Course 10-101
Mastering Femtosecond Laser-Assisted
Cataract Surgery in Challenging Cataracts

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Introduction
Femtosecond laser assisted cataract surgery enables the surgeon to create a perfect capsulotomy which is circular, of a pre-determined size and centred. In addition, nuclear fragmentation facilitates cataract removal using less ultrasound energy. This is especially advantageous in eyes which have dense nuclei, shallow anterior chambers or compromised corneas. Fragmenting the nucleus is also helpful as removal of nuclear fragments can be done without the need to rotate the entire nucleus. This may be especially advantageous in eyes with posterior polar cataracts and subluxated cataracts.

Introduction - Cont’d
The femtosecond laser is also able to create incisions and arcuate keratotomies. In eyes that are already challenging to handle, the surgeon may wish to avoid laser created corneal incisions which may not be able to be placed peripheral enough due to the presence of opacities such as arcus senilis. In addition, the placement of the paracentesis incisions may need to be non-conventional and situational due to the complexity of the case.
Soft Cataracts
Soft cataracts that are too hard to aspirate and too soft to crack can be challenging to handle. By creating a waffle pattern of fragmentation and softening, the nucleus is easily aspirated with minimal phaco energy. When combined with a cataract pre-chopper which cleanly separates the nucleus into 4 quadrants following successful hydrodissection, the lens can be safely and rapidly aspirated with minimal manipulation.

White cataracts
There are various types of white cataracts. Perhaps the most difficult of these to handle is the intumescent lens. Achieving an intact and well sized capsulotomy can be very challenging in such a situation when the intralenticular pressure is high and the anterior chamber is shallow. When the lens is punctured during initiation of a capsulorhexis, the surgeon may encounter the dreaded ‘Argentinian flag sign’.

White cataracts - Cont’d
The femtosecond laser has the ability to achieve a perfect capsulotomy in an intumescent cataract. In addition to this, capsular fibrotic tags and subcapsular fibrotic bands often associated with these hypermature lenses can also be successfully cut through by the laser. If the underlying nucleus is brown, fragmentation of the nucleus may be effective. If the nucleus is white, the same may not be possible as the laser is unable to penetrate.
White cataracts - Cont’d
In order to achieve a complete capsulotomy, it is important to docking levelly so that the laser hits the entire anterior capsule simultaneously. This step avoids an anterior capsule rip that may occur when a distended lens is cut at one site first, creating a pressure differential as liquefied cortex egresses from the highly pressurised capsular bag. Running intravenous mannitol half hour prior to surgery will greatly help to reduce vitreous pressure and deflate the capsular bag. This step is important as docking the eye for laser treatment itself increases the intraocular pressure.

White cataracts - Cont’d
If capsular fibrosis is present, one needs to remember to increase the laser energy settings so as to ensure complete sectioning of the fibrotic bands. The use of capsule dye such as trypan blue is advised to facilitate visualization of the capsulotomy as often, the entire anterior chamber may be clouded with spilt lens material and gas bubbles.

Brunescent Cataract
The use of the femtosecond laser is especially advantageous for the dense nucleus which tends to also be rather thick. Various software fragmentation patterns are available and generally the smaller the resultant fragments, the less the phaco energy required for emulsification. A very popular pattern is the waffle pattern. Equally important are 2 other parameters which need to be selected. Firstly, the depth of fragmentation and secondly the peripheral extent of the cut. One should maximise on these settings so as to facilitate cracking of the posterior plate and lateral separation of the nucleus. During the surgery, frequent topping up of dispersive viscoelastic substance to protect the cornea is important.
**Posterior Polar Cataract**
The posterior polar cataract is identified by the presence of a whirled onion appearance. This type of cataract is associated with a very fragile posterior capsule with an increased propensity to rip during surgical manipulation. When removing a posterior polar cataract, it is mandatory to avoid hydrodissection and rotation of the nucleus. Instead, gentle hydrodelamination without excessive distension of the capsular bag should be performed. In general, both the density of the nucleus and size of the polar opacity are related to the risk of posterior capsule rupture.

**Posterior Polar Cataract - Cont’d**
The femtosecond laser is able to reduce the risk of posterior capsule rupture as the lens can be fragmented into many pieces, facilitating its removal without necessitating its rotation. Furthermore when using the fragmentation pattern of ring cuts combined with multiple radial cuts, a cortical plate is left, protecting the posterior capsule until the end of surgery. This greatly increases the safety of the procedure.

**Compromised corneas and Post corneal transplant states**
In eyes where the endothelial cell count is significantly reduced, removal of the cataract which has been fragmented helps to reduce the amount of phaco energy used. Smaller nuclear pieces generally require less phaco energy to emulsify. This is especially important in eyes that have undergone corneal transplantation. Also important is the role of dispersive viscoelastics in protecting the cornea throughout the surgery, which cannot be over emphasized. The surgeon should try to keep the phaco tip in the capsular bag and importantly avoid allowing the small hard nuclear fragments from hitting the endothelium or being ricocheted into the posterior chamber where they may be lodged subsequently, only to be discovered postoperatively.
Compromised corneas and Post corneal transplant states - Cont’d
Incomplete capsulotomy may be encountered where suture track scars of a penetrating or deep lamellar keratoplasty overlap the capsulotomy site. Very steep or very flat corneas may pose a problem with docking and care should be taken to ensure that no air bubble is trapped between the patient interface and the cornea, impeding the passage of the laser beam. As visualization of the anterior capsule may be difficult following femto, the use of capsular dye is advised to improve visualization of the capsule to ensure its completeness.

Small Pupil
The laser safety margin for femtocapsulotomy is 0.5mm. In order to achieve a 5mm capsulotomy, the pupil will need to be dilated to at least 6mm, failing which the capsulotomy will automatically be downsized to maintain the preset safety margin. Thus the smaller the pupil, the smaller the capsulotomy and volume of nucleus fragmented. In order to overcome this problem, in manual cases, a pupil expander can be inserted after viscoelastic has been introduced into the anterior chamber.

Small Pupil - Cont’d
If posterior synechiae or pupillary membranes are present, these should first be removed before insertion of the pupil expander. Similarly, in femtolaser cases, the pupil expander is first inserted after introduction of viscoelastic, which is subsequently aspirated and removed. The main incision is then sutured and the femtosecond laser procedure carried out. Surgery is then undertaken. The pupil expander is removed at the end of surgery. Iris hooks cannot be used to expand the pupil in this instance. If the femtosecond laser platform used does not incur significant intraocular pressure rise, the incision following pupil expander insertion may be left unsutured.
Subluxated cataract
This is perhaps the most challenging type of cataract encountered by the ophthalmologist. Creating a capsulorhexis that is well sized, centred and round can be difficult as the zonular support is inadequate to provide the necessary counter traction force and control desired. The femtosecond laser allows the surgeon to obtain a perfect capsulotomy when displaced anterior or posterior within the safety limits of treatment of the laser. When the nucleus is displaced laterally, the capsulotomy may need to be down sized and manually adjusted in order to position it in the centre of the anterior capsule. The laser can also cope with a degree of lens tilt but in general does not handle this as well as with other directions of lens displacement. Hence, capsular tags may sometimes be encountered. If vitreous is present in front of the anterior capsule, this can be cut through by increasing the laser energy.

Subluxated cataract - Cont’d
Nuclear fragmentation in a subluxated cataract is desirable as it not only spares the endothelium by reducing the phaco energy required, but also facilitates removal of the cataract even when nuclear rotation cannot be fully achieved with hydroadissection. This spares the remaining zonules. Furthermore the posterior offset often results in a cortical plate which protects the posterior capsule until the last fragment has been removed. Using a linear aspiration mode, low aspiration flow rate and low ultrasound energy, the cortex can be safely aspirated removed without rupturing the posterior capsule.

Subluxated cataract - Cont’d
However, caution should be exercised when using any device such as hooks or rings in the more severe cases of zonulysis, that may contact and press against the capsular rim. Hooking on to the capsulotomy to support the lens or manipulating the modified tension ring suture eyelet above the capsular bag for example, may rip the anterior capsule, leading to its posterior extension. The use of capsular bag hooks which support the bag at the equator rather than iris hooks which hook onto the capsulotomy rim are preferred. Capsular tension segments are safer to insert than modified capsular tension rings as they do not stress the capsular rim nor induce torque on the bag.
Subluxated cataract - Cont’d

Careful use of capsule stains may aid visualization and avoidance of the capsulotomy rim in cases where the zonulysis is not severe. However, capsule dyes may alter the elasticity of the anterior capsule and predispose it to rips when the rim is stressed. The fragility of the capsulotomy rim may be greater in advanced cataracts and extra care should be taken when managing the dense subluxated cataract.