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Femtosecond Laser-Assisted Cataract Surgery

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> The femtosecond laser is a near-infrared laser of 1053 nm wavelength and femtosecond pulse duration (10^{-15} s) that activates free electrons and ionised molecules and creates cavitation bubbles. The expansion of the cavitation bubbles leads to the cleavage of target tissues. The tight focus of the laser energy induces tissue breakdown at a desired point and at the desired depth with minimal thermal or shockwave damage to the surrounding tissue. Due to its precision, it has several advantages compared with manual incisional surgery, including improved accuracy, safety and reproducibility.

Femtosecond laser technology has now expanded into the field of cataract surgery with four applications: corneal incisions construction, anterior capsulotomy (laser-incised capsulorhexis), crystalline lens fragmentation and arcuate corneal incisions.[1]

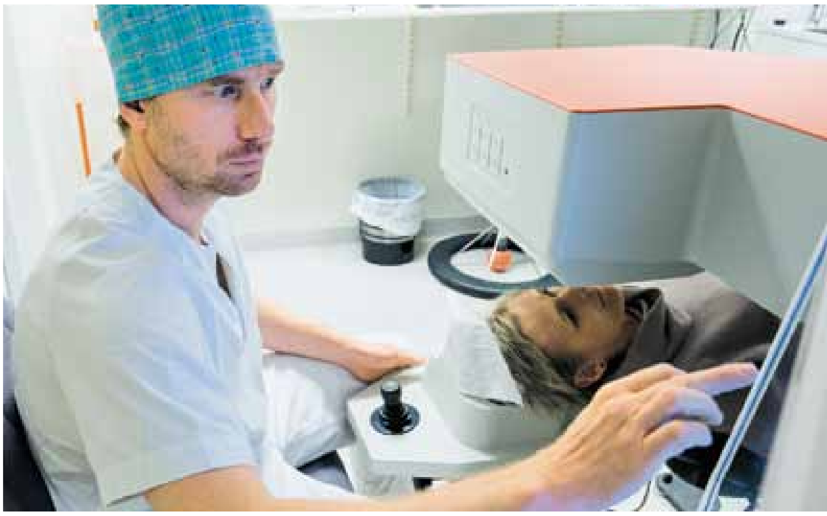
At the moment, commercially available femtosecond laser systems that are used for cataract surgery include LenSx (Alcon Laboratories, Inc., Forth Worth, TX), Catalys (Abbott Medical Optics, Santa Ana, CA), LensAR (Topcon, Gamagori, Japan), Victus (Technolas/Bausch & Lomb, Munich, Germany) and Femto LDV Z8 (Ziemer Ophthalmic System AG, Port, Switzerland). The overall procedures are similar across all platforms, but they differ in certain aspects, such as the docking system (contact corneal applanation or liquid immersion patient interfaces), imaging modality (spectral domain anterior segment optical coherence tomography or Scheimpflug imaging), energy levels, and separation and sizing of the laser spots.

Since the first publication on Femtosecond Laser-Assisted Cataract Surgery (FLACS) in 2009,[2] there has been debate on the superiority of FLACS over conventional phacoe-mulsification cataract surgery. To date there is no evidence showing a clinically meaningful difference in the visual and refractive outcomes between FLACS and conventional phacoemulsification cataract surgery.[3] Also, the economic modelling continues

Erlend Sødal, Head of Department of Ophthalmology, Sørlandet Hospital Arendal, shows Catalys® in use.

The femtosecond laser procedure is done in three steps: docking, anterior segment OCT scanning and laser treatment. Total time from docking to end of laser treatment is 2 to 3 minutes. The Catalys® is operated on a touch screen and have an intuitive user interface. The settings are easily personalized in the planning of the surgery.

Since june 2015, Catalys® has been used for approximately 80% of the cataract surgery at this Department as it simplifies and standardizes the surgery. The team at the eye department in Arendal have experienced safer surgery for patients with loose zonula, hard cataracts and narrow anterior chamber after the femtosecond laser was introduced.



to indicate that FLACS remains not cost-effective.[4]

In femtosecond laser-assisted cataract surgery (FLACS), several challenging steps are machine-driven, removing the surgeon factor to a certain extent. Theoretically, this can decrease the learning curve for the novice cataract surgeon and make the results more predictable.[5] FLACS has shown the benefit of achieving a more precise circular capsulotomy, more reproducible corneal incision construction and significant reduction in ultrasound energy and time during cataract surgery; therefore, a femtosecond laser can be a great asset in complex cataract surgery.

In a subluxated cataract, the femtosecond laser-assisted capsulotomy and lens fragmentation would decrease the risk of further zonular damage compared to manual phacoemulcification. FLACS has also shown to cause less endothelial cell damage due to the use of less ultrasound energy, which is especially advantageous in denser cataracts.[6] Therefore, eyes with endothelial dysfunction could greatly benefit from FLACS. The use of less ultrasound energy with FLACS can also be helpful in eyes with a shallow anterior chamber, where there is less space to manoeuver and there are higher risks for endothelial damage. Furthermore, the femtosecond laser can create arcuate incision length, depth, radius and symmetry with a precision that is unattainable with manual techniques. Compared to manual arcuate keratotomy with a diamond blade, femtosecond laser assisted arcuate keratotomy showed better cylinder power reduction, less axis misalignment and fewer complications such as corneal perforation.[7, 8]

Capsulotomy created by the femtosecond laser is more predictable in shape and size than manually performed capsulorhexis, reducing the possibility of intraocular lens (IOL) decentration and tilt. This may lower the risk of introducing optical aberrations in multifocal lenses and astigmatism with toric lenses. Whether this translates into superior visual and refractive outcomes with these premium lenses remains to be seen.

Complications inherent in FLACS are steadily diminishing as the technique is being refined. There were initial concerns surrounding anterior radial tears and posterior capsule tears in FLACS. The use of non-applanating fluid immersion interface design and the reduction of laser energy levels in general have shown to lead to less tissue damage around the laser spots and to improvement of mechanical properties of lens capsules after femtosecond laser-assisted capsulotomy.[9, 10] The proinflammatory effect of FLACS, mediated through raised prostaglandin levels,[11] may lead to intraoperative miosis, early postoperative posterior capsular opacity and uveitis.[3] Pretreatment with non-steroidal anti-inflammatory agents was found to inhibit prostaglandin release in FLACS.[12]

In conclusion, the FLACS laser has the potential to increase the already high safety profile of cataract surgery. However, FLACS is still in its infancy, and further refinements are needed to achieve better results.

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