Editorial

Femtosecond Laser Assisted Cataract Surgery

Cataract surgery has passed through many phases. From couching to Intracapsular Cataract extraction to Extracapsular Cataract Extraction and then to Phacoemulsification.

Phacoemulsification, a revolutional invention of Charles Kelman, brought great refinement in surgical management of cataract. Now ever increasing use of modern technology has lead to use of Laser Assisted Cataract Surgery. This is a new emerging use of a technology called as Femtosecond Laser. It is an ultrafast, infrared laser with the speed of 0.001 mm at one billionth of a second (10^{-15} sec) working at wave length of 1052 nm.

Uses of Femtosecond Laser in ophthalmology

1. Flap preparation in LASIK
2. Laser Assisted Cataract Surgery
3. Astigmatic Keratotomy
4. Tunnel formation for Implantation of ICRS in Progressive Keratoconus.
5. Corneal Biopsy

Among all these indications, the use in cataract surgery is extremely important as cataract is the commonest eye surgery performed. Image guided femtosecond laser brings a lot of automatation in many crucial steps of cataract surgery which ultimately makes some of the more difficult and unreliable parts of cataract surgery more precise and more dependable. The femtosecond is a more accurate, reproducible and gives surgeons the ability to be more consistent. This laser is precise down to micron level instead of millimeters. Although enhanced performance in all of these areas is desirable for every cataract patient, however the individuals who elect premium IOLs perhaps desire improvement, the most. Their high expectation have been fuelled by excellent safety and performance of refractive laser corneal surgery. Most patients in general, however, now expect emmetropia after cataract surgery. The following steps of cataract surgery will be performed by femtosecond laser.

THE CAPSULORHEXIS

Femtosecond laser will be used to perform centered, round, custom – designed anterior capsulotomy in any size of surgeon's choice. Capsulorhexis is a key determinant of an emmetropic outcome in cataract surgery. Many ophthalmologists have identified this step as single most important surgical contributor to the predictability of the refractive outcome. Variations in the shape, size and position of capsulorhexis have a significant influence on the effective lens position and correspondingly patients refractive outcome. For example in case of too large sized rhexis, the edge of rehexis does not completely overlap IOL's optic and it can slide behind the optic, which will alter the position of IOL, and with small sized capsular rhexis, phimosis can occur which can cause tilt and anterior displacement of IOL. Both these scenarios will have adverse refractive outcomes. The manual techniques of capsulorhexis formation have changed significantly over the years nevertheless great variation still exists in terms of outcomes. It has been found that only 10% of manually created capsulorhexes are with in 0.25 mm of their intended diameter versus 100% of those created by femtosecond laser[1]. Femtosecond laser can allow surgeon to place a circular rhexis with a precise diameter at an exact location on the anterior capsule. In some machines real time OCT is integrated into the femtosecond laser system to image anterior and posterior capsule intraoperatively in three dimensions. The true spheroid of the lens can then be defined. With this information a logical location of capsular-hexis can be determined that would otherwise be impossible with current mechanical and subjective means, which are limited to the surgeon's view of two-dimensional surface of the anterior lens capsule and the pupil.

CONDITIONING OF CRYSTALLINE LENS

Image guided femtosecond laser softens or emulsifies cataract into small fragments using shock waves that will cause bubble like implosions. This technology can condition the lens to reduce both the amount of ultrasonic energy and the number and amplitude of manipulations needed for its removal. Lens-conditioning patterns include a 'cubing' guide laid down with in the central endonucleus. The resultant cubes represent a fractionation and disruption of the mechanical structure of the crystalline lens and the effectively decrease the nuclear density. A nuclear sclerotic cataract is typically softened by two grades (eg, from grade 4 to grade 2). This softening increases the patient's safety, because less vigorous manipulations will be required than for a denser nucleus. This conditioned nucleus is removed by using traditional ultrasonic handpiece. In the future it may be possible to cube and soften lenses to the extent that their removal is possible with irrigation and aspiration alone. Another option in lens conditioning is the creation of fracturing plane. This is like mechanical prechopping technique of Takayuki Akahoshi. Femtosecond laser can create a channel in the nucleus. A chopping or quadranting maneuver can then be performed along these planes but with considerably less intraocular force. Safety should increase due to less imposed zonular and capsular stress.

INCISIONS

The image guided Femtosecond technology has the potential to greatly augment the current cataract procedure by addressing the inherent variability of mechanical methods for making corneal incisions. The main cataract incision can induce astigmatism and contribute to wound leaks and subsequent endophthalmitis. With its high level of precision and consistency, femtosecond technology can allow surgeons greater control of corneal curvature and astigmatism induced by the corneal incision. More importantly, the laser has the potential to create more consistently watertight incisions, which should decrease the postoperative ingress of pathogens. Femtosecond technology may also offer a means of improving the creation of peripheral corneal relaxing incisions. Many techniques for relaxing incisions call for a set blade depth of 600 micron, which likely has an unpredictable effect because the depth of the peripheral cornea varies among patients and even with in the perimeter of a given patient's cornea. Such variation can lead, at best, to suboptimal refractive accuracy and, at worst, to micro- or macro-corneal perforations. Nomograms such as that developed by Louis Nichamin are designed to deliver greater accuracy by measuring peripheral corneal pachymetry and adjusting the diamond blade accordingly. These efforts represent a step in the right direction. Femtosecond technology can go farther by combining the flexibility of patterns with optical coherence tomography, not only to deliver more precise cuts, but also to permit completely different approaches to relaxing incisional architecture.

Advantages of Femtosecond Cataract Surgery

1. Less time than standard phaco surgery.
2. Less corneal complications than standard phaco surgery due to reduction in power or U/S power.
3. Femtosecond laser can be used to create a perfectly centered, shaped and sized refractive capsulotomy with no radial tears.
4. Water tight main corneal incision and improved and consistant peripheral corneal relaxing incisions.
5. Good IOL centration and improve outcomes of premium IOL implantation and accommodative IOL insertion because these IOLs need a continuous central capsulotomy to hold them in place.

Based on the technology's established results for LASIK and the promising human cataract trials currently being conducted, the femtosecond cataract surgery may well be the first major paradigm shift since ultrasound disrupted the status quo.

REFERENCE

1. **Nagy Z.** Intraocular femtosecond laser applications in cataract surgery. Cataract & Refractive Surgery Today. 2009; 9: 79-82.

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