

Lens Anterior Capsule Opening Procedures

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ABSTRACT:

Manual Small Incision Cataract Surgery (MSICS) and phacoemulsification are two of the most commonly performed cataract surgeries worldwide. The opening of the anterior capsule step is arguably the most critical for a successful MSICS and phacoemulsification. Technique employed for this task have undergone sustained evolution from Vogt technique to can opener capsulotomy and continuous curvilinear capsulorhexis and evolution of new instruments and machines from cystitome, capsular forceps to laser assisted capsulotomy helped the surgeon to achieved continuous, curvilinear and circular capsulorhexis. Each technique have their own advantages and disadvantages. The mechanical capsulotomies that are performed by femtosecond laser and zepto are functionally similar to capsulorhexis but much more expensive in cost. Manual capsulotomies are still performed where mechanical capsulotomy is not feasible. This article discusses the technique, advantages, disadvantages and complication related to continuous curvilinear capsulorhexis.

Introduction

Manual small incision cataract surgery (MSICS) and phacoemulsification are two of the most commonly performed cataract surgeries worldwide. The opening of the anterior capsule step is arguably the most critical for a successful MSICS and phacoemulsification. The capsulorhexis or mechanical capsulotomies are the best methods for opening the anterior capsule. The capsulorhexis should be continuous, curvilinear and circular. The opening is created by a controlled shearing and tearing of the anterior capsule by either a needle cystotome or capsulorhexis forceps. The mechanical capsulotomies that are performed by femtosecond laser and zepto are functionally similar to capsulorhexis but much more expensive in cost. Manual capsulotomies are still performed where mechanical capsulotomy is not feasible.

Evolution of the Anterior Capsule Opening Procedures

1. Manual Capsulotomy
 - ‘Can-opener’ or multi-puncture capsulotomy
 - Envelope capsulotomy
2. Manual capsulorhexis
3. Mechanical capsulotomy
- A. Laser Assisted Capsulotomies
 - Femto Laser assisted capsulotomy
 - Zepto Laser assisted capsulotomy
- B. Radio frequency-assisted capsulotomy

Evolution of Capsulotomy Instruments and Machines

Manual

- Cystotome or Capsulotome
- Capsular Forceps

Mechanical

LASER-assisted Capsulotomy

- Femto Laser-assisted capsulotomy
- Zepto Laser-assisted capsulotomy

Other Modalities

- Fugo Blade
- Radio frequency Diathermy

Manual Capsulotomies

1. ‘Can-opener’ or multi-puncture capsulotomy

A circular opening of approximately 5 to 6 millimeters in diameter is created with the cystotome by bending a 26-gauge or finer needle, or from various other customized styles. The entire procedure may be performed in a closed chamber with the cystotome entering the un-opened anterior chamber, or in a completely open or semi-closed chamber.¹ The irrigating cystotome, air bubble, or viscoelastic material may be used to maintain the anterior chamber depth. I prefer a viscoelastic material.

ADVANTAGES

1. This style of capsulotomy is easy to learn and is therefore practiced widely.
2. This can be performed on all types of cataracts including intumescent and hyper-mature cataracts.

DISADVANTAGES

1. Capsulotomy incisions leave multiple ragged edges, any of which could potentially promote catastrophic radial tears proceeding outwards towards the zonules.²
2. Surgical manipulations during phacoemulsification or MSICS of the nucleus may lead to unintentional tearing of the peripheral anterior capsular rim. These tears could



often extend to the capsular equator or even into the posterior capsule.

3. Posterior capsule tears may or may not be associated with vitreous loss and dropped nucleus fragments into the vitreous cavity.
4. The multiple ragged edges of the anterior capsule causes disturbance in aspiration of peripheral cortical residues.
5. Anterior capsular tears could result in de-centration of the intra ocular lens.

B. ENVELOPE (INTERCAPSULAR) CAPSULOTOMY

Sourdilla and Baikuff described the envelope capsulotomy technique in 1979 in France.¹ However Galand developed it to its present stage and popularized the 'Envelope Technique'.^{1,2}

Technique

A horizontal, slightly curved linear capsulotomy is aimed at the junction of the upper 1/3rd to middle section of the anterior capsule. This makes the superior flap slightly more mobile and gives a better access to the superior capsular fornix for the removal of cortical matter. Therefore, placement of the implant in the bag is easier.

Advantages

1. The preservation of the anterior capsule creates a semi-closed system within the anterior chamber and therefore, facilitates removal of cortical material.
2. The presence of the anterior capsule until the intraocular lens (IOL) is implanted reduces the chances of radial extension of tears
3. It facilitates the removal of the epithelial cells of the lens.

Disadvantages

1. It produces marked asymmetry of the capsular flaps. This predisposes to de-centration of the IOL. The IOL tends to sit upwards.

Capsulorhexis or Continuous Curvilinear Capsulotomy (CCC).

The capsulorhexis is also called continuous curvilinear capsulotomy (CCC). It was invented by Gimble and Neuhann simultaneously from different parts of the world.¹ This technique involves controlled shearing and tearing of the anterior capsule producing a strong, smooth, and regular circular opening.

Procedure

The anterior chamber is formed with viscoelastic, and a 26-gauge needle cystotome is advanced through the side port incision. The first puncture is made in the centre of the anterior capsule. The cystotome traverses to the left or right of the central slit to create a horizontal slit. The cystotome is placed underneath the slit in contact with the lens, and is lifted

upwards towards the surgeon, so that a tear is produced and a small flap of anterior capsule is fashioned. This small anterior capsular flap is everted. The needle is placed near the junction of the flap and the peripheral anterior capsule. The needle pushes the flap along the tangent of that particular point along the imaginary circumference of the capsulorhexis opening. The flap is guided with push and pull motions in such a way that the correct size of circular opening is produced. The direction of flap rotation can be clockwise or counter clockwise according to the surgeon's preference. (Figure 1,2,3)

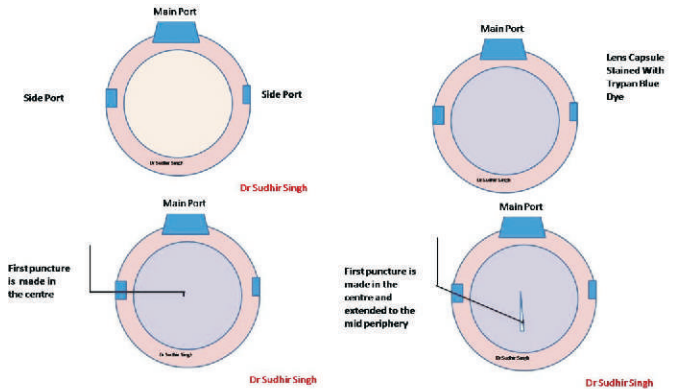


Figure 1 : Initiation of capsulorhexis

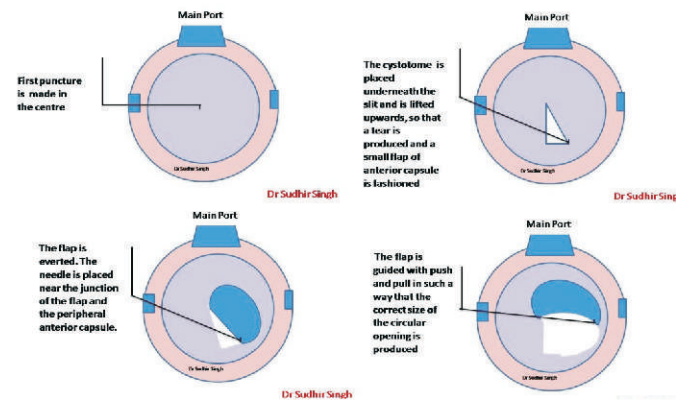


Figure 2 : Lifting of capsulorhexis flap in anticlockwise direction

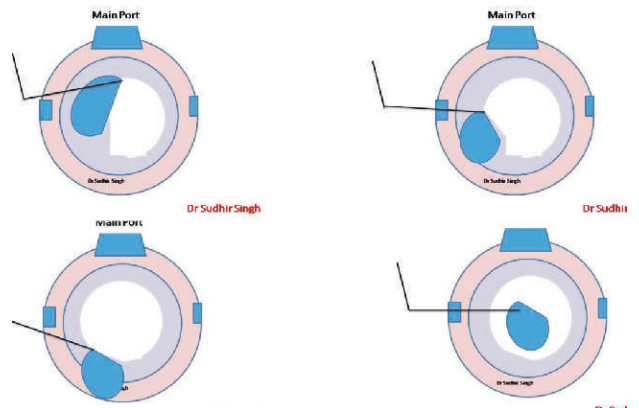


Figure 3 : Completion of Capsulorhexis

Capsulorhexis Creation by Needle Cystotome Versus Forceps

Capsulorhexis is performed by both the needle cystotome as well as forceps equally well in expert hands. The cystotome can easily be advanced through the side ports while capsulorhexis forceps need to enter through the main incision. While maneuvering in the main port there may be more risk of anterior chamber collapse compared to performing this from the side port. Anterior chamber shallowing may cause peripheral extension or lost capsulorhexis. The capsulorhexis forceps are very useful in certain conditions like pediatric cataracts where the lens capsule is more elastic and in intumescent cataracts where intra-lenticular pressure is increased. However, it is important to maintain a deep anterior chamber with good viscoelastic materials.

Video <https://youtu.be/z4S1JTc7sB4>

ADVANTAGES

1. The capsulorhexis contributed significantly to the safety and effectiveness of cataract extraction and IOL implantation
2. It facilitates the size of a smooth, circular, capsular opening, and it produces a strong capsular rim that resists tearing even when stretched during lens material removal or lens implantation
3. The capsulorhexis facilitates procedures such as hydro-dissection, endo-lenticular phacoemulsification, capsular polishing, and safe lens implantation in both adults and children

DISADVANTAGES

Performing capsulorhexis requires some practice, experience and skill.

Capsulorhexis in difficult situations

It is extremely difficult to perform capsulorhexis in intumescent, mature and hyper mature cataracts, and cataracts in neonates and infants. With practice, however, it is possible to perform a small size capsulorhexis in these difficult situations. The use of forceps is desirable in bringing the peripheral extension of the capsulorhexis towards the centre.³ However, it is important to maintain the anterior chamber with good viscoelastic substance, if forceps are being used for this technique.

Capsulorhexis in Intumescent White Cataract

Capsulorhexis in intumescent white cataract is done in three stages

Stage 1 Small Central Capsulorhexis: The anterior lens capsule is stained with trypan blue dye. The anterior chamber is filled with preferably cohesive viscoelastics in such cases. Initially a curvilinear tear to the anterior capsule is made and a capsular flap is folded. A small capsulorhexis is made by shearing and tearing forces using 26G needle cystotome from the side port incision.

Stage 2 Capsular Bag Debulking: This is done by aspirating cortical matter using the Simcoe irrigation/aspiration cannula. .

Stage 3 Small capsulorhexis Enlargement: This is enlarged with the forceps after creating a curvilinear nick in the margin of the small capsulorhexis. Although most cases can be dealt with using these techniques, if radial extension occurs, safe surgery can still be performed.

Video <https://youtu.be/PJgueIL8qoQ>

The 'Argentinian flag sign' is a peri-operative sign seen in patients with intumescent 'pearly white' mature cataracts during surgery. During capsulotomy a radial anterior capsular tear occurs through a trypan blue stained anterior lens capsules. After the tear has propagated equatorially what is left is a light blue torn anterior capsule with a central white cataract protruding from the capsule. Despite taking precautions, the 'Argentinian flag sign' is still encountered. It's not end of the world. The capsular tear can be converted to a 'can-opener' capsulotomy.

Video: Argentinean Flag Sign in a White Intumescent Cataract and Management <https://youtu.be/DzwQrGgclY>

When this occurs, it can be successfully dealt with using simple techniques without compromising final visual outcome.

Large nuclear size and small capsulorhexis opening

If one plans to carry out MSICS with a small capsulorhexis along with a large nucleus, then two or three equidistant relaxing incisions are made at the capsulorhexis margins for safe prolapse of the nucleus into the anterior chamber. If one attempts to prolapse a large nucleus through a small capsulorhexis without making relaxing incisions, this can lead to zonular dialysis and rupture. If one plans to carry out phacoemulsification with a small capsulorhexis and a large nucleus then it is possible to proceed with phacoemulsification in the bag with special precaution not to damage the capsulorhexis margins.

Radial Extension of the Capsulorhexis Margins and Management

The predisposing factors for radial tears during capsulorhexis are:³

1. A shallow anterior chamber due to inadequate amount of viscoelastic or leaking of viscoelastic from the ports.
2. High intra-lenticular pressure as seen in intumescent cataracts.
3. High positive vitreous pressure.
4. Weak zonules mostly associated with pseudo exfoliation syndrome
5. Pediatric cataracts, especially below 5 years of age have elastic anterior capsules.
6. A large capsulorhexis margin extending into the anterior zonular area causing disruption of the anterior zonules.

7. Inexperienced surgeons.

Rescuing Radial Tear Extension

When a radial tear starts to extend, inject more viscoelastic into the anterior chamber and try to pull the capsule flap towards the centre. If this step does not salvage the radial extension then start again from the opposite direction to complete the capsulorhexis. Despite all efforts, if a radial tear occurs then this is not the end of the world. Surgeons should take a deep breath for a few moments, keep calm and start again. The remaining part of the capsulorhexis can be completed by fine multiple incisions as seen in ‘can-opener’ capsulotomy. If phacoemulsification is planned, an experienced surgeon can complete the phacoemulsification with caution. If the radial tear is large and extending to the equator then it is wise to convert the procedure to MSICS.

Complications of the radial extension of the capsulorhexis

Radial extension of the capsulorhexis may lead to zonular dialysis, posterior capsular tears, vitreous prolapse, an unstable capsular bag and a dropped nucleus into the vitreous cavity during phacoemulsification.

Femtosecond Laser-Assisted Capsulotomy

Femtosecond laser-assisted capsulotomy is commonly known as femto capsulotomy. ⁴ The desired size and a round, regular and circular capsulotomy is made by this laser. These capsulotomies are more circular than manual capsulorhexis. Femto capsulotomy is useful in intumescent cataracts and fibrosed anterior capsule. Incomplete capsulotomies and anterior capsular tags are the main complications ⁵ of femto capsulotomies. Contraindications of femto capsulotomy are corneal media haze and a small pupil. The femtosecond laser machine is however very costly to install and this carries a very high cost of procedure. The comparison of manual capsulorhexis and femto capsulotomy is given below

Table 1 : Comparison between femtocataract surgery and Phaco surgery

Capsulotomy			
	Femto Cataract Surgery	Phaco Surgery	Remark
Capsulotomy Type	Capsulotomy	Capsulorhexis	Functionally both are same
Circularity	More Circular	Less circular	*Non Significant if IOL is covered 360 degree by capsulotomy
Anterior Capsule tags	More	Less	
Non Dilated Pupils	Not Possible	Possible	With rings and hooks phaco is possible in abnormal pupils

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Zepto Capsulotomy

The zepto capsulotomy is a new technique ⁶ employing novel technology for creating a circular capsulotomy. The zepto device and hand piece is an alternative to manual capsulorhexis that allows the capsulotomy alignment with the patient's visual axis for optimized intraocular lens placement and positioning. The hand piece is connected to a power console positioned away from the sterile field. The device is designed to produce round, accurately sized, centered capsulotomies during the surgical routine through the use of highly focused multi-pulse low-energy discharge across 360 degrees. This is useful in certain conditions like intumescent cataracts, pediatric cataracts and fibrosed anterior capsules. The zepto capsulotomy adds an extra cost to the procedure without substantial benefits.

Video: Manual Capsulorhexis in Difficult Cataracts Cases

<https://youtu.be/Lois48qFKME>

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EYE FACTS



Shark corneas are similar to human corneas, which is why they are being investigated to be used in human transplants.

Will It Happen ??