the anterior chamber.⁷ As a result, the anterior chamber may become shallow, which will bring the posterior capsule closer to the instruments and increase the chances of a posterior capsular tear.

The weakness of the structures of the anterior segment

makes any interruption of irrigation during the aspiration of cortex dangerous, because uncontrolled forces in the anterior segment may cause zonular rupture or dialysis despite the CTR. The bimanual method of cortical stripping allows for the standard I/A handpiece to maintain a fixed position in the center of the anterior chamber and to provide infusion while a separate aspiration handpiece frees the cortex and brings it to the I/A handpiece for aspiration. This method ensures a continuous inflow of fluid and, in the presence of a small pupil, permits the cannula to retract the iris for better visualization.⁷⁻¹⁰ With a second aspiration cannula available, the surgeon can apply gentle, controlled force while stripping cortex. The application of constant positive pressure keeps the posterior capsule continuously stretched and prevents instruments from accidentally touching or tearing the posterior capsule. Of note, when removing cortex in the presence of a CTR, one must tangentially strip the cortex in a back-and-forth motion to loosen it around the device and then pull the cortex to the center of the pupil. Removal will then be more efficient. ■

Rosa Braga-Mele, MD, MEd, FRCSC, is Assistant Professor at Mount Sinai Hospital, University of Toronto. She is a consultant for Bausch & Lomb but states that she does not hold a financial interest in the products or other companies mentioned herein. Dr. Braga-Mele may be reached at (416) 462-0393; rbragamele@rogers.com.



Tania Paul, BSc, is a medical student at the University of Toronto, Faculty of Medicine. She states that she does not hold a financial interest in any of the products or companies mentioned herein. Ms. Paul may be reached at (416) 462-0393; tania.paul@utoronto.ca.

1. Naumann GOH, Schlotzer-Schrehardt U, Kucle M. Pseudoexfoliation syndrome for the comprehensive ophthalmologist: intraocular and systemic manifestations. *Ophthalmology*. 1998;105:951-968.
2. Bayraktar S, Altan T, Küçükşumer Y, et al. Capsular tension ring implantation after capsulorhexis in phacoemulsification of cataracts associated with pseudoexfoliation syndrome: intraoperative complications and early postoperative findings. *J Cataract Refract Surg*. 2001;27:1620-1628.
3. Olivius EOP, Nordell SI, Walinder PE. Fibrinoid reaction after extracapsular cataract extraction and its relationship to exfoliation syndrome—a prospective study. *Eur J Implant Refract Surg*. 1989;1:5-8.
4. Hara T, Hara T, Yamada Y. “Equator ring” for maintenance of the completely circular contour of the capsular bag equator after cataract removal. *Ophthalmic Surg*. 1991;22:358-359.
5. Menapace R, Findl O, Georgopoulos M, et al. The capsular tension ring: designs, applications, and techniques. *J Cataract Refract Surg*. 2000;26:898-912.
6. Gimbel HV, Sun R. Clinical applications of capsular tension rings in cataract surgery. *Ophthalmic Surg Lasers*. 2002;33:44-53.
7. Sakamoto T, Kunuhiko S, Inoue K, et al. A simple, safe bimanual technique for subincisional cortex aspiration. *Ophthalmic Surg Lasers*. 2002;33:337-339.
8. Hagan JC. Irrigation/aspiration handpiece with changeable tips for cortex removal in small incision phacoemulsification. *J Cataract Refract Surg*. 1992;18:318-320.
9. Isakov I, Madjarov B, Bartov E. Safe method for cleaning the posterior lens capsule. *J Cataract Refract Surg*. 1995;21:371-372.
10. Colvard, M. Bimanual technique to manage subincisional cortical material. *J Cataract Refract Surg*. 1997;23:707-708.