Early Experience with the Femtosecond Laser for Cataract Surgery.

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Source
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Abstract

OBJECTIVE:
To describe the intraoperative complications and to evaluate the learning curve with femtosecond laser cataract surgery.

DESIGN:
Prospective, consecutive cohort study.

PARTICIPANTS:
The first 200 eyes undergoing femtosecond laser cataract surgery and refractive lens exchange in a single center.

METHODS:
The initial 200 eyes undergoing cataract surgery between April 2011 and June 2011 by 6 surgeons were included in the study. The cases underwent anterior capsulotomy, lens fragmentation, and corneal incisions with the femtosecond laser. The procedure was completed by phacoemulsification and insertion of an intraocular lens. Data were collected about patient demographics, preoperative investigations and intraoperative complications. The cases were divided into 4 groups - group 1 included the first 50 cases, group 2 included cases 51 through 100, group 3 included cases 101 through 150, and group 4 included cases 151 through 200 and were analyzed.

MAIN OUTCOME MEASURES:
Intraoperative complication rates.

RESULTS:
The mean age of patients included was 69.2±9.8 years. Of the 200 eyes, 74.5% underwent a complete procedure of laser capsulotomy, lens fragmentation, and corneal incisions. Five eyes had suction breaks during the laser procedure that led to the remainder of the laser procedure being aborted. Twenty-one (10.5%) eyes showed the presence of small anterior capsular tags. The number of eyes with free-floating capsulotomies was 35 (17.5%). The other complications during the study were anterior radial tears (n = 8; 4%), posterior capsular ruptures (n = 7; 3.5%), and dropped nucleus (n = 4; 2%). A significant difference was noted among the sequential groups with respect to the number of docking attempts (P<0.001), miosis after the laser procedure (P<0.001), and free-floating capsulotomies (P<0.001), suggesting an improving learning curve. The surgeons with prior experience with femtosecond lasers had fewer complications in the first 100 cases (P<0.001). No difference in complications was observed after the initial 100 cases.

CONCLUSIONS:
In this case series, there was a clear learning curve associated with the use of femtosecond lasers for cataract surgery. Adjustment to surgical technique and prior experience with a femtosecond laser seemed to flatten the learning curve.
Capsular block syndrome associated with femtosecond laser-assisted cataract surgery.

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We report intraoperative capsular block syndrome occurring during the first 50 femtosecond laser-assisted cataract surgeries performed in our facility. Two patients had uneventful combined laser fragmentation, capsulotomy, and corneal incision procedures. In both cases, following transfer to the operating room and manual removal of the laser-cut capsulotomy, posterior capsule rupture was noted during hydrodissection, resulting in posterior dislocation of the lens. Pars plana vitrectomy, removal of the crystalline lens, and sulcus implantation of an intraocular lens were performed in both patients with good visual outcomes. Femtosecond laser-assisted cataract surgery changes the intraoperative environment with the generation of intracapsular gas and laser-induced changes in the cortex. With awareness of the changed intraocular environment following laser lens fragmentation and capsulotomy and a modification of the surgical technique, no additional cases of intraoperative CBS have been seen in more than 600 laser-assisted cataract surgery procedures performed to date at our facility.

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Internal aberrations and optical quality after femtosecond laser anterior capsulotomy in cataract surgery.

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PURPOSE: To compare ocular and internal aberrations after femtosecond laser anterior capsulotomy and continuous curvilinear capsulorrhexis in cataract surgery.

METHODS: In this prospective study, anterior capsulotomy was performed during cataract surgery with an intraocular femtosecond (FS) laser (Alcon LenSx Inc) in 48 eyes. As a control group, continuous curvilinear capsulorrhexis (CCC) was performed in 51 eyes. Wavefront aberrometry, corneal topography, and objective
visual quality were measured using the OPD-Scan (NIDEK Co Ltd). Vertical and horizontal tilt, coma, and visual quality metrics were evaluated separately to determine whether the source of aberrations was ocular or internal. Main outcome measures included postoperative residual refraction, uncorrected and corrected visual acuities, ocular and internal aberrations, Strehl ratio, and modulation transfer function (MTF).

RESULTS: No statistically significant differences were noted between the FS and CCC groups, respectively, in postoperative sphere (-0.60 ± 1.50 vs -0.50 ± 1.40 diopters [D]), postoperative cylinder (1.30 ± 1.01 vs 1.10 ± 1.10 D), uncorrected distance visual acuity (0.86 ± 0.15 vs 0.88 ± 0.08), or corrected distance visual acuity (0.97 ± 0.08 vs 0.97 ± 0.06). The FS group had significantly lower values of intraocular vertical tilt (-0.05 ± 0.36 vs 0.27 ± 0.57) and coma (-0.003 ± 0.11 vs 0.1 ± 0.15), and significantly higher Strehl ratios (0.02 ± 0.02 vs 0.01 ± 0.01) and MTF values at all measured cycles per degree, compared to the CCC group.

CONCLUSIONS: Capsulotomy performed with an intraocular FS laser induced significantly less internal aberrations measured by the NIDEK OPD-Scan aberrometer compared to eyes that underwent CCC, which may result in better optical quality after the procedure.


Effect of femtosecond laser cataract surgery on the macula.
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PURPOSE: To compare the effect of conventional and femtosecond laser-assisted (Alcon LenSx Inc) phacoemulsification on the macula using optical coherence tomography (OCT).

METHODS: Twenty eyes of 20 patients underwent uneventful cataract surgery in both study groups: femtosecond laser-assisted (laser group) and conventional phacoemulsification (control group). Macular thickness and volume were evaluated by OCT preoperatively and 1 week and 1 month postoperatively. Primary outcomes were OCT retinal thickness in 3 macular areas and total macular volume at 1 week and 1 month postoperatively. Secondary outcomes were changes in retinal thickness at 1 week and 1 month postoperatively, with respect to preoperative retinal thickness values and effective phacoemulsification time.

RESULTS: Multivariable modeling of the effect of surgery on postoperative macular thickness showed significantly lower macular thickness in the inner retinal ring in the laser group after adjusting for age and preoperative thickness across the time course (P=.002). In the control group, the inner macular ring was significantly thicker at 1 week (mean: 21.68 μm; 95% confidence limit [CL]: 11.93-31.44 μm, P<.001). After 1 month, this difference decreased to a mean of 17.56 μm (95% CL: -3.21-38.32 μm, P=.09) and became marginally significant.

CONCLUSIONS: Results of this study suggest that femtosecond laser-assisted cataract extraction does not differ in postoperative macular thickness as
compared with standard ultrasound phacoemulsification.

Femtosecond laser capsulotomy and manual continuous curvilinear capsulorrhexis parameters and their effects on intraocular lens centration.

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PURPOSE: To measure and compare sizing and positioning parameters of femtosecond laser capsulotomy with manual continuous curvilinear capsulorrhexis (CCC).

METHODS: Femtosecond capsulotomies (Alcon-LenSx Lasers Inc) and CCC were carried out in 20 eyes of 20 patients, respectively. Intraocular lens (IOL) decentration, circularity, vertical and horizontal diameters of capsulotomies, and capsule overlap were measured with Adobe Photoshop (Adobe Systems Inc) 1 week, 1 month, and 1 year after surgery. Between-group differences of parameters and predictors of IOL decentration were determined with repeated measures analysis of variance, chi-square test, and logistic regression analyses.

RESULTS: Vertical diameter of CCC was statistically significantly higher in the first week and month. Significantly higher values of capsule overlap over 1 year and circularity in the first week showed more regular femtosecond capsulotomies. Horizontal IOL decentration was statistically significantly higher in the CCC group over 1 year. A significant difference was noted between the two groups in dichotomized horizontal decentration values at 0.4 mm with chi-square test after 1 week and 1 year (P=.035 and P=.016, respectively). In univariable general estimating equation models, type of capsulorrhexis (P<.01) and capsule overlap (P=.002) were significant predictors of horizontal decentration. Vertical diameter showed significant correlation to the overlap in the CCC group (1 week: r=-0.91; 1 month: r=-0.76, P<.01; 1 year: r=-0.62, P<.01), whereas no significant correlation was noted in the femtosecond group (P>.05).

CONCLUSIONS: More precise capsulotomy sizing and centering can be achieved with femtosecond laser. Properly sized, shaped, and centered femtosecond laser capsulotomies resulted in better overlap parameters that help maintain proper positioning of the IOL.
PURPOSE: To evaluate a laser technique and manual technique to perform capsulorrhexis in cataract eyes.

METHODS: Anterior capsulotomy was performed with an intraocular femtosecond laser (LenSx Lasers Inc) in 54 eyes (FS group) and manual continuous curvilinear capsulorrhexis was performed in 57 eyes (CCC group). Circularity and area of capsulotomy and IOL decentration were measured using Photoshop CS4 Extended (Adobe Systems Inc) 1 week after surgery. Average keratometry, axial length, and preoperative anterior chamber depth were examined with the Lenstar LS 900 (Haag-Streit AG).

RESULTS: No statistically significant differences were noted between groups in axial length, preoperative refractive state, and in the area of capsulotomy. Circularity values were significantly better in the FS group (P=.032). We found incomplete overlap of capsulotomies in 28% of eyes in the CCC group and 11% in the FS group (P=.033). Significant correlations were noted between axial length and area of capsulotomy, and between average keratometry and area of the capsulotomy in the CCC group (R=0.278, P=.036; and R=0.29, P=.033, respectively), but both did not correlate in the FS group (P>.05). In the CCC group, the pupillary area correlated significantly with the area of the capsulotomy (R=0.27, P=.039). Significant correlation was noted between IOL decentration and axial length in the CCC group (R=0.30, P=.026), but there was no correlation in the FS group (P>.05).

CONCLUSIONS: Femtosecond laser capsulorrhexis was more regularly shaped, showed better centration, and showed a better intraocular lens/capsule overlap than manual capsulorrhexis.


Femtosecond laser capsulotomy.


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Erratum in

PURPOSE: To evaluate a femtosecond laser system to create the capsulotomy.

SETTING: Porcine and cadaver eye studies were performed at OptiMedica Corp., Santa Clara, California, USA; the human trial was performed at the Centro Laser, Santo Domingo, Dominican Republic.

DESIGN: Experimental and clinical study.

METHODS: Capsulotomies performed by an optical coherence tomography-guided femtosecond laser were evaluated in porcine and human cadaver eyes. Subsequently, the procedure was performed in 39 patients as part of a prospective randomized study of femtosecond laser-assisted cataract surgery. The accuracy of the capsulotomy size, shape, and centration were quantified and capsulotomy strength
was assessed in the porcine eyes.  

RESULTS: Laser-created capsulotomies were significantly more precise in size and shape than manually created capsulorhexes. In the patient eyes, the deviation from the intended diameter of the resected capsule disk was 29 μm ± 26 (SD) for the laser technique and 337 ± 258 μm for the manual technique. The mean deviation from circularity was 6% and 20%, respectively. The center of the laser capsulotomies was within 77 ± 47 μm of the intended position. All capsulotomies were complete, with no radial nicks or tears. The strength of laser capsulotomies (porcine subgroup) decreased with increasing pulse energy: 152 ± 21 mN for 3 μJ, 121 ± 16 mN for 6 μJ, and 113 ± 23 mN for 10 μJ. The strength of the manual capsulorhexes was 65 ± 21 mN.  

CONCLUSION: The femtosecond laser produced capsulotomies that were more precise, accurate, reproducible, and stronger than those created with the conventional manual technique.


Femtosecond laser: the future of cataract surgery?  
Mamalis N.


Cataract surgery: from couching to femtosecond, look how far we have come!  
Afshari N.


Femtosecond laser-assisted cataract surgery.  
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PURPOSE OF REVIEW: In 2010, the US Food and Drug Administration (FDA) cleared femtosecond laser systems for cataract surgery. Available in 2011, this technology has the potential to significantly impact cataract surgery.  

RECENT FINDINGS: Femtosecond lasers offer surgeons the ability to make very precise cuts in a targeted area without damaging the surrounding tissues. This technology has already dramatically changed refractive surgery and is poised to do the same for cataract surgery. Three companies, OptiMedica, LenSx (acquired by Alcon in September 2010), and LensAR, in different stages of FDA clearance, are developing femtosecond laser systems for cataract surgery. These systems will create the initial corneal incisions, capsulotomy, and also fragment the lens.  

SUMMARY: This article outlines the advantages of femtosecond laser cataract
surgery and provides an initial comparison of the LensAR, LenSx/Alcon, and OptiMedica systems and early clinical results.


How a femtosecond laser increases safety and precision in cataract surgery?
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PURPOSE OF REVIEW: To look at the recent applications of femtosecond laser (FSL) technology for capsulotomy and nuclear fragmentation in cataract surgery, the potential advantages, such as more precise and adjustable capsulotomies and the use of less phaco energy with this technology.

RECENT FINDINGS: The FSL can create incisions or spaces of different shapes, at a desired depth. This has started the application of the technology in the lens: after a clear image is taken of the lens through a previously dilated pupil, circular capsulotomy is done, with precision in shape and diameter, and in most cases, just needs to be grabbed, or requires very small use of the with the forceps. Then photofragmentation of the nucleus is done, without the risk of damaging the posterior capsule, because it is well visualized, to achieve the aspiration of the nuclear material without applying phaco energy, in the soft or medium-hard nucleus, but eventually in almost all nucleus.

SUMMARY: FSL is now used at the level of the lens, with the potentiality for very precise circular and adjustable diameter capsulotomies, and the fragmentation of the nuclear material, allowing the aspiration of the material and less emulsification especially in soft nucleus.


Femtosecond laser-assisted cataract surgery with integrated optical coherence tomography.


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About one-third of people in the developed world will undergo cataract surgery in their lifetime. Although marked improvements in surgical technique have occurred since the development of the current approach to lens replacement in the late 1960s and early 1970s, some critical steps of the procedure can still only be executed with limited precision. Current practice requires manual formation of an
opening in the anterior lens capsule, fragmentation and evacuation of the lens tissue with an ultrasound probe, and implantation of a plastic intraocular lens into the remaining capsular bag. The size, shape, and position of the anterior capsular opening (one of the most critical steps in the procedure) are controlled by freehand pulling and tearing of the capsular tissue. Here, we report a technique that improves the precision and reproducibility of cataract surgery by performing anterior capsulotomy, lens segmentation, and corneal incisions with a femtosecond laser. The placement of the cuts was determined by imaging the anterior segment of the eye with integrated optical coherence tomography. Femtosecond laser produced continuous anterior capsular incisions, which were twice as strong and more than five times as precise in size and shape than manual capsulorhexis. Lens segmentation and softening simplified its emulsification and removal, decreasing the perceived cataract hardness by two grades. Three-dimensional cutting of the cornea guided by diagnostic imaging creates multiplanar self-sealing incisions and allows exact placement of the limbal relaxing incisions, potentially increasing the safety and performance of cataract surgery.


Alternative applications of the femtosecond laser in ophthalmology.

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PURPOSE: To provide an update of novel applications for the femtosecond (FS) laser in ophthalmology. DESIGN: Perspective, literature review, case report, and commentary. METHODS: Literature review. RESULTS: The many advantages of etching flaps with the FS laser for laser in situ keratomileusis (LASIK) have been well established. Alternative applications of the FS have been approved and are now used in clinical practice. In refractive ophthalmology, the FS laser can be used for lenticule extraction to correct myopia and intrastromal biochemical manipulation to correct presbyopia. This laser can be used for preparing host and donor tissue for both full thickness and lamellar keratoplasty. Research is underway, exploring ways to employ the FS laser for different stages of cataract surgery. Cosmetic procedures with FS-assisted tattooing serve to correct leukoria. CONCLUSIONS: Advancements in technology have allowed measurable improvements in the surgical safety, efficiency, speed, and versatility of FS lasers in ophthalmology.


Femtosecond laser-assisted cataract incisions: architectural stability and reproducibility.
Initial clinical evaluation of an intraocular femtosecond laser in cataract surgery.

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PURPOSE: To evaluate femtosecond laser lens fragmentation and anterior capsulotomy in cataract surgery.

METHODS: Anterior capsulotomy and phacofragmentation procedures performed with an intraocular femtosecond laser (LenSx Lasers Inc) were initially evaluated in ex vivo porcine eyes. These procedures were then performed in an initial series of nine patients undergoing cataract surgery. In addition to standard intraoperative assessments (including capsulotomy diameter accuracy and reproducibility), optical coherence tomography was used to evaluate human procedures.

RESULTS: For an intended 5-mm capsulorrhexis in porcine eyes, average achieved diameters were 5.88±0.73 mm using a standard manual technique and 5.02±0.04 mm using the femtosecond laser. Scanning electron microscopy revealed equally smooth cut edges of the capsulotomy with the femtosecond laser and manual technique. Compared to control porcine eyes, femtosecond laser phacofragmentation resulted in a 43% reduction in phacoemulsification power and a 51% decrease in phacoemulsification time. In a small series of human clinical procedures, femtosecond laser capsulotomies and phacofragmentation demonstrated similarly high levels of accuracy and effectiveness, with no operative complications.

CONCLUSIONS: Initial results with an intraocular femtosecond laser demonstrate higher precision of capsulorrhexis and reduced phacoemulsification power in porcine and human eyes.