Surgical Time Using Femtosecond Laser (FSL)

Introduction: cataract surgery most commonly performed intraocular surgery; techniques constantly under review to improve efficiency, decrease costs, increase patient safety, and produce more reliable outcomes; FSL used for refractive surgery, and applicable to cataract surgery; currently, 4 laser platforms approved by Food and Drug Administration to perform portions of cataract surgery and other intraocular procedures; benefits of FSL not yet fully delineated, but consensus in literature include more consistent capsulotomy size, shape, and centration, as well as decreased ultrasound energy and time during phacoemulsification

Operative times: limited data on how FSL changes operative times and complication rates; one study in literature evaluated operative times, but did not include time spent performing FSL portion of procedure (FSL in this study located outside of operating room [OR])

Recent study at speaker’s center: evaluated operative times of experienced surgeons using FSL for cataract surgery; study included all cataract surgeries performed in OR that housed FSL; traditional cases using ultrasound performed in same OR, and used as comparative group; surgeries performed by 3 experienced refractive surgeons; operating time (ie, from when patient entered OR to when patient left OR) included all steps required to complete each type of surgery

Results: total of 420 cataract surgeries performed within first 6 mo of when FSL acquired; ≈38.6% of surgeries FSL-assisted cases; variety of intraocular lenses (IOLs) used, depending on surgeon preference; with all 3 surgeons, duration of FSL-assisted cases 11 to 12 min longer compared to traditional cases; to remove possible confounding data, complex cases or those requiring extra equipment (ie, cases involving placement of hooks, Malyugin rings, or vitrectomy) excluded; of these remaining 311 cases, duration of FSL-assisted cases slightly longer by 11 to 13 min compared to traditional cases; comparing each surgeon’s first 10 FSL-assisted cases to most recent 15 cases did not show significant time difference, suggesting learning curve fairly flat (likely due to prior experience with FSL)

Complications: vitrectomy required in 3 out of 258 traditional cases (1.16%) and in 3 out of 162 FSL-assisted cases (1.85%); 2 out of 3 cases involved concomitant Malyugin ring placement

Educational Objectives
The goal of this program is to improve the management and use of the femtosecond laser (FSL) in cataract surgery. After hearing and assimilating this program, the clinician will be better able to:
1. Critique new techniques in FSL-assisted cataract surgery.
2. Demonstrate appropriate management of the small pupil in cataract surgery.
3. Formulate a plan for the management of astigmatism at the time of cataract surgery.
5. Assess new treatment paradigms for the management of myopia using FSL.

Faculty Disclosure
In adherence to ACCME Standards for Commercial Support, Audio-Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, the following has been disclosed: Dr. Yoo is a consultant for Abbott Medical Optics (part of Abbott Laboratories), Alcon, Bausch & Lomb, and Carl Zeiss Meditec. Members of the planning committee reported nothing to disclose.
Case 2: patient with hypermature brunescent cataract, taking tamsulosin, maximum dilation <4.5 mm, and asymmetric pupil; managed with side port incision and placement of viscoelastic and Malyugin ring prior to FSL application; FSL had difficulty acquiring pupil margins, and required manual settings; important to remember Malyugin ring may distort anatomy; FSL capsulotomy and lens segmentation completed without complication

Conclusion: anterior chamber penetration prior to FSL application feasible; however, air bubbles from viscoelastic interfere with laser scanning and lens application; use care when removing capsulotomy; consider increasing laser energy (eg, 10 μJ) during capsulotomy

**Astigmatic keratotomy (AK):**

**Definition:**

By creating paired corneal incisions on steep axis of cornea; traditionally done freehand with diamond blades; more recent technology involves mechanical trephines (eg, Hanna arcitome), in which suction applied to eye and blades rotate to create arcuate incisions; complications of AK include corneal perforation, low predictability, irregular astigmatism, or even worsening of astigmatism; speaker suggests FSL as better tool for performing AK; FSL creates thousands of laser pulse bubbles connected together to create corneal incisions; with FSL, cornea can be marked preoperatively, assuring incisions uniform (compared to manual AK techniques); depth, length, and curvature also highly accurate and reproducible with FSL; indications for use of FSL include naturally occurring astigmatism, postcorneal and keratoplasty astigmatism, and astigmatism following Descemet stripping endothelial keratoplasty (DSEK)

**Advantages:**

- FSL potentially powerful tool for making astigmatic correction; FSL safe and effective

**Complications in Refractive Cataract Surgery**

**Case 1:** typically, keratometry measurements in postmyopic laser in situ keratomileusis (LASIK) lead to underestimation of IOL power; 51-yr-old man reported blurry vision in left eye (OS); had history of LASIK and bilateral cataract extraction; pre-LASIK refraction reported as -5.00 sph OD and -4.50 sph OS; preoperative keratometry measurements noted as -3.00 sph OD and -1.00 sph OS; he underwent bilateral cataract extraction and at postoperative month 1, OD plano but OS surprisingly myopic with IOL in bag bilaterally; options for management of this refractive surprise include LASIK enhancement, surface ablation, piggybacking lens, use of spectacles or contact lenses, or lens exchange; patient opted for lens exchange, and on postoperative day 1 had 20/20 vision OS

**Case 2:** after radial keratotomy (RK), IOL power often underestimated, leading to hyperopia after cataract surgery; 48-yr-old man presented with desire for better vision; had history of RK in 1986; in 2006, he has consecutive hyperopia with astigmatism, particularly in OD; he had good spectacle-corrected vision, but could not tolerate spectacles due to his anisotropia, and patient not interested in contact lenses; topography showed 8 fairly regular RK incisions; techniques to minimize risk for RK wound dehiscence during cataract surgery include lowering infusion pressure, operating between radial incisions, and using scleral tunnel in lieu of corneal tunnel; postoperatively, patient still had hyperopia; at 5 mo postoperatively, he reported halos at night with vision worsening throughout day; options for management included LASIK, photorefractive keratectomy, IOL exchange, or piggyback lens; patient opted for piggyback lens; Holladay formula or Maskom nomogram (speaker’s preference) used to calculate IOL power; speaker prefers Staar AQ 5010 IOL for piggybacking because its silicone composition reduces chance of interface opacification with underlying acrylic lens, and it folds easily into sulcus; postoperatively, patient’s vision much improved; Staar AQ 5010 IOL has large 6.3-mm optic with 14.0-mm diameter; important to order cartridge and inserter to assist with folding

**Case 3:** 70-yr-old man with mixed astigmatism, decreased best corrected vision, and bilateral cataracts; topography noted as irregular, perhaps due to forme fruste keratoconus or pellucid marginal degeneration; speaker decided on phacoemulsification and toric lens implantation bilaterally; postoperative uncorrected vision very good

**Refractive Lenticule Extraction (ReLEX) using FSL**

**Definitions:** ReLEX involves intrastromal removal of refractive lenticule of cornea using FSL; original femtosecond lenticule extraction (FLEX) entails lenticule of stromal tissue removed underneath LASIK flap; more recent small incision lenticule extraction (SMILE) procedure involves creation of small smile-shaped pocket through which lenticule manually dissected out; procedure divided into 3 steps of creating lenticule with FSL, manually separating stromal top and bottom of lenticule through small incision, and then manually extracting lenticule out of pocket

**Equipment:** speaker uses VisuMax FSL, manufactured by Carl Zeiss Meditec; VisuMax FSL much faster (500 kHz) compared to other lasers, allowing creation of lower energy pulses very close together; large size of this laser requires more space; interface easy for staff and surgeons to use; has curved corneal application with low vacuum, allowing patient to maintain vision and fixation, resulting in improved patient comfort and satisfaction; requires compliant patient who does not move during procedure

**Ongoing study:** multicenter study in United States using SMILE for treatment of myopia ranging from -1.00 to -10.00 D; of first 216 eyes treated, mean spherical equivalent -4.39 D (excluded highest myopes; extension of study ongoing now); postoperative refractions excellent at -0.12 D at 1 wk, -0.15 D at 1 mo, -0.11 D at 6 mo, and -0.01 D at 12 mo; refractive outcomes within 0.5 D for vast majority at 12 mo; uncorrected visual acuity 20/20 or better for most patients; although LASIK performed in opposite eye, study did not compare method outcomes; however, speaker anecdotally reports less patient discomfort in SMILE eyes; few adverse events (only 2 cases of difficult or incomplete lenticule removal; one case of viral conjunctivitis); in SMILE eyes, 95% had uncorrected vision of 20/20 or better at 6 mo postoperatively (91% at 9 mo postoperatively)

**Advantages:** SMILE flapless; requires only one laser (FSL; excimer laser not required); process integrated into single procedure; potentially fewer nerves severed (incidence of dry eye
intrastromal arcuate keratotomy to reduce corneal astigmatism. In cataract surgery: curse of the small pupil. Further information about continuing medical education from the Bascom Palmer Eye Institute, please visit bascompalmer.org. The Academy of Ophthalmology, and held March 21-23, 2014, in New Orleans, LA. For more on the upcoming annual symposium presented by the New Orleans Academy of Ophthalmology, scheduled for January 30 to February 1, 2015, please visit noao.org. Audio-Digest Foundation thanks Dr. Yoo and the Bascom Palmer Eye Institute for their cooperation in the production of this program.

Suggested Reading


Acknowledgements

Dr. Yoo was recorded at Eye to the Future: Explorations in Cornea, Cataract, Pediatrics, and Retina, presented by the New Orleans Academy of Ophthalmology, and held March 21-23, 2014, in New Orleans, L.A. For more on the upcoming annual symposium presented by the New Orleans Academy of Ophthalmology, scheduled for January 30 to February 1, 2015, please visit noao.org. Audio-Digest Foundation thanks Dr. Yoo and the Bascom Palmer Eye Institute for their cooperation in the production of this program.

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Estimated time to complete the educational process:

- Review Educational Objectives on page 1: 5 minutes
- Take pretest: 10 minutes
- Listen to audio program: 60 minutes
- Review written summary and suggested readings: 35 minutes
- Take posttest: 10 minutes

May be decreased; more protective of biomechanical integrity of cornea

Disadvantages: SMILE only approved for treatment of myopia and myopic astigmatism worldwide; not yet approved for use in United States; enhancements potentially more difficult, although side cut could be created to perform LASIK enhancement; questionable whether interface as smooth as in LASIK, as excimer laser might have additional smoothing effect on FSL bed; centration potentially problematic, similarly to LASIK.
1. Studies show that the benefits of using femtosecond laser (FSL) in cataract surgery include:
   (A) More consistent capsulotomy size, shape, and centration
   (B) Decreased ultrasound energy during phacoemulsification
   (C) Decreased ultrasound time during phacoemulsification
   (D) All the above **

2. Identify the *incorrect* statement about FSL-assisted cataract surgery.
   (A) Has some proven benefits over traditional approach
   (B) Results in longer operating times, even with experienced surgeons
   (C) Vitrectomy rate lower compared to traditional approach
   (D) Vitrectomy more common in cases that require additional hardware

3. Which of the following is a risk factor for the small pupil in cataract surgery that is associated with use of \( \alpha_1 \)-antagonists?
   (A) Synechiae
   (B) Pseudoexfoliation syndrome
   (C) Chronic miotic therapy
   (D) Intraoperative floppy iris syndrome **

4. Which of the following techniques is *not* appropriate for management of the small pupil during FSL-assisted cataract surgery?
   (A) Paracentesis    (C) Viscoelastic injection
   (B) Shugarcaine injection   (D) Decreased laser energy settings

5. In astigmatic keratotomy, axis misalignment of 30º results in _______ loss of astigmatism correction.
   (A) 100% ** (B) 75% (C) 50% (D) 30%

6. Advantages of intrastromal astigmatic keratotomy using FSL include all the following, except:
   (A) Minimally invasive technology
   (B) Wide range of flattening effect **
   (C) Decreased risk for epithelial ingrowth
   (D) Potentially less loss of corneal sensation

7. Which of the following statements is *not* true about intraocular lens (IOL) implantation after refractive surgery?
   (A) Standard IOL power formulas can lead to significant unintended postoperative refractive errors
   (B) Special methods of IOL calculations should be used in these cases
   (C) Standard keratometry measurements in postmyopic laser in situ keratomileusis (LASIK) eyes can lead to overestimation of IOL power **
   (D) Previous refractive surgery introduces error into standard IOL predictions

8. Techniques to minimize the risk for radial keratotomy wound dehiscence during cataract surgery include:
   1. Increasing infusion pressure
   2. Operating between radial incisions
   3. Using a scleral tunnel
   4. Using a corneal tunnel
      (A) 2,4    (B) 2,3    (C) 1,2,3    (D) 1,2,3,4

9. Identify the *incorrect* statement about use of the VisuMax FSL for the small incision lenticule extraction (SMILE) procedure.
   (A) Large size of laser requires more space
   (B) Has curved corneal applanation and low vacuum
   (C) Interface can be difficult for staff and surgeons to learn
   (D) Requires compliant patient who does not move during procedure

10. Disadvantages of the SMILE procedure include all the following, except:
    (A) Only approved for the treatment of myopia in the United States
    (B) Enhancements potentially more difficult
    (C) Side cut can be created to allow for LASIK enhancement
    (D) Centration potentially problematic