

Management of Posterior Capsular Tear



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Posterior capsular tear or PCT is one of the disastrous complications of cataract surgery. Although common in the learning stages, it can occur even in the hands of experienced surgeons – specially if they are in hurry or overconfident. The situation does create panic in the mind of operating surgeon – the surgeon sometimes tends to do lot of unwarranted steps. If not managed properly, the outcome can be disastrous for the eye; however, if managed properly the results can be quite rewarding.

This booklet by Dr. Harbansh Lal, one of the pioneers of Cataract Surgery, describes in a very lucid and practical way the do's & don'ts of PCR.

Complications do happen in the best of hands but the true competence of a surgeon is judged by how he handles complications.

I am sure this masterpiece by Dr Harbansh Lal will help everyone.

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Phacoemulsification is being practised all over the country in all types of setups and by all types of surgeons. PCT is the most commonly encountered complication irrespective of the experience of the surgeon. With the good experience accumulated over the years, it is now possible to manage PCT to the satisfaction of both the patient and the surgeon.

Majority of the management of posterior capsular tear is by the anterior segment surgeon, however, the role of the posterior segment surgeon cannot be undermined, especially in situations associated with nucleus drop and IOL drop. While managing PCT, not only does the surgeon need to handle the cataract and vitreous, but also has to be well aware of the types of IOLs suitable in a given situation. I am very pleased to see that this CME Series covers all types of IOL implantation techniques.

Dr. Harbansh Lal, who is a pioneer in Phacoemulsification surgery, and has been actively involved in training of postgraduate students has put in his vast experience and brought out this CME Series. I also want to thank Dr. Lalit Verma, and Dr. Tinku Bali for their contribution to the CME series, especially regarding the management of PCT by the posterior segment surgeon.

I hope this CME will be of great help to all cataract surgeons.

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Management of PCT

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AC	Anterior chamber	PCC	Posterior continuous capsulorhexis
ACD	Anterior chamber depth	PCIOL	Posterior chamber intraocular lens
ACIOL	Anterior chamber intraocular lens	PCT	Posterior capsular tear
CCC	Continuous curvilinear capsulorhexis	PFCL	Perfluorocarbon liquid
CCI	Clear corneal incision	PMMA	Polymethylmethacrylate
CL	Contact lens	PPV	Pars plana vitrectomy
CME	Cystoid macular edema	PUSZ	Peripheral unsafe zone
CSZ	Central safe zone	PVD	Posterior vitreous detachment
ECCE	Extracapsular cataract extraction	RD	Retinal detachment
EPN	Epinuclear plate	RMT	Rhexis margin tear
I/A	Irrigation aspiration	RR	Rounded repositor
IOL	Intraocular lens	SFIOL	Scleral-fixated intraocular lens
IOP	Intraocular pressure	SICS	Small incision cataract surgery
IPD	Interpupillary distance	VES	Viscoelastic substance
PAL	Posterior-assisted levitation		
PC	Posterior capsule		



Phacoemulsification is the standard of care for cataract patients all over the world. We promise sutureless surgery and early visual rehabilitation from the first post-operative day, which has led to an increased expectation of the patient. Posterior capsular tear (PCT) may compromise not only the expected outcome but may also cause serious complications and sleepless nights for the surgeon, if not managed properly.

PCT can be defined as an iatrogenic breach in the continuity of posterior capsule. The incidence of PCT in various studies varies between 1–4%¹. This largely depends upon the equipment, setup and surgeon's experience and skill. The incidence of PCT goes down as the surgeon develops a better understanding of the equipment and his surgical skill improves. If beginners are able to understand the causes and factors responsible for PCT, they can take essential steps to prevent its occurrence.

Our aim is to analyze how and why PCT takes place and in case it occurs, how can we have a surgical outcome comparable to an uncomplicated surgery, in terms of good visual outcome, early visual rehabilitation and prevention of secondary consequences of PCT like

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Glaucoma, Nucleus drop, IOL drop, Distorted pupil, Decentered IOL, Corneal decompensation, Cystoid macular edema, Prolonged inflammation, Retinal detachment, etc.

To have a satisfactory outcome when there is an IOL or nuclear drop, it has to be managed by a posterior segment surgeon. We are thankful that none other than Dr. Lalit Verma has written the part of 'PCT management by a posterior segment surgeon'.



Prevention is the best form of management. Prevention is possible only if we know what causes PCT. The predisposing factors can be classified as follows:

1. Equipment related
 - (a) Operating microscope
 - (b) Phacomachine
2. Extraocular – Ergonomics
 - (a) Prominent eyebrows
 - (b) Deep set eyes
 - (c) Narrow palpebral fissure
 - (d) Disorders of spine
3. Ocular
 - (a) Corneal causes
 - (b) Anterior chamber depth
 - (c) Iris and pupillary factors
 - (d) Capsule, lens and zonules
4. Surgeon's factor

1. Equipment related

(a) Operating microscope

Focussing of the oculus, proper inter-pupillary distance (IPD) selection,

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well positioned microscope, and comfortable seating are essential prior to surgery.

- **Adjusting the oculus:** If there is no anisometropia, the surgeon can keep the oculus at 0, in both eyes. In case of anisometropia, the surgeon keeps one oculus at 0 and focusses with the other eye closed; now the surgeon closes the focussed eye and adjusts the oculus of the other eye. Maximum plus which provides a clear view should be chosen in the oculus, so as to relax the accommodation.
- **IPD:** Maximum IPD which does not cause diplopia should be selected.

(b) Phacomachine

Proper understanding of phacodynamics and the machine is an essential prerequisite for a successful surgery.

2. Extraocular

Ergonomics

For the ease of surgery it is important to have the eye horizontally placed. Any angulation may lead to an oblique plane causing rotation and distortion of the globe, leading to unfocussed surgical field and difficulty in depth perception. Optimum exposure of the surgical field and unhindered access to anterior chamber are prerequisites for a good surgical outcome. Attaining a horizontal position of the eye during surgery by either adjusting the table, sutures, block or extra support under the head or the shoulders is essential.

- (a) **Prominent eyebrows:** Chin can be raised and extra support if needed can be given below the shoulders to position and stabilize the head.
- (b) **Deep set eyes:** Temporal incision is better as eyebrows can be avoided. If needed, superior and inferior rectus bridle sutures can be passed to elevate and stabilize the eyeball.
- (c) **Narrow palpebral fissure:** If it is felt that the speculum is pressing on the globe and the exposure is not adequate then lid traction or bridle sutures can be passed. If the exposure is still not adequate, cantholysis (crushing and cutting of lateral canthus can be done, which can be sutured after phacoemulsification) is a good option.

- (d) **Disorders of the spine:** Extra support may be needed behind the shoulders or the spine to make the patient comfortable. This may lead to elevation of the patient's head. To compensate this we can elevate the foot end of the table to make the head horizontal. Being a closed chamber technique, elevating the foot end of the table will not alter the surgery as it used to do in open chamber surgeries due to increased orbital pressure and vitreous thrust.

Never hesitate to give blocks in patients in whom you consider eye positioning may be suboptimal.

Certain modifications in the surgical practice can help in overcoming the problems posed by the ergonomic factors, such as:

- If doing superior phacoemulsification, shift to a temporal incision.
- Side port incision can be made more central i.e. corneal instead of limbal, if there is obstruction due to prominent eyebrows or cheek bones.
- If there is excessive pooling at the medial side, causing annoying reflexes, then slight temporal tilting of the head can be done or drainage through merosel sponges/gauze, placed at the lower fornix and draining out can be done.

3. Ocular factors

Assessing ocular risk involves evaluation of the corneal clarity, anterior chamber depth, extent of pupil dilation, iris, capsular status, cataract density and extent of zonular weakness, if any.

(a) Corneal problems leading to poor visibility

Scarring from any corneal pathology can cause irregular corneal haze, increasing light scatter and reducing contrast during surgery. The use of trypan blue to stain the anterior capsule during capsulorhexis is a must.

The annoying reflexes by the microscope light in presence of corneal pathology during Continuous Curvilinear Capsulorhexis (CCC) can largely be overcome by the use of an endoilluminator² (used by retinal surgeons). It can be placed on the limbus or inside the AC with the microscope light off, which enhances the visibility and facilitates the CCC.

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(b) Anterior chamber depth (ACD)

Proper evaluation of ACD is essential prior to surgery, as ACD can be shallow in high hypermetropes, intumescent and hypermature cataracts with secondary glaucoma which decreases the safety margin, as there is a reduction in the central safe zone (CSZ). We will discuss the concept of CSZ later.

ACD is deep in high myopes, vitrectomized eyes and zonulopia (stretched weak zonules) which makes the lens lie deep. So when we access the lens during phacoemulsification, the direction of the phaco tip is more posterior. This leads to corneal striae and folds along with a posterior direction force, which increases the chances of PCT. To prevent this, bottle height should be low; a small corneal tunnel is warranted with no undue pressure on the nucleus.

(c) Iris and pupillary factors

Small pupil and floppy iris increase the risk of PCT. If pupil is smaller than 5 mm then appropriate measures have to be taken for sustained dilation of pupil.

Sclerosed pupil: Easier to handle as compared to floppy iris. Stretching of pupil or multiple sphincterotomies (8–12) of about 400–500 μ each can be done.

Floppy iris: More dangerous than the above. Prolapse of the iris from the wounds and progressive miosis being a major problem. Hence careful evaluation of a floppy iris³ should be made and iris hooks or expanders (Malyugin rings) should be kept ready and used whenever required.

Even if during surgery the pupils get miosed, there should be no reluctance in usage of hooks and expanders.

(d) Capsule, zonules and lens

Thin friable PC in certain situations, such as posterior polar cataract, pseudoexfoliation, vitrectomized eye, high myopia and **floppy and lax PC**, as in hard cataract, zonulopia, zonular dehiscence, poses increased threat of posterior capsule tear.

Hard cataract is one of the most important risk factors for PCT. The capsule is generally thin and friable in such cases (Fig. 1.1). Over-

stretching of the capsule because of the large volume of the nucleus increases the tendency of the PC to keep coming forward. Also, it is difficult to separate and chop the leathery fibres.

4. Surgeon's factor

As the surgeon keeps on gaining experience, the incidence of complication goes down, but any complication due to lack of understanding of the basics is unacceptable. Every surgeon should be aware of the mechanism of surge and should know how to prevent or control surge during the surgery. Before going to various stages and how PCT happens, let us understand the mechanism of surge.

For that we first need to understand the concepts of:

- (a) Central safe zone,
- (b) Peripheral unsafe zone,
- (c) Compliance,
- (d) Flow rate, vacuum and their relationships.

(a) Central safe zone (Fig. 1.2)

The **central safe zone** is not an anatomical area but a concept that needs to be understood for performing safe aspiration. This is an area within the CCC margin which is bounded vertically by the cornea on the top and the posterior capsule in opposite direction. This is the area with maximum space in the AC. All aspiration—nuclear, epi-nuclear or cortical—should be done here as there is maximum safety here. Even if there is AC flutter, the probe will not damage any vital structures. The nuclear pieces and cortical matter can be held in the

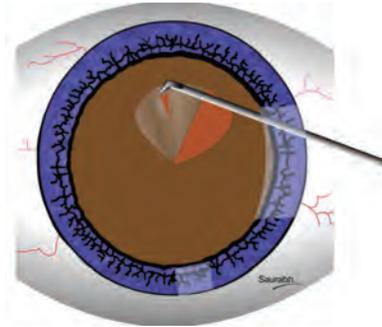


Fig. 1.1. Friable capsule – hard cataract.



Fig. 1.2. Central safe zone (CSZ).

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periphery and then brought to the CSZ for aspiration. This is a dynamic area – as more of the nuclear pieces are removed, the space and thus the safety margin keeps on increasing. **In myopes, zonular stress syndromes and vitrectomized eyes the CSZ is further increased whereas in hypermetropes, small pupil and small CCC the CSZ is smaller.**

(b) Peripheral unsafe zone (Fig. 1.2)

Due to the corneal curvature, as one proceeds towards the periphery, one enters an unsafe zone as there is less space for manoeuvring. The capsular fornices and the angle region are thus areas where it is dangerous to do phaco-aspiration since the vital structures are extremely close. This constitutes the **Peripheral unsafe zone (PUSZ)**.

(c) Compliance

A silicon tube connects the aspiration system with the handpiece in both types of pumps. Additionally thick wide bore tubing is required for the rollers to be effective in a peristaltic pump. While the rollers are rotating, there is no occlusion and no collapse of tubing. When occlusion occurs, vacuum builds up, the rollers stop and negative pressure is generated within the whole system. This causes the tubing to collapse.

Property of the tubing to collapse (deform under pressure) is the compliance of the tubing. Once the occlusion breaks, there is a release of negative pressure and the tubing re-expands to the original size. Fluid is drawn from the AC to fill up this extra volume (this is what causes surge). Though this volume is not much, it is this instantaneous withdrawal of fluid over an extremely short period of time which causes the surge (Fig. 1.3a).

This extent of collapse of the tubing will depend on the lumen size, the level of vacuum generated and the thickness of the tube. The collapse is more at higher vacuum levels and less if the lumen is smaller and the walls are thicker (less compliant tubing). Tubings of these characteristics are known as ‘High Vacuum’ tubing.

SURGE

Sudden withdrawal of fluid from AC after occlusion breaks is called surge. Beyond a certain limit it may cause collapse of

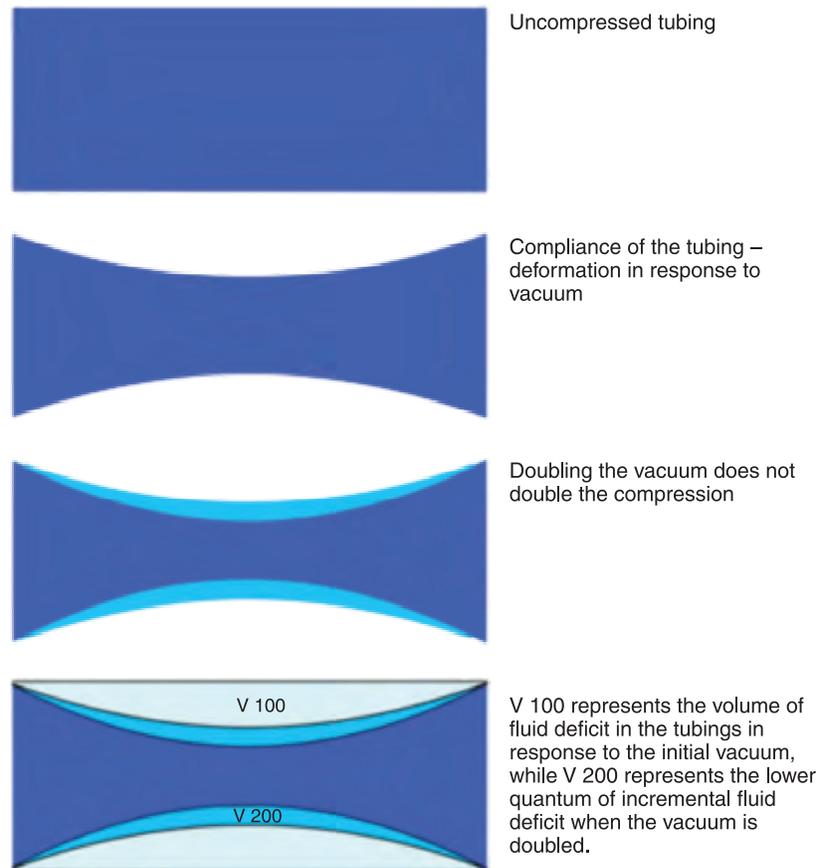


Fig. 1.3a. Compliance.

chamber, jeopardizing the vital structures of eyes and making the surgery filled with complications. In fact modifications introduced over a period of time have taken place to manage this surge and thus make phaco surgery free from complications. If there was no surge, any one could have mastered phacoemulsification. To maintain a constant volume and IOP of the AC, inflow, i.e. infusion has to be equal to outflow, which is the sum of aspiration by pump and the wound leakage. For a given bottle height inflow is constant and so is the leakage. The only variable parameters left in the above equation are the aspiration flow rate and the vacuum, i.e. the outflow by aspiration (Fig. 1.3b).

THE GENESIS OF SURGE

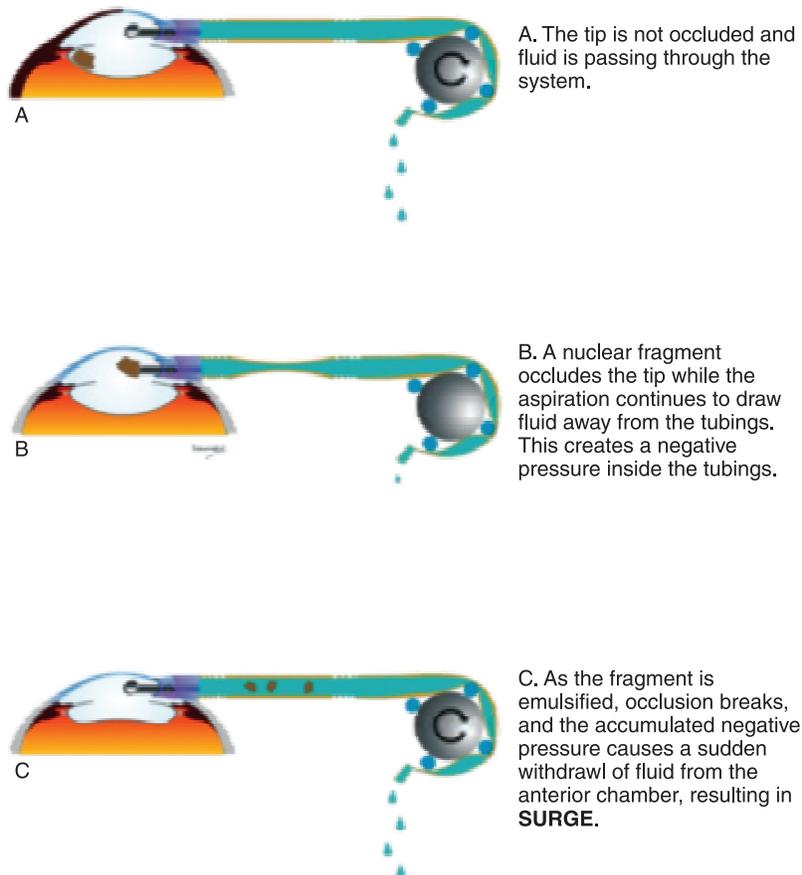


Fig. 1.3b. Surge.

(d) Relationship between vacuum, surge and flow rate

Suppose there is surge beyond acceptable limits. Now there are two options—either reduce the flow rate or the vacuum. Decreasing the AFR has a direct and linear effect but increases the rise time and makes the procedure slower, which may not be such a disadvantage to a beginner. On the other hand decreasing the vacuum will decrease the holding power which is not desirable in steps like chopping/phacoaspiration of a hard cataract. So, it is better to lower the FR in such a situation to decrease the surge, while maintaining high vacuum. On the

other hand, in situations where a firm hold is not so important, like divide and conquer technique, soft cataracts or epinuclear plate removal, one can lower the vacuum settings to decrease the surge while maintaining the AFR.

Control of surge

There are various methods of controlling the surge. Some are incorporated into the newer machines and there are some measures that the surgeon can apply.

Surge prevention by the machine

Venting, high vacuum tubings, use of cassettes, delay in start of motor after breaking of occlusion, differential settings for flow rate and vacuum at different stages of surgery, dual/linear foot pedals, microtips and above all highly responsive sensors and computing have been successful in decreasing the surge.

Surgeon's control of surge

1. **Decreasing the effective flow rate:** Without changing the actual setting on the machine, the surgeon can decrease the effective FR by using a smaller bore aspiration port, e.g. Microflow tip.
2. **Increasing the infusion** by raising the bottle height or using a TUR (Transurethral resection) set may be useful in some cases.
3. The use of an **ACM** is useful for decreasing surge (especially for beginners).
4. **Proper wound construction:** A leaking wound will disturb the equilibrium of the chamber so that even a very small amount of fluid withdrawn can cause it to collapse. This highlights the importance of making a good main wound and side port. The wound construction should be such that it conforms to the tip that you are using. Premature entry also results in a leaking wound. Distortion of the wound, with the co-axial IA handpiece may cause a leaky wound. Too tight a wound or too long a tunnel can also cause a problem by reducing the inflow. Thus both a leaky and too tight a wound can increase the surge.
5. **Increased viscosity of the AC contents:** The flow rate settings are for clear fluids like BSS/Ringers. A thicker fluid increases the resistance and does not flow out easily. The use of viscoelastic substance (VES) can cause a decrease in the effective FR and thus

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decrease the surge. This is particularly useful in hard cataracts where the settings are usually high and whilst aspirating the last nuclear fragment.

6. **Partial occlusion of the tip:** Partially occluding the tip with another piece before the occlusion breaks and the occluding fragment gets aspirated ensures that any surge that occurs will be used to draw in the next piece to occlude the tip. This will maintain occlusion and prevent fluid from the AC being aspirated.
7. **Foot control:** Above all, good foot pedal control is of paramount importance in controlling surge and utilizing it to your own advantage. If one can anticipate the events then surge control is not a problem. That is why experienced surgeons can operate on any settings and any machine. As soon as the occlusion is about to break (i.e. the piece is about to be aspirated into the tip), the surgeon lifts the FP to IAo (position 1 of foot pedal or completely in the Continuous Infusion Mode), the piece will go in on its own momentum and without any of surge as the FR will decrease. Thus fluid withdrawn from the AC will be very little to overcome the compliance of the system. However, if the FP is withdrawn too early and there is not enough momentum then it will take more time to build up vacuum again. This balancing between the AFR, vacuum and the momentum of the pieces needs to be done very carefully.



It is indeed surprising that just a 4 μ thin posterior capsule can withstand so much stress and pressure, arising because of the various forces during phaco surgery. Why then, under certain situations, does its tenacity give way? To understand this we have to assess each and every step of the surgery, understand what predisposes to PCT and what remedial measures can be taken.

1. WOUND CONSTRUCTION

Though wound construction may not be directly responsible for PCT, but leaky wounds are the most important factor for unstable AC. A sharp keratome, according to the size of the phaco tip is a must for a good wound construction. Trying to create a 2.75 mm incision with a 3.2 mm keratome will always result in a leaky wound. Even a tight wound will lead to increase in surge by reducing the inflow.

Sideport incisions are even more important. The chopper is much thinner than the aspiration cannula used in bimanual I/A system. We generally create the sideport incisions to the size of the I/A cannula and when we are at the highest parameter setting of phaco machine, i.e. during chopping and phacoaspiration this wound keeps on leaking. Due to the same reason beginner can make initially small incision corresponding to the size of chopper and then enlarge it afterwards for I/A.

2. ANTERIOR CONTINUOUS CURVILINEAR CAPSULORHEXIS (CCC)

The CCC can withstand turbulence, pressure and mechanical stress created by the fluid, nucleus, chopper, IOL, etc., during phacoemulsification. If CCC is not intact, or there is cone formation in the CCC, then these forces may cause the anterior rhexis margin to extend posteriorly leading to a PCT. Rhexis margin tear (RMT) could be primary, occurring at the stage of performing anterior CCC or secondary, i.e., happening at any other stage of the surgery.

Primary RMT

There are certain situations which are more prone to RMT, such as:

1. Intumescent or hypermature cataract
2. Pediatric cataract
3. Hard cataract
4. Fibrosed capsule

1. Intumescent or hypermature cataract

Due to the high intra-lenticular pressure, many a time as soon as a nick is made on the anterior capsule, the rhexis tends to run away, or one is able to start the rhexis, but it tends to run to the periphery midway. In such a scenario use of **Healon 5** or **Healon GV** to flatten the anterior capsule may prevent it.

To prevent this, one may try to reduce the intra-lenticular pressure by doing multiple **YAG capsulotomies**, few hours before the surgery. This is the best method as holes created by YAG are round and don't have the tendency to run away. Same can also be achieved by **multiple small punctures** at the centre instead of one linear cut to relieve the intra-lenticular pressure. Fluid is allowed to escape slowly, but these punctures are not round, and will have a tendency to run away.

After making the punctures, some of the released fluid can be manually **sucked by a syringe** by putting the cannula at various locations underneath the anterior capsule or viscoexpressed. **Viscoexpression** is better as it maintains the pressure from the top and thus prevents the rhexis from running away.

Another, very good option is to make a **small rhexis** initially and enlarge it before or after phacoemulsification, depending upon the size

of the rhexis and hardness of the cataract. If the CCC is less than 3.5 mm and the nucleus is large and hard, it's better to enlarge it before doing phacoemulsification.

Many surgeons prefer to make a **sinusoidal CCC**, i.e. start as small CCC and after completing 120–180° start enlarging it and instead of finishing it at the site of origin go beyond and get an adequate CCC.

2. Pediatric cataract

Younger the patient, more are the chances of RMT. To perform CCC in such cases requires special surgical skill. Capsule has to be stained, high viscosity viscoelastics are a must and CCC has to be done with a forceps.

Small CCC is attempted and instead of applying tangential force, the cut end is **pulled in towards the centre**. AC has to be maintained at all times, as even a slight collapse of the AC will make the CCC run away.

3. Hard cataract

Hard cataracts in older patients usually have a very thin and friable capsule. Trying to do an anterior CCC by cystitome, many times leads to tears in the anterior capsule underneath the turned flap, making it difficult to get a round CCC. If such tears go unnoticed, these lead to RMT (Fig. 2.1).

Use of **forceps and trypan blue** stained capsule is a better choice.

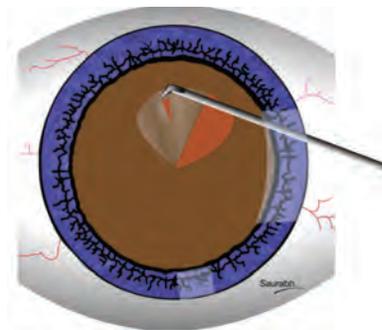


Fig. 2.1. Friable capsule – hard cataract.

4. Fibrosed capsule

Sometimes in long standing traumatic and hypermature cataract, the cataract gets partially absorbed and the patient develops plaque, fibrosis of the capsule and wrinkling of the anterior capsule. In such situations CCC is difficult and one may land up in incomplete and irregular CCC.

Secondary RMT

This occurs because of inadvertent injury to the anterior CCC, which can be due to the chopper, phaco tip, IOL or the hard nucleus. The most common culprit is the sharp chopper.

Types of RMT

There are two types of RMT:

1. Curved or tangential
2. Radial or coned

1. Curved

When trying to do a CCC, it goes to the periphery in curvilinear fashion and you are not able to retrieve it. This retrieval is difficult in younger patients due to high elasticity of the zonules. When the rhexis is pulled in, zonules get stretched and prevent this force to be applied on to the cut end of the rhexis margins in proper direction (Fig. 2.2).

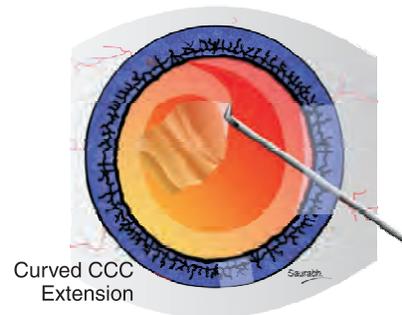


Fig. 2.2. Rhexis margin tear.

2. Radial

This happens in morgagnian or intumescent cataract when rhexis runs away to the periphery or due to injury to the rhexis margin by chopper or phaco tip during surgery, which leads to the formation of a cone (Fig. 2.3).

In presence of RMT, excessive pressure by nuclear fragment, while dialing or during chopping may cause RMT to extend posteriorly. Collapse of the chamber during any phase of the surgery will cause vitreous to bulge

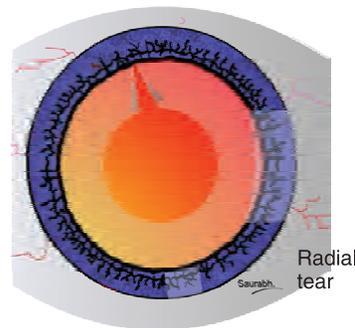


Fig. 2.3. Rhexis margin tear.

Curved RMT is not as dangerous, as its chance to run to the posterior capsule is much less as compared to the radial RMT.

forward and cause RMT to run posteriorly. This happens more when the last nuclear fragment is being removed. As long as some nuclear fragment is present in the capsular fornices, it prevents PC to come forward.

The most important strategy to prevent PCT is to **maintain AC depth at all times**. For this reason do not lower the bottle height, but lower the fluidics parameter by 20%, so as to avoid any chamber fluctuation.

Viscoelastics have to be injected before removal of the probe, at every step of the surgery, even after cortical aspiration before removing the infusion cannula inject viscoelastics from the side port.

Alternatively nucleus can be prolapsed into the AC and supracapsular phacoemulsification can be performed, but still ACD should be maintained during every step of the surgery.

3. DURING HYDRODISSECTION

There are 3 main reasons for posterior capsular rupture during hydro procedures:

1. Block to outflow

The outflow may be blocked due to increased resistance offered by viscoelastic in the chamber or a small CCC/small pupil. Also injecting from the side port when main wound is sealed can lead to a PCT due to increased pressure (Fig. 2.4).

The fluid from hydro is blocked by the tight approximation of the capsular rim and the lens matter. This increases the intracapsular pressure, leading to a break in the posterior capsule.

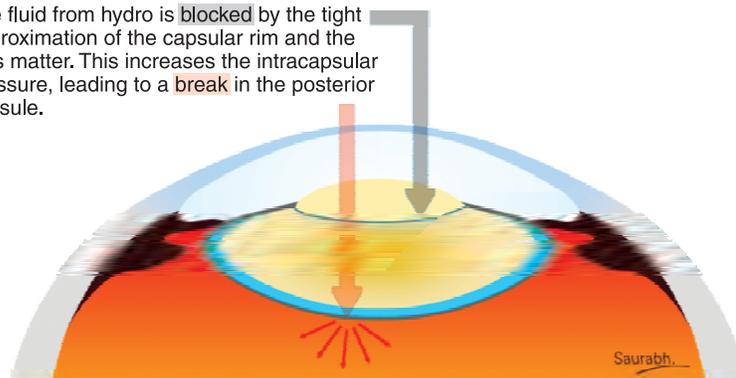


Fig. 2.4. Hydrodissection.

2. Injection of too much fluid

Injection of too much fluid with too much force or using a faulty technique/wrong syringes and cannula can lead to PCT.

3. Inherent weakness

Weak capsule may be seen in case of posterior polar cataract, high myopes, post-vitrectomy, traumatic cataracts, pseudoexfoliative syndromes and some cases of posterior subcapsular cataract. In these cases one can avoid hydrodissection (since this step can lead to a nuclear drop) and perform a careful hydrodelineation.

If the PCT goes unnoticed and if the phaco probe is placed in the anterior chamber, the nucleus will be dislodged in the vitreous cavity. So, early recognition of the PCT is of utmost importance at this step. Few signs that help in the recognition of PCT are as follows:

Signs of a PC rupture during hydrodissection

These are:

- **Sudden deepening of the chamber**
- **Abnormal tilt in the nucleus**
- **Inability to rotate the nucleus**
- **Sudden dilation of the pupil – Snap sign⁴**
- **Bright red reflex.**

4. DURING NUCLEOTOMY

Nucleotomy comprises of Trenching, Splitting, Chopping and Aspiration. Any of these steps if not performed properly can lead to a PCT.

1. Trenching

In case of a **soft cataract**, while trenching if the power has not been adequately lowered, one can go through and through, which can lead to a PCT in the periphery. On the other hand, in case of a **hard cataract** if the power has not been adequately increased, surgeon tends to apply excessive force on the nucleus pushing it down, which can lead to PCT or zonular dehiscence.

2. Splitting

If trenching depth is not adequate, excessive force applied during splitting can lead to damage to the capsule. If the fibres are very leathery, on attempted splitting we tend to dip the periphery of the nucleus which may lead to development of zonular dehiscence or a peripheral PCT. In such cases make sure, not to push the nucleus too far away, and keep on moving your instruments closer to the area of the split, so that the fragments do not move very far apart.

3. Chopping and Aspiration

At this stage of surgery fluidic parameters are highest and surge is the most important causative factor. Sudden surge or collapse of anterior chamber can lead to a direct injury to the posterior capsule by the chopper. When chopping in a soft cataract, the soft part tends to be sucked in, and the probe may damage the posterior capsule (PC) more so in the periphery.

Epinuclear plate, the cortical matter and nuclear pieces in capsular fornices keep the PC away from the probe, while emulsifying the last nuclear piece the capsular fornices are empty and a slight surge moves PC towards the probe, causing PCT. This is more common in conditions where the capsule is lax and floppy as in hypermature, brown hard cataracts. In such cases the nucleus size is very large, which stretches the capsule and the capsule becomes large and floppy. This also occurs in cases of zonular dehiscence and weakness wherein the PC is lax again.

In such cases various steps can be taken to prevent a PCT, such as:

- **Lowering the aspiration parameters.**
- **Increasing the bottle height.**
- **Using an AC maintainer (another port for fluid to go in).**
- **Removal of last piece under viscoelastic.**
- **Extreme cases – assistant can keep on injecting viscoelastic from the side port, to keep the PC away.**
- **Use of micro-tip instead of kelman.**
- **Phaco-aspiration to be done in Central Safe Zone.**

Partial occlusion of tip

Sometimes the aspiration tubing or the phaco tip may get blocked, particularly in hard cataracts, and on sudden release of this blockade there will be increased surge and increased chances of chamber collapse and PCT. In such cases when a tube blockade is expected (poor follow-ability and poor hold on the nucleus) one should take out the probe from AC and flush it. The probe should be tested in a test chamber, before use.

5. DURING EPINUCLEAR PLATE REMOVAL

Many a time one is left with a posterior epinuclear plate with no anterior extension. In such cases turning the bevel of the phaco tip down to lift the EPN may lead to PCT. Any attempt to lift the posterior EPN with iris reposer may lead to PCT if the eye is not adequately visco-compressed.

While doing cortical aspiration with the bimanual I/A system, EPN gets automatically prolapsed and suck out along with the cortex.

6. DURING CORTICAL ASPIRATION

High incidence of PCT occurs during cortical aspiration, especially in the sub-incisional area. This is because of poor access and decreased visibility, problem being exaggerated by small capsulorhexis. A coaxial hand piece leads to further distortion of the wound, causing the PC to come anteriorly.

GOLDEN RULE

When the PC is caught in the suction port a star-shaped tented area appears. Immediately, **without moving the hand piece/cannula**, release the foot pedal to stop suction (Fig. 2.5).

In some cases, reflux may be required. Catching does not tear the posterior capsule but pulling does. Use of bimanual technique reduces the incidence of PCT.

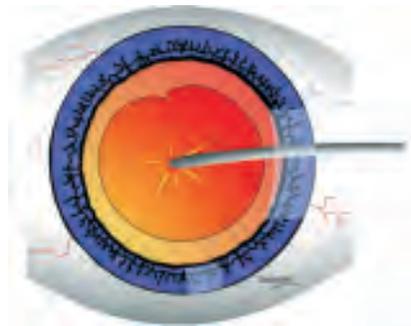


Fig. 2.5. Catching the posterior capsule.

PCT does not occur if the PC is only caught in the probe; sudden movement after holding with the probe / cannula is what causes it to tear.

7. DURING CAPSULAR POLISHING

During polishing, a well-focused PC in retro-illumination view under high magnification and a bag filled with VES is a must to prevent PCT (Fig. 2.6). The bag must always be concave and visco-compressed so as to provide easy sliding of the instruments. If the bag is lax and some wrinkling appears on the capsule during the movement of rounded repositor/polisher, the chances of creating a PCT are high (Fig. 2.7).

Patients with thin PC (as discussed during hydro procedures) are particularly prone to PCT.

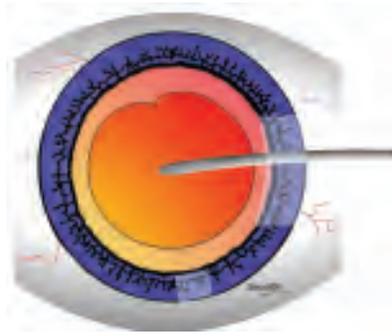


Fig. 2.6. Well filled bag – no striae.

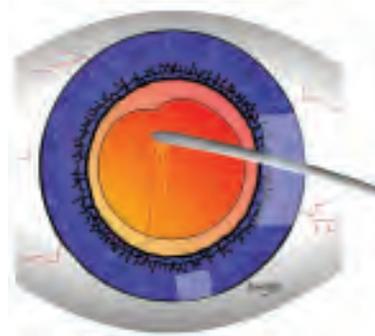


Fig. 2.7. Poor filled bag – capsular striae.

8. DURING IOL IMPLANTATION

IOL implantation should be done under a well pressurized globe. The bag should be filled with viscoelastics. If the viscoelastic leaks or the capsule is not taut, then chances of capsule getting entangled in the leading loop are very high. While using an injector system, the leading loop has to be kept horizontal all the time, for that one has to observe the leading loop carefully and keep on rotating the nozzle of the cartridge as and when required.

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In this era of micro-incision surgeries with reducing incision size, there may be leakage of viscoelastic from the wounds, particularly in wound-assisted insertion of the IOL. In such cases one can re-inject the viscoelastic or release the IOL in the sulcus rather than the bag. The IOL is positioned in the bag, after re-injection of viscoelastics.

All the companies provide same cartridge size for all IOL powers. High power IOLs are much thicker and excessive force is required to inject these IOLs. This at times causes sudden and jerky release inside the bag causing PCT.

P C T

3

MANAGEMENT

Diagnosis and Goals

GOLDEN RULE

Once PCT is noted, or one is in doubt about the status of the posterior capsule, be calm and maintain the phaco probe in the AC, keep the infusion on and inject viscoelastics from the side port. After ensuring that the AC is well pressurized, the phaco probe is withdrawn (Fig. 3.1).

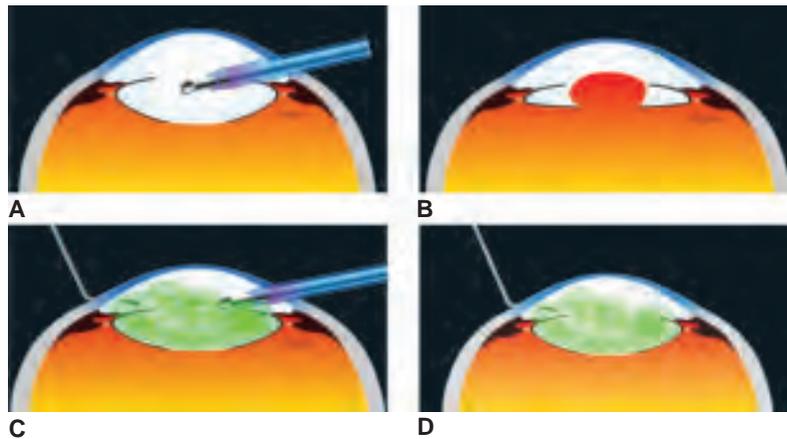


Fig. 3.1. **A.** Posterior capsular tear. **B.** Removal of probe – vitreous prolapse in AC. **C.** Pressurizing the AC from the side port. **D.** Removal of probe – no prolapse of vitreous into AC.

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If one withdraws the phaco probe suddenly, then the anterior chamber collapses, causing the PCT to enlarge and the hyaloid face may get disrupted, leading to prolapse of the vitreous in the AC and prolapse of the nuclear fragments into the vitreous cavity.

Converting tear to PCC

Converting a PCT into a PCC is ideal, but most of the times impractical. Conversion to PCC is possible only if PCT is small and central and the hyaloid faces nearly intact. Also, if the hyaloid face is intact, risk of disrupting it while attempting PCC is very high.

One should attempt conversion to PCC only when one has small central/paracentral PCT (not more than 3 mm), good viscoelastics, excellent capsulorhexis forceps and a good operating microscope. However, the failure rate is still very high.

DIAGNOSIS

CONFIRMATION OF PCT AND HYALOID FACE RUPTURE (HFR)

The next step is to confirm the presence and extent of PCT, and even more important is to ascertain whether hyaloid face is intact or not. Majority of the cases of PCT will have a disrupted hyaloid face, but an intact hyaloid face can be encountered if PCT occurs at the stage of capsular polishing, IOL insertion or cortical aspiration.

Signs of HFR

- Torn edge
 - Shiny/golden
 - Rolled up
- Anterior chamber
 - Irregular depth
- Nucleus
 - Restricted movements of the fragments

Indicate disruption of hyaloid face

Tests

One can do the following tests:

Sponge test (Fig. 3.2)

One can sweep a sponge along the incision to detect the presence of vitreous.

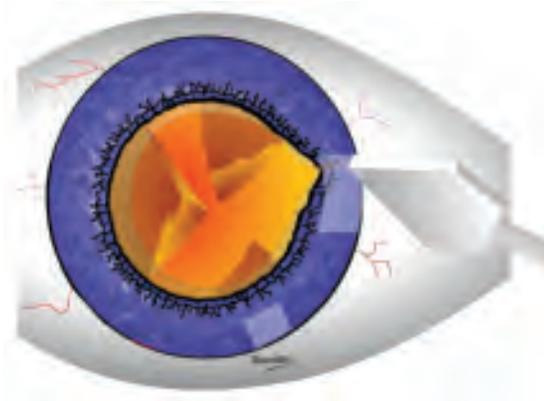


Fig. 3.2. Sponge test.

Sweep test

One may also try to sweep the spatula from the anterior chamber angle under the incision towards the PCT. Vitreous, if present, will be seen dragging in (due to tendency of the vitreous to come towards the wound).

Halo test (Fig. 3.3)

Put viscoelastic in the bag, to flatten it or keep it slightly convex to elicit the halo test. Try to look for the ring reflex by applying the pressure

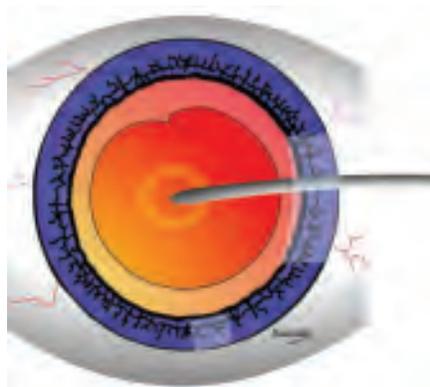


Fig. 3.3. Halo test.

in the centre of the capsule with the help of a rounded reposer. If the hyaloid face is intact, a halo will be seen which will vary in size depending upon the amount of pressure applied. This ring reflex will be broken at the site of PCT.

Stain test

One can also inject Triamcinolone into the anterior chamber just adjacent to the PCT (not above it as it will fall back into the vitreous cavity), to stain the vitreous. However, *when one is in doubt consider the hyaloid face as disrupted.*

GOALS OF MANAGEMENT

The goal of every complication created during surgery is to minimize the short term and long term damage to the eye. For this purpose we can divide the goals of management into major goals and important goals.

MAJOR GOALS

1. To avoid posterior dislocation of nucleus, nuclear fragments, epinucleus or cortical matter into the vitreous cavity.
2. Prevent any damage to the corneal endothelial surface.

IMPORTANT GOALS

These goals are very important to achieve so that the end result of the surgery is as good as if nothing had happened. Surgery remains sutureless, astigmatically neutral with well centered IOL and without any secondary complications.

1. Prevent enlargement of tear.
2. Prevent damage to capsulorhexis.
3. Minimize size of vitrectomy, avoiding traction.
4. Removal of left over cortex.
5. Maintain the wound size.
6. Proper positioning of the IOL.

P C T



4

Management by Anterior Segment Surgeon

MANAGEMENT

GOLDEN RULE

DO NO HARM TO THE PATIENT

If the primary surgeon is ill-equipped or inadequately trained, secondary management by a senior or trained surgeon should be done. If nucleus is not retrievable from the anterior route, then leave it for the posterior segment surgeon to do the needful. Be truthful to yourself and the patient, inform the patient about the scenario. Your ego might get hurt, but you will have better peace of mind, with the shared responsibility.

FACTORS IN DECISION MAKING

Management will depend on various factors, such as:

- Extent of PCT
- Hyaloid face intact or not
- Location of the nucleus – whether dislodged into the vitreous cavity
- Availability of equipment – vitreous cutter, vitrectomy machine
- Availability of alternative IOLs
- Availability of specialized instruments
- Knowledge about anterior vitrectomy and confidence of the surgeon
- Availability of VR surgeon.

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Above factors help in deciding the plan of management:

- Management by Anterior Segment Surgeon
 - Primary
 - Secondary
- Management by Posterior Segment Surgeon
 - Primary
 - Secondary

PRIMARY MANAGEMENT STRATEGIES

Primary management is the best approach, as it causes least stress to the patient and harm to the reputation of the surgeon. It causes a lesser amount of inflammation and provides an early rehabilitation as promised to the patient. We need to have strategies to manage:

1. Nucleus/nuclear fragments
2. Epinucleus
3. The cortex
4. IOL implantation
5. Final vitrectomy and closure

1. NUCLEUS / NUCLEAR FRAGMENTS

Managing of nucleus/nuclear fragments is the most important step in a case of PCT. The main goal is to prevent any dislocation of the nucleus/nuclear fragment into the vitreous cavity. There are two main steps but many techniques for the same.

1. **Supracapsular relocation**
 - Dislodging
 - Tumbling
 - Chopstick technique
2. **Extraction from eye**
 - Manual
 - (i) Viscoexpression
 - (ii) Chopstick technique
 - Automated
 - (i) Vitrectomy cutter

- (ii) Phacoemulsification
 - (a) Without scaffold
 - (b) With scaffold
 - 1. HEMA Contact lens
 - 2. Lens glide
 - 3. IOL
- Conversion to ECCE/SICS

1. Supracapsular relocation

In a viscopressurized eye, nuclear fragments are relocated anteriorly in front of the CCC and iris, preferably at the angle of the AC to prevent these from dropping into the vitreous cavity by any of the following techniques:

Dislodging

Small fragments of the nucleus are moved just sideways into the capsular fornices and then brought gently upwards towards the iris plane and then pushed towards the angle of AC.

Tumbling

This is a very good technique for small fragments. It can also be used for soft cataracts and epinuclear plate. In this technique the repositor pushes the nucleus to the periphery initially (Fig. 4.1), and then upwards, maintaining a constant counter-pressure from the anterior capsule, the nucleus can be easily brought out from anterior CCC (Fig. 4.2).

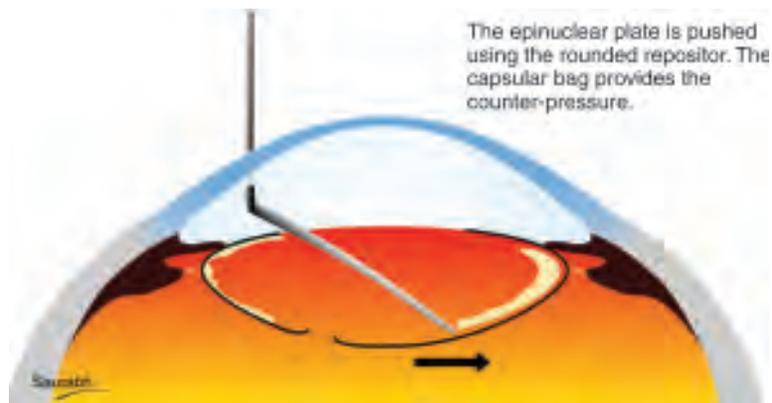


Fig. 4.1. Rounded repositor pushes the nucleus to the periphery initially.

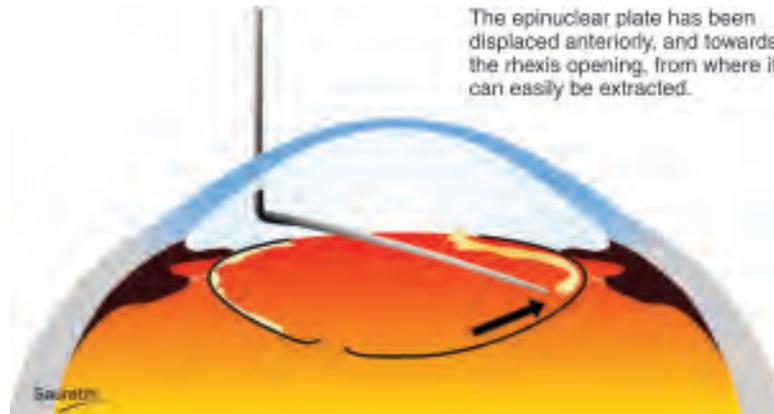


Fig. 4.2. Upward pressure is maintained and a constant counter pressure from the anterior capsule facilitates easy removal of the nucleus from the anterior CCC.

Even, if the pupil is small, which is obscuring the peripheral view, this technique comes in handy.

Chopstick technique

Chopstick technique in PCT

As the name suggests, two instruments are used in this technique, through which the nucleus/nuclear fragments can be held and repositioned to a desired site. The instruments that could be used are the Sinsky hook, chopper, rounded repositor or dumbbell dialer. Sinsky hook is particularly good as it gets buried into the nucleus and provides a good grip. Both the instruments can be introduced from the main port or one from the main port and another from side port. One is put below and the other above, or alternatively one on each side of the fragment, so that the fragment is sandwiched. The fragment is gripped firmly between the two instruments and is now moved into the supracapsular area away from the site of tear (Fig. 4.3).

Chopstick technique in impending nuclear drop

In case the nucleus is hanging down in the anterior vitreous cavity, never try to fish it out through the anterior route. Such an impending nucleus drop is best managed by either the ‘Chopstick technique’ as described by Dr. Harbansh Lal⁵ or the ‘Posterior assisted levitation’ as described by Dr. Kelman. In both these techniques, one port is made

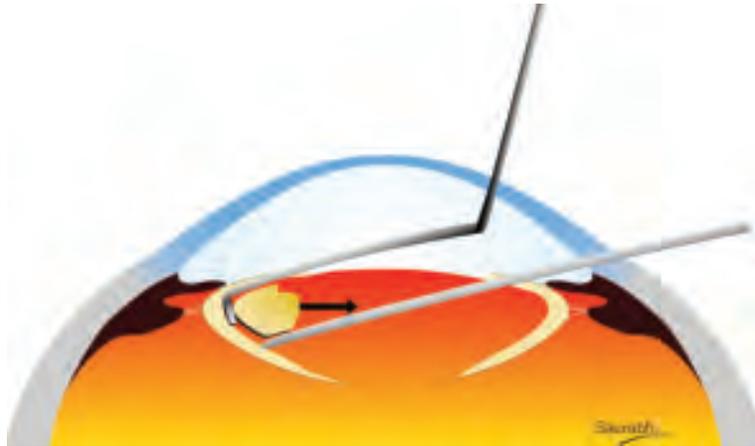


Fig. 4.3. In case of a PCT if a nuclear fragment is remaining in the bag then two instruments can be used to grip the fragment. It is now moved into the supracapsular area away from the site of tear.

through the pars plana by giving a stab incision with 15 degree blade or V-lance knife, 3.5 mm away from the limbus.

Through the pars plana incision, in PAL technique Viscoat is injected behind the nucleus and the thin cannula of Viscoat or iris repositor is used to push the nucleus forward. In chopstick technique an instrument (Sinskey hook) is passed through the pars plana incision and buried into the undersurface of the nucleus, which helps to support the nucleus and prevents it from sinking into the vitreous. The nucleus is sandwiched and stabilized with the second instrument from above which may pass through the side port or the main port. The nucleus is then brought into the supracapsular area after having been stabilized (Fig. 4.4).

Chopstick technique without PCT

Chopstick technique is not only helpful in case of PCT, but also in any case where we want to reposition the nuclear fragment to prevent the PCT. In case of a miosed pupil, the visibility of the surgeon particularly in the area of capsular fornices is hampered. If a small nuclear fragment has gone in the capsular fornices or between the iris and the anterior capsule or as in a case of resistant sub-incisional nuclear fragment, which fails to rotate, the surgeon can use two instruments to hold and reposition the nuclear piece in the central safe zone (Figs. 4.5 and 4.6).

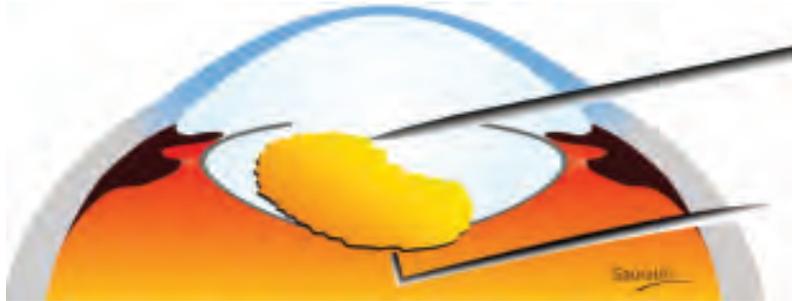
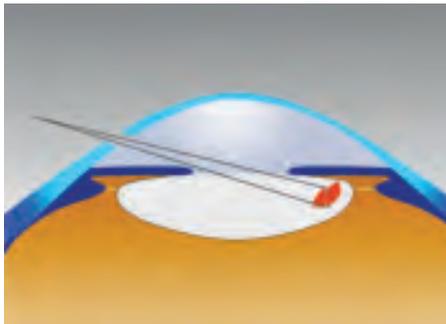


Fig. 4.4. In case of an impending nuclear drop an instrument (Sinsky hook) is passed through the pars plana incision and buried into the undersurface of the nucleus, which helps to support the nucleus and prevents it from sinking into the vitreous. The nucleus is sandwiched and stabilized with the second instrument from above which may pass through the side port or the main port. The nucleus is then brought into the supracapsular area after having been stabilized.



Figs. 4.5 & 4.6. If a small nuclear fragment has gone in the capsular fornices or between the iris and the anterior capsule, two instruments can be used to hold and reposition the nuclear piece in the central safe zone.

In case of failure of the phaco machine, this method can be used to bring the nucleus/nuclear fragments not only into the anterior chamber but also for removal from the eye.

2. Removal from eye

Manual

(i) Viscoexpression

Soft nuclear fragments are crushed between two instruments, such as chopper, Sinsky hook or a repositor. Thick cannula of viscoelastic is

passed underneath and well beyond the nuclear fragments (Fig. 4.7). Now viscoelastic is injected with simultaneously minimal pressure at the posterior lip of the wound with the cannula, causing the viscoelastic to flow out along with the nuclear material (Fig. 4.8). Care is taken to maintain AC depth at all times.

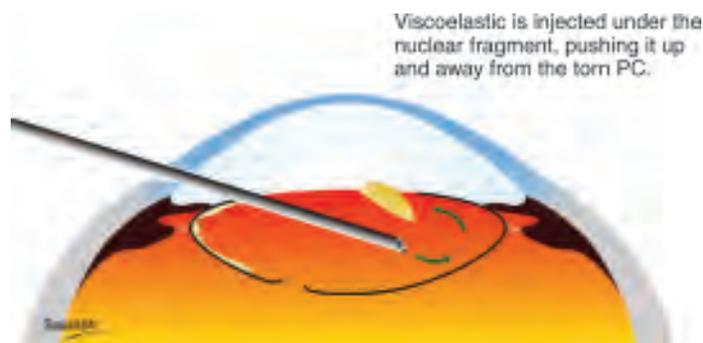


Fig. 4.7. Thick cannula of viscoelastic is passed underneath the nuclear fragments.

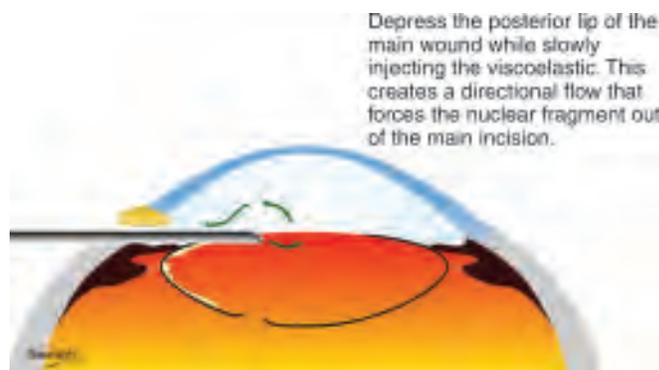


Fig. 4.8. Viscoelastic is injected with simultaneously minimal pressure at the posterior lip of the wound with the cannula, causing the viscoelastic to flow out along with the nuclear material.

(ii) Chopstick technique

As already discussed in the relocation of nucleus, the chopstick technique can also be used for removal of the fragments from the eye. The incision size will depend upon the size of the nucleus. If half of the nucleus is remaining then 5 mm incision is adequate, and if less than that a 4 mm incision would be sufficient.

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Long axis of the nuclear fragment is positioned perpendicular to the long axis of the wound. The eye is now visco-pressurized, and any two instruments, as discussed earlier, are inserted through the main port. These instruments are buried one on each side of the long axis of the fragment. Now both instruments along with the nuclear fragment are pulled out through the wound.

Advantages of the chopstick technique:

- Non-bulky instruments.
- Small incisions are needed.
- Any number of side ports can be made.
- Better than other techniques, such as wire vectis which relies on counter pressure, leading to damage to the cornea.
- Least traction on the vitreous, as instruments are even thinner than vitreous cutter.
- AC is maintained at all times.
- Better than PAL as counter pressure provides more controlled elevation of the nucleus with no risk of viscoelastic going into the vitreous cavity. No risk of increased IOP.

Disadvantage:

- Not suitable for soft cataracts or epinuclear plate as it will cheese wire through.

If the posterior capsular tear occurs early in the surgery with almost the entire nucleus remaining in the bag, it is of utmost importance to secure the nucleus by bringing it out of the bag and positioning it above the anterior rhexis margin. If CCC is small, release it by giving appropriate number of small relaxing cuts in the CCC margin, according to the size of the nucleus.

Automated

(i) Vitrectomy cutter

Using automated vitreous cutter is a very good option for soft cataracts and epinuclear plate. For using the cutter an infusion cannula is needed, which can be placed through the corneal sideport, through the pars plicata (i.e. 1.5 mm from the limbus) or via the pars plana route (i.e. 3.5 mm from the limbus). Self-retaining infusion cannula from the pars plana route would be ideal as it causes the least disturbance of vitreous,

with lesser chances of enlargement of the PCT and diminishes the chances of epinuclear plate or the nucleus fragment falling into the vitreous cavity.

A 20 G cutter system would be ideal, because of its larger port size, but 23 G system is equally effective if the cataract is soft and there are minimal nuclear fragments. Limbal, pars plicata or pars plana routes can be used for the cutter (Fig. 4.9). If most of the nuclear fragment has been relocated to the supracapsular area, then the limbal route is preferred. If the nuclear material is still in the capsular fornices, either a pars plicata or pars plana route would be preferable.

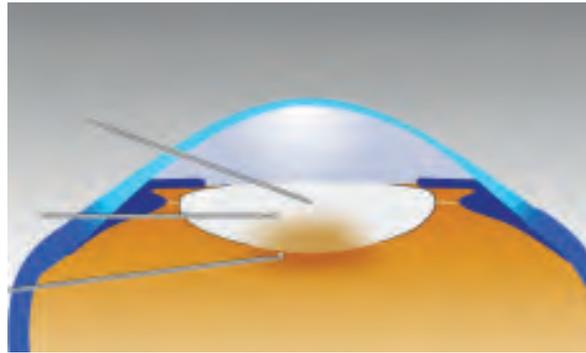


Fig. 4.9. Automated vitreous cutter can be placed through the corneal sideport through the pars plicata (i.e. 1.5 mm from the limbus) or via the pars plana route (i.e. 3.5 mm from the limbus). Self-retaining infusion cannula from the pars plana route would be ideal as it causes the least disturbance of vitreous, with lesser chances of enlargement of the PCT and diminishes the chances of epinuclear plate or the nucleus fragment falling into the vitreous cavity.

For pars plicata vitrectomy, stab incisions are given at about 1.5 mm from the limbus, through which the cutter enters the AC, behind the iris. The advantage being that there is no disturbance to the vitreous base, whereas the disadvantage would be a risk of bleeding and inadvertent damage to the iris.

Cut rate for nuclear removal should ideally be in the medium range, at a very high cut rate the suction port of the cutter gets occluded leading to a loss of vacuum and grip on the nucleus. The rate of 800/cuts per minute should be ideal for the nucleus. A vacuum of 300–400 is preferred for the nucleus removal AC depth should be maintained at all times with no fluctuation.

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For vitrectomy, the cut rate is kept at maximum and an aspiration rate of 150–200 is preferred so as to avoid any traction on the vitreous.

(ii) Phacoemulsification

(a) **Without scaffold:** This is a safe technique if PCT is small and vitreous face has not been disturbed. If the capsular support is good and there is no vitreous in the anterior chamber, the most important step is to secure the nucleus by bringing it away from the site of PC defect.

Viscoat is placed below the nuclear fragment and infusion bottle is kept at approx. 3 feet. All other fluidic parameters are lowered. The tip is then placed close to the nuclear fragment so as to achieve a full occlusion of the aspiration port and minimal phaco energy is used to emulsify the nucleus. This will reduce the risk of further damage to the capsule and aspiration of vitreous.

The main aim in such a case is to avoid any fluctuation in the anterior chamber, either by lowering the parameters or by the use of viscoelastics.

If vitreous face has been disrupted a limited anterior vitrectomy is done before coating and pushing back the hyaloid face with chondroitin sulphate (Viscoat). Viscoat being a visco-dispersive material stays longest in the eye, the next best choice would be methyl cellulose. Hyaluronic acid is not preferable as it disappears at the earliest during phacoemulsification.

(b) **Use of scaffold:** Use of scaffold is generally advocated when there has been a disturbance to the hyaloid face. Various scaffolding techniques have been described. These are:

1. **HEMA boat** as described by Dr. Keiki Mehta, which utilizes a HEMA contact lens as a scaffold. Ideally any soft contact lens can be punched with the help of a corneal trephine of 8–9 mm in size.

The C.L. is rolled and injected by the IOL injector beneath the fragment after the fragment has been relocated to the supracapsular area. Before injecting the C.L. limited anterior vitrectomy should be done. After the C.L. has been injected it should be made sure that there is no vitreous above the C.L., before starting phacoemulsification. If need be vitrectomy can be repeated after staining the vitreous with diluted tricort (1:2, 1:4).

2. **Lens glide:** Lens glide is a thin long plate which is passed underneath the nuclear fragment, supporting the leading end at the iris angle and second end is kept outside the wound. After proper vitrectomy, phacoemulsification is performed on top of the glide.
3. **IOL scaffolding:** IOL scaffold is one of the very good techniques for removal of nucleus, nuclear fragment and epinuclear plate, which has been popularized by Dr. Amar Agarwal⁶.

This procedure is intended for use in cases where PCT occurs with a non-emulsified, moderately hard to soft nucleus. After anterior vitrectomy the nucleus/nuclear fragments have to be prolapsed into the AC by the techniques described earlier.

Combining the ‘Chopstick technique’ and the IOL scaffolding would be the ideal method of managing cases of PCT with soft to moderate cataracts. The chopstick technique would be used to reposition all of the nuclear fragments above the rhexis margin, followed by insertion of a three-piece foldable IOL, which would act as a scaffold.

TECHNIQUE

- (a) Thorough anterior vitrectomy.
- (b) Prolapsing nucleus, Nuclear fragment or Epinucleus plate in the AC.
- (c) IOL positioning: 3-piece foldable IOL is injected into the AC above the iris plane, keeping the trailing loop out of the wound to prevent IOL drop, and allow for easy manoeuvring of IOL afterwards (Fig. 4.10). Use of the second hand sometimes becomes necessary to stabilize the IOL and keep it in the centre, by holding it at the optic-haptic junction.

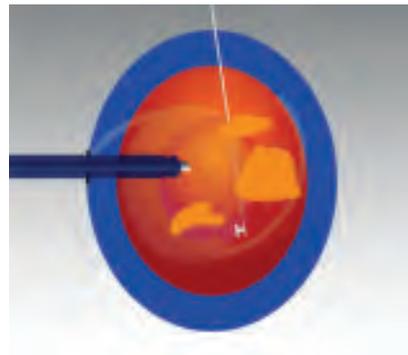


Fig. 4.10. One haptic is kept out, and another instrument supports the IOL.

Alternatively – We can place both the loops above the iris (Fig. 4.11), or else the IOL can be directly placed in the sulcus (Fig. 4.12).

- (d) Check for vitreous again and make sure there is no vitreous in AC.

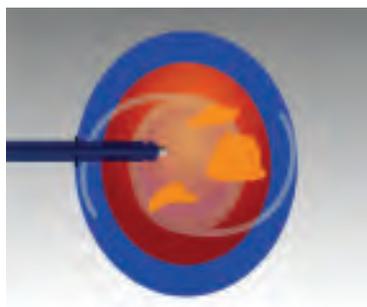


Fig. 4.11. Both the loops are placed above the iris.

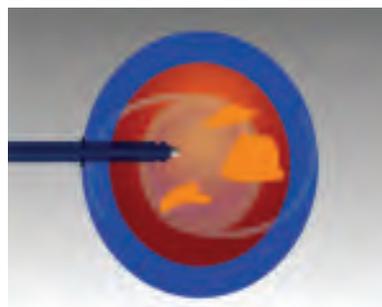


Fig. 4.12. IOL is placed in the sulcus after repositioning the remaining nuclear fragments in the supracapsular area. Phacoemulsification can be done after confirming the absence of vitreous.

- (e) Phacoemulsification: Phaco energy is used to emulsify the nucleus/nuclear fragments.

Advantages of the IOL scaffold technique are as follows:

1. The three-piece foldable IOL as a **scaffold or barrier to compartmentalize the anterior and posterior chamber**, thereby preventing
 - (a) vitreous prolapse,
 - (b) vitreous hydration, and
 - (c) nucleus drop.
2. IOL is **inserted through the existing corneal incision**.
 - (a) Hence maintenance of anterior chamber stability and IOP.
 - (b) Preserving the astigmatic benefits of sutureless, small incision surgery.
3. Same IOL can be used for sulcus or bag fixation, or in cases with absence of adequate capsular support can be used for glued IOL, which will be discussed later.

In cases of hard cataract, the damage to the cornea during phacoemulsification can be there; hence this technique is not advised in such cases.

Conversion to ECCE/SICS

The supracapsular phacoemulsification of nearly complete and comparatively hard nucleus may damage the corneal endothelium

permanently. In such case it is better to convert to SICS/ECCE. Viscompress the eye, give peribulbar or subtenons block, do gentle compression decompression of the orbit by fingers between the globe and inferior orbital margin without applying much force on the globe.

If the **initial incision was temporal**, leave it undisturbed and move superiorly to create a pocket for SICS or a limbal incision for ECCE, according to the size of the nucleus. If the **initial incision was superior**, enlarge the pocket for SICS, whereas for ECCE the scleral pocket is released and incision is enlarged at the limbus. Now the wound configuration will be like the incision which we make for combined ECCE and Trabeculectomy.

Nucleus delivery

- SICS – Bluementhal technique, irrigating wire vectis or surgeon's preferred technique
- ECCE – Chopstick technique

2. EPINUCLEUS

A remaining epinuclear plate in cases of PCT has to be managed very carefully, and should never be taken lightly, as an epinuclear plate falling into the vitreous cavity is much more common than a nucleus falling into the vitreous cavity. Even a small epinuclear plate can lead to intense inflammation, as it takes longer time to absorb, and can lead to various complications such as CME, increased IOP, iris neovascularization, neovascular glaucoma.

Before any manoeuvre, at this stage a proper assessment should be made about the presence or absence of vitreous. It is important to clear the chamber of any vitreous by doing a **good vitrectomy with an automatic cutter**. After clearing most of the vitreous, fill the capsular bag with viscoelastics to open the capsular fornix. The epinuclear plate is tough to remove because it is difficult to hold it with anything.

Relocation of epinuclear plate

1. Use of rounded repositor
2. Use of suction

Rounded repositor

The EPN is mobilized using a rounded repositor, taking counter pressure from the capsular fornices or anterior capsule. Rotating the epinucleus helps to dislodge it from the fornix and prolapse into the anterior-chamber (Figs. 4.1 and 4.2).

Use of suction

With the help of I/A cannula, under low bottle height and low aspiration parameters, the cortical fibres can be held at various places and can be pulled gently to the centre. This leads to the dislodgement of the epinuclear plate, which lies in front of the cortical fibres.

Extraction from eye

1. IOL scaffold technique
2. Viscoexpression
3. Automated vitreous cutter

1. IOL scaffold technique

This technique has already been described in the text.

2. Viscoexpression

Once the EPN has been prolapsed, the technique is same as described for soft cataracts.

3. Automated vitreous cutter

Anterior relocation of the EPN particularly of the sub-incisional area is difficult. While doing removal by vitrectomy cutter, if the fluid is coming from the top, i.e. from the limbus, it may push the EPN into the vitreous cavity. In case of failed relocation of EPN, infusion from the pars plana is recommended, as it will push the EPN forward. Rest of the technique is same as for soft nucleus.

3. CORTEX

Cortex removal can be broadly divided into the following categories:

- Manual
 - Dry – Suck and spit
 - Semi-dry – Simcoe cannula

- Automated
 - Vitrectomy cutter

Dry – Suck and spit

Mechanical suck and spit is a better controlled system than irrigation and aspiration. In a viscopressed chamber, with a 27 gauge cannula mounted on a viscoelastic syringe go underneath the capsulorhexis margin, hold the cortical fibres and do not try to aspirate there, instead hold and pull them out of the incision and then spit (Fig. 4.13). Take the cannula back,



Fig. 4.13. Cortex removal: dry – suck and spit.

and repeat the same process. Sometimes the spitting can be done in the AC and can be removed later. While sucking if the vitreous is caught, spit the cortical matter within the eye, which can be washed afterwards. Sometimes, cortical matter may be removed after insertion of IOL.

Semi-dry – Simcoe cannula (Fig. 4.14)

The chamber is formed with VES and aspiration is done using Simcoe cannula. Always aspirate at the site where there is no vitreous. If need be, another side port may be constructed. A little infusion is required to release the cortical matter. For this purpose, enter with irrigation tube of Simcoe cannula pinched between thumb and forefinger and as and when required, allow the irrigating fluid through. Continuous irrigation should be avoided.



Fig. 4.14. Cortex removal – Simcoe cannula.

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Cortex should be removed by dry aspiration after ensuring that no vitreous is in the chamber.

Automated – Vitrectomy cutter

Best method for handling the cortex in presence of PCT is with a bimanual vitrectomy cutter. The best part of the system is that, on pressing the foot pedal you can change the system into vitrectomy mode or bimanual irrigation and aspiration system. Once inside do vitrectomy and switch to I/A system for cortical aspiration. During this if at any time one feels the vitreous is being held, the surgeon can shift back to vitrectomy mode to cut the vitreous. This causes least traction and best possible cleanup of the cortical fibres.

4. IOL IMPLANTATION

1. No IOL
2. IOL in bag
3. IOL in sulcus
4. Anterior chamber IOL
5. Scleral fixated IOL
6. Iris fixated IOL
7. Glued IOL

1. No IOL

Indications

- Lenticular matter is not cleared adequately.
- Not sure about the capsular support.
- Status of vitreous in AC can't be assessed.
- Nonavailability of instruments or IOLs.

After 2–3 days the cortex becomes fluffy, and vitreous gets organized. So, at this point of time, secondary anterior vitrectomy and removal of lenticulate material becomes easier. In majority of the cases secondary PCIOL insertion is possible as fibrosed capsule is taut and able to support the IOL well, particularly if surgery is delayed for 2–3 weeks or more.

2. IOL in the bag

Indications

- If *hyaloid face is intact*, in the bag fixation of IOL is ideal.

- In case of a *small capsular tear with a good capsular support* where the *hyaloid face has been disturbed* – adequate anterior vitrectomy may make in the bag fixation possible.

Many a time it is difficult to ascertain whether all the vitreous has been cleared or not. In such a situation there are certain techniques which have to be followed for IOL implantation.

- **Inflate the bag with viscoelastics:** Viscoelastics serve as essential adjuncts in such cases. Viscoelastic of choice for this step would be hyaluronic acid (Healon GV). Firstly, they help in maintaining the AC and prevent further prolapse of vitreous. Secondly, they push the already prolapsed vitreous back into the cavity. Finally, due to the inflated capsular fornices it is easier to place the IOL in the bag.
- **Do not dial the IOL:** Dialing the IOL may entangle the vitreous, which may cause traction on the retina and can even enlarge the tear. We will be describing techniques of haptic placement into the bag without dialing the IOL, for PMMA as well as foldable IOL.

A. PMMA IOL

We will be describing 2 techniques here, depending upon the remaining area of capsular support.

1. Pronate and Release
2. Hook and Release

1. Pronate and Release

In cases where there is adequate capsular support in the **cross-incisional area**, place the leading haptic in the bag. Hold the tip of the trailing haptic with a Mepheron forceps. The IOL is pushed down till the loop of the trailing haptic is well beyond the CCC margin. Pronate your hand so that the tip is lifted up and the loop of the haptic dips down. This brings the loop of the haptic underneath the CCC and then the haptic is released.

2. Hook and Release

The IOL is placed over the anterior capsule or iris and positioned in such a way that the haptics come to rest at the site of maximum posterior

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capsular support (Fig. 4.15). Once the IOL has been positioned, the haptics are guided one by one underneath the CCC. Dumbbell-dialer, Sinsky hook or chopper can be used for this purpose.

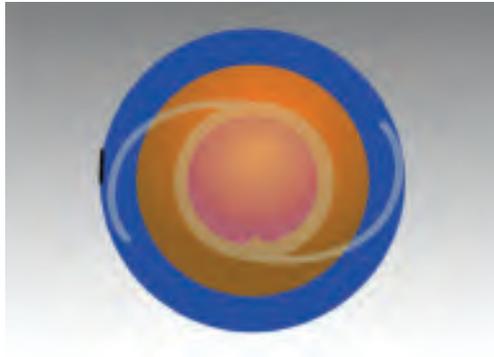


Fig. 4.15. The IOL is placed over the anterior capsule or iris.

In this technique, the dumbbell-dialer is used to hold the haptic close to its apex and is pulled beyond the CCC margin. Now, the dumbbell-dialer along with the haptic is taken underneath the CCC margin. The dialer is disengaged by sliding it sideward (Fig. 4.16), thus positioning the haptic in the bag (Fig. 4.17).

If the visibility is poor, or the rhexis margin is too large or small, another instrument, preferably a Rounded Repositor (RR) can be used

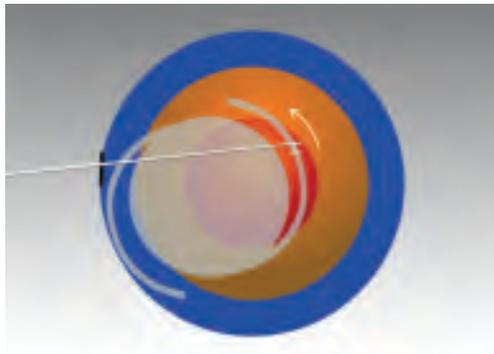


Fig. 4.16. The dumbbell-dialer is used to hold the haptic close to its apex and is pulled beyond the CCC margin. Now, the dumbbell-dialer along with the haptic is taken underneath the CCC margin. The dialer is disengaged by sliding it sideward, thus positioning the haptic in the capsular bag.

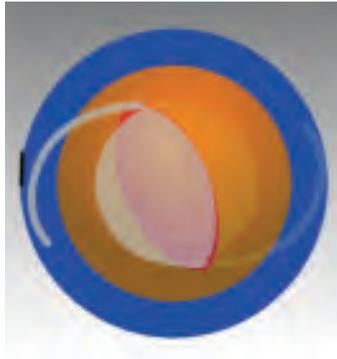


Fig. 4.17. One haptic is inside the capsular bag and other is still outside the bag.

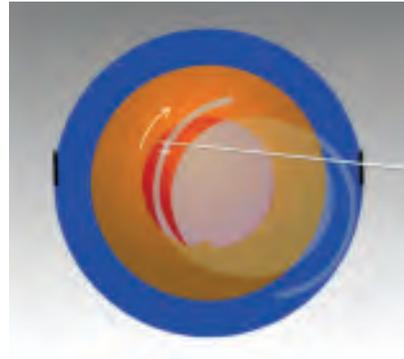


Fig. 4.18. Same procedure is repeated for the second haptic to place it inside the capsular bag.

to guide the haptic underneath the CCC. In this technique the haptic is hooked with the dumbbell-dialer as described previously, the second instrument lifts the CCC, ensuring that the haptic is released into the bag.

Same procedure is repeated for the second haptic (Fig. 4.18). It is ideal to have the entry point of the dialer diagonally opposite to the position of the haptic. Now, if the surgeon feels that he can't access the second haptic from the existing incisions, he can create a new side port incision for this purpose.

GOLDEN RULE

If there is doubt about the stability and centration of the IOL, a 10-0 silk suture can be tied to the trailing haptic for retrieval if needed, which can be cut if IOL is well positioned.

B. Foldable IOL

Three-piece hydrophobic acrylic IOLs are ideal, to be used for bag fixation in cases of a PCT. However, if the hyaloid face is intact any IOL can be used. Holder-folder technique is safer as compared to the injector system, as it ensures a more controlled opening of the IOL.

Fill the anterior chamber and the bag with cohesive viscoelastic (Healon GV), which maintains the AC depth and prevents a jerky opening of the IOL. Using the insertion forceps the IOL is released inside the AC on top of anterior capsule or iris.

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In case using the injector system, make sure that the leading loop remains horizontal inside the eye. This can be achieved by constantly positioning the cartridge by rotation of the injector system. Release the IOL on top of the anterior capsule.

Now, the haptics are positioned into the bag, as described for the PMMA IOLs.

Another technique which should be mentioned here is the technique of optic capture.

OPTIC CAPTURE

The chances of decentration of IOL are high in cases of PCT because of uneven contraction of the capsule. Incomplete anterior vitrectomy increases the incidence of decentration drastically.

To prevent decentration of IOL, optic capture can be done, wherein if the haptics are in the bag, optic is outside the bag (Figs. 4.19 and 4.20) i.e., anterior to CCC and if the haptics are in the sulcus then the optics is posterior to the CCC, i.e., in the bag (Figs. 4.21 and 4.22).

This enables centration and stability of the IOL. There are certain pre-requisites for doing an optic capture; the anterior CCC should be uniform, central and 4–5.5 mm in size.



Fig. 4.19. IOL in the bag.

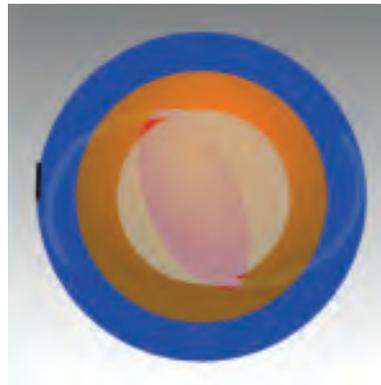


Fig. 4.20. Optics is prolapsed out of CCC into the AC while haptics remain in bag.

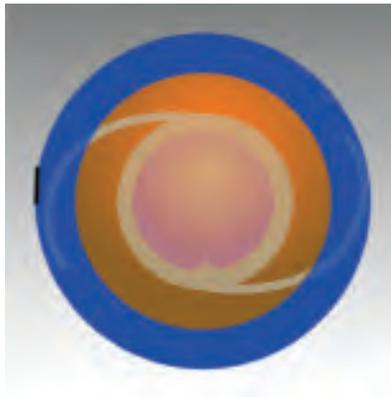


Fig. 4.21. IOL placed in the sulcus.

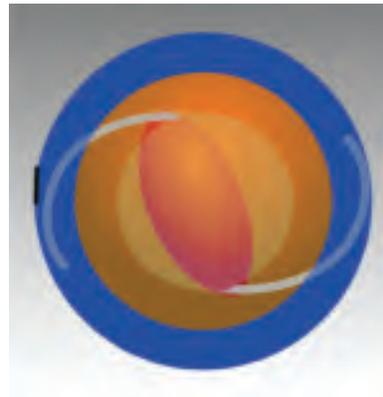


Fig. 4.22. Optic is pushed in the bag and haptic remains in the sulcus.

3. Sulcus fixated IOL

In case of a large PCT with or without a damaged CCC it is better to place the IOL in the sulcus.

CCC is not intact: Best is to choose a large optic PMMA IOL (6.5 mm with an overall diameter of 13 mm).

CCC is intact: If the anterior rhexis is intact and a large posterior capsular tear lies underneath, foldable IOL can be placed in the sulcus with or without a reverse optic capture. After releasing the IOL in the sulcus the optic is gently pressed underneath the anterior rhexis margin (Figs. 4.21 and 4.22).

Single piece foldable IOLs should be avoided when sulcus fixation is planned, as rubbing of the large area of the haptic will lead to increased inflammation and iris chaffing.

4. Anterior chamber IOL (ACIOL)

In case of excessive damage to capsule and zonules, the stability of in the bag or sulcus fixated IOL becomes doubtful. In such cases ACIOL implantation is the easiest and most often performed procedure. Though ACIOL appears to be an inferior technique, in comparison to iris fixated, scleral fixated or glued IOLs, there is no conclusive evidence for the same.

Do not place PCIOL in the AC. PCIOL in the AC can cause fibrosis of the angle structures leading to glaucoma. The angulation of the PCIOL

is unsuitable for the angle. The forward angulation leads to corneal problems and if placed the other way, the backward angulation may lead to pupillary block. ACIOL may cause ciliary tenderness, inflammation, glaucoma, CME and corneal complications such as decompensation; hence regular follow-up is a must.

TECHNIQUE

1. Choose the correct powered ACIOL, which is less than that of PCIOL by 4–5 D, depending upon the A constant.
2. Anterior vitrectomy: Constrict the pupil using 0.5% pilocarpine, inject diluted triamcinolone acetonide (tricot; 1 : 4 dilution) into the AC, so as to stain the vitreous. Anterior vitrectomy is performed to take care of any remaining vitreous.
3. Enlarging the incision: Inflate the AC with viscoelastics and enlarge the incision to 5.5 mm, or to the width of the IOL.
4. Inserting the IOL: The IOL is held with a McPherson forceps, and the leading loop is advanced in the AC. While advancing the leading loop of the ACIOL towards the opposite angle, make sure it does not touch the iris (Fig. 4.23). **In fact the IOL should be kept closer to the cornea, till the loop is about to reach the angle** (Fig. 4.24). This will prevent any distortion or ovalization of the pupil post-operatively.

The convexity of the IOL should always be away from the pupil, to avoid pupillary block. Now the trailing IOL is pushed below the incision.

5. Iridectomy: One or two iridectomies, at the site where there is no vitreous, should be done, preferably with the help of vitreous cutter. This prevents the chances of pupillary block glaucoma.
6. Wound closure: Suturing of the wound is essential, as a shallow AC in presence of an ACIOL can lead to damage to the cornea. When using ACIOLs certain points have to be taken care of:
 - (i) “A constant” of the IOL – lesser power required as compared to a PCIOL
 - (ii) Proper positioning of ACIOL – maintaining forward convexity of the IOL
 - (iii) Need for peripheral iridectomy – should be at a site where there is no vitreous

We usually prefer to wait and insert a secondary PCIOL later, as compared to ACIOL.

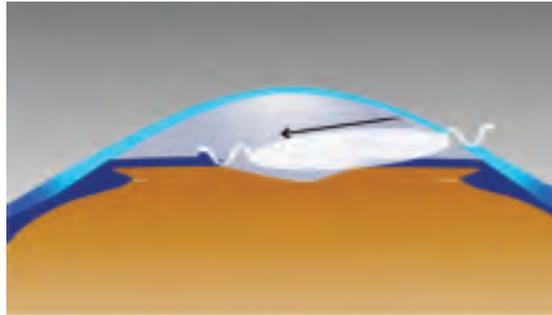


Fig. 4.23. Wrong placement of an ACIOL – If an ACIOL is inserted with a downward direction, its haptic will get stuck in the iris which can lead to an irregular pupil.

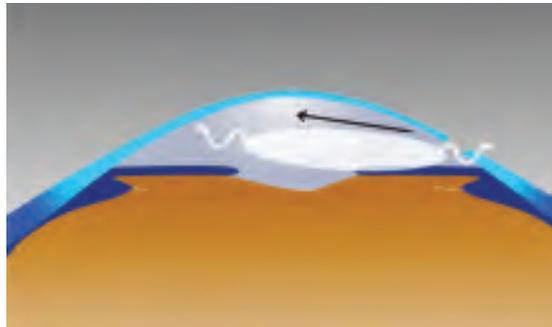


Fig. 4.24. Correct placement of an ACIOL – An ACIOL should be inserted with an upward direction, so that the haptic does not interfere with the iris, and on reaching just before the angle the direction of the IOL is changed.

5. Scleral fixated IOL (SFIOL) (Figs. 4.25–4.31)

Scleral fixation of IOL is a good option if there is inadequate capsular support for bag or sulcus fixation of IOL. Usually specialized IOLs are available for scleral fixation, which have extra eyelets. We need SFIOL and double armed straight needle prolene sutures (9-0/10-0).

If SFIOL is not available, foldable or non-foldable IOL can be used for scleral fixation.

TECHNIQUE

1. 2 points are marked 180° apart, either by RK marker or toric marker (Fig. 4.25).

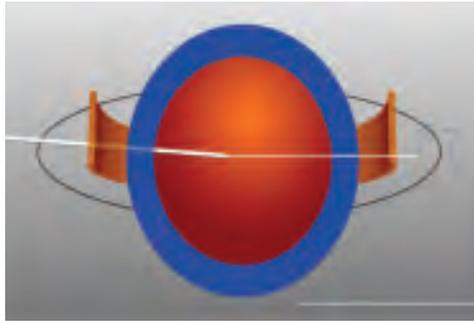


Fig. 4.25. 2 points are marked 180° apart, fornix based conjunctival flaps are raised and light cautery is applied. Limbus based partial thickness scleral flaps are raised, 2.5 × 3 mm and 500 μ in depth. At 1.5 mm from the limbus, through the scleral bed a 26 G needle is passed from one side and a straight 9-0 needle from the other side, which is loaded into the barrel of the 26 G needle in the centre of the eye.

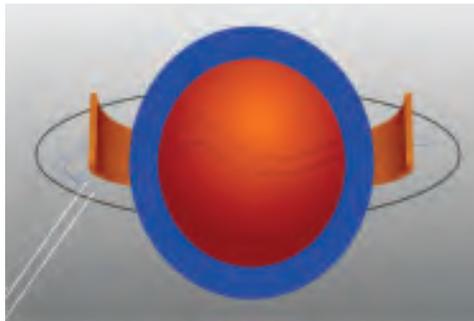


Fig. 4.26. The prolene needle is brought out along with the 26 G needle. Similarly the second arm of the needle is also brought out through the opposite scleral bed. Hence, we have now two threads in the eye.

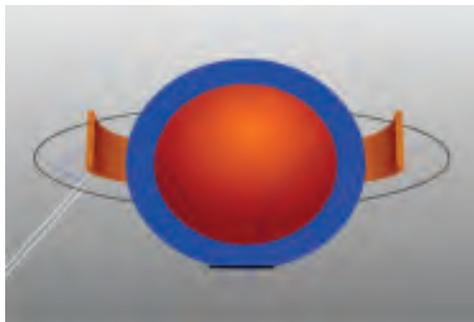


Fig. 4.27. The two threads are brought out through the main wound and cut in between.

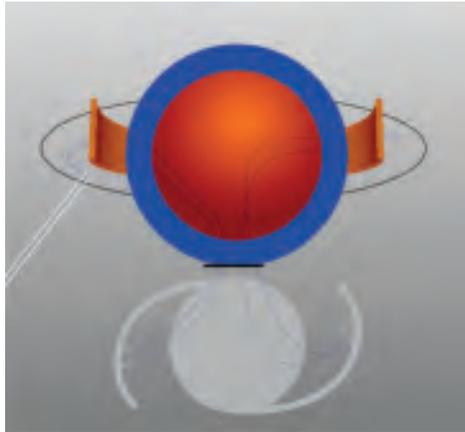


Fig. 4.28. The SFIOL is positioned and the cut ends of threads are tied at the eyelets of the SFIOL on both sides.

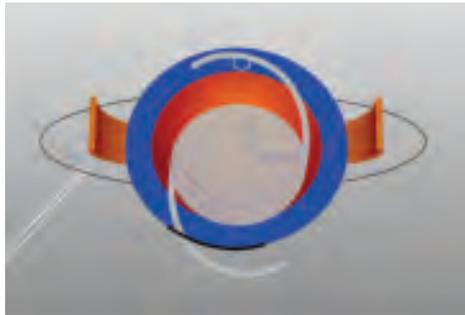


Fig. 4.29. The SFIOL is introduced in the AC.

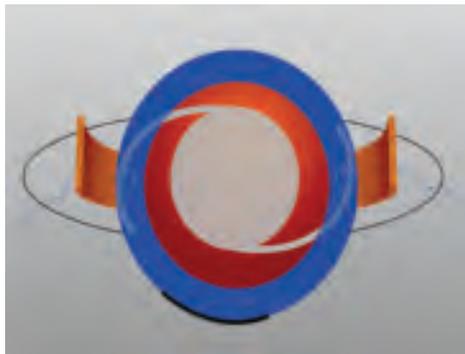


Fig. 4.30. The SFIOL is positioned with slight traction on the threads.



Fig. 4.31. The sutures are tied to the scleral bed. The scleral flaps are sutured, one by one on both the sides. Conjunctiva above is sutured.

2. Fornix based conjunctival flaps are raised and light cautery is applied (Fig. 4.25).
3. Creation of scleral flaps (Fig. 4.25): Two partial thickness quadrangular scleral flaps are created 180° apart at limbus, 3 × 2.5 mm in dimension, as for trabeculectomy.

ALTERNATIVES TO SCLERAL FLAP CREATION

Scleral pockets may be created which may be limbus- or fornix-based.

Alternative 1 – Limbus-based scleral pocket: Instead of making flaps we can make scleral pockets (limbal based pocket), of the same size as we make for phacoemulsification. The advantage of this technique is that scleral flap closure is not required at the end of surgery.

Alternative 2 – Fornix-based scleral pocket:

- Straight 3 mm incisions are given 180° apart at the limbus without removing the conjunctiva.
- 2.5 mm deep pocket is made towards the sclera, making fornix based scleral pocket.
- As the direction of the pocket is opposite to the direction of the needle, it is not possible to insert the needle directly at the base underneath the flap. The needle perforates the conjunctivoscleral upper flap and scleral base to enter the eye.
- The threads are passed and tied into the IOL. Then these threads are pulled out from the scleral pocket by Sinsky hook for tying and burying the knot in the pocket.

This is a little more complicated, with more chances of bleeding, but still a great technique to master as it is faster and requires no cautery and suturing of conjunctiva or scleral flap.

4. Rail road technique (Fig. 4.25):
 - 26 G needle is mounted on the back of a repositor or a chopper.
 - The needle is bent at an angle of 45–60° from its hub.
 - At the junction of the lower 1/3rd and upper 2/3rd of the scleral bed, about 1.5 mm away from limbus, the needle is passed.
 - First we go perpendicular to the globe and then turn the needle in such a way that it comes to lie parallel and just behind the iris. If it tucks the iris, or comes anterior to the iris, the needle can be withdrawn and passed again slightly posterior to the original site.
 - Straight needle of prolene suture is passed through the opposite scleral pocket at the same location.
 - In the centre of the eye, the straight needle is threaded into the barrel of 26 G needle, and both are withdrawn from the side of 26 G needle.
 - Now, similar procedure is repeated, at the junction of upper 1/3rd and lower 2/3rd of the scleral bed (Fig. 4.26).
 - Hence now we have 2 prolene threads in the eye (Fig. 4.26).
5. Placing sutures on the IOL:
 - The 2 prolene threads are brought out through the corneal/limbal incision, which is created for the insertion of IOL, and are cut in the centre (Fig. 4.27).
 - Now, we have two threads on each side of the incision, which have to be tied to respective haptics.
 - For tying, one thread is passed 2–3 times in the eyelet and the other thread is passed from the opposite direction before tying (Fig. 4.28).
 - After securing both the haptics, the leading haptic i.e., the haptic fixed on the right side suture is gently introduced inside the AC, maintaining a slight pull on the prolene sutures. A gentle pull is maintained by the assistant on this while inserting the leading haptic as well (Fig. 4.29).
6. Securing the sutures: Once the IOL is inserted, slight traction is given to the prolene sutures, which are secured onto the sclera after proper centration of the IOL (Fig. 4.30).

7. Suturing the flaps: The partial thickness scleral flaps and the conjunctiva are sutured back to the scleral bed with 10-silk suture (Fig. 4.31).
8. Main incision is closed. Pupil is constricted and diluted tricort is injected in the AC to look for any vitreous. Anterior vitrectomy has to be done if vitreous is present.
9. Corneal wounds are hydrated if foldable IOL is used, or sutured if non-foldable IOL is used.

If especially designed SFIOLs are not available, same procedure can be done with single or 3-piece PMMA IOLs. It is advisable to use ECCE IOL, as compared to the phacoemulsification profile IOL, due to its bigger optics and overall size, though it's not a must.

In case using a foldable IOL, it's possible to do the same procedure with a 3-piece foldable IOLs. The only modification being that, one set of sutures have to be passed through the barrel of the cartridge before securing it on the leading haptic of the IOL. Once the leading haptic is secured, the IOL is injected inside the eye. Trailing haptic is left outside and second set of prolene threads are tied. Now, the trailing haptic is dialed inside the AC. Alternatively the holder folder method of IOL insertion can be used.

6. Iris fixated IOL

Iris fixation of PCIOL

Technique 1 (Figs. 4.32–4.38)

1. Two side port clear corneal incisions, nearly 3'o clock away from the site of the haptic fixation on either side, directing towards each other are made.
2. After releasing the IOL in the AC, both the haptics are placed behind the iris and the optic is kept above the iris.
3. Now pilocarpine is injected into the AC to constrict the pupil.
4. The IOL is lifted up with the forceps (lens holding forceps), to identify the position of the haptics.
5. Now prolene 10-0 is passed through the clear corneal incision behind the iris and haptics and then taken out in front of the iris from the other side. 26 G needle is introduced and by rail road technique needle of prolene thread is brought out.

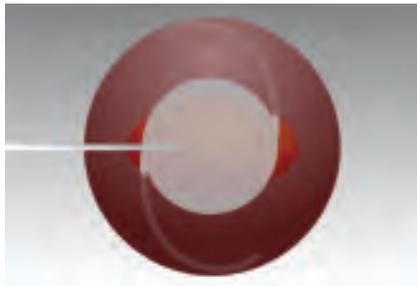


Fig. 4.32. The IOL is positioned such as the optic is above the iris plane and the haptics are behind the iris. Lens holding forceps or a rounded reposer is used to elevate the optic so that the haptics can be appreciated better behind the iris.

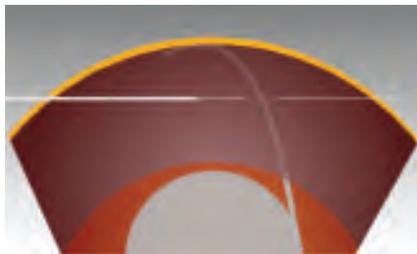


Fig. 4.33. Railroad technique – 9-0 straight needle is passed from the corneal incision going beneath the iris and haptic elevation and re-emerging from the iris soon after. 26 G needle is inserted from the opposite site, and the prolene needle is loaded into its barrel and is brought out of the eye.

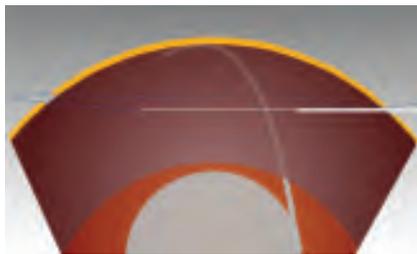


Fig. 4.34. Now the prolene needle is reinserted through the same wound from which it was externalized. 26 G needle is now inserted from the opposite site and again the prolene is loaded into its barrel. This complex is above the iris haptic elevation.



Fig. 4.35. Both threads are externalized from the same wound.

6. Now hands are changed and 26 G needle comes from the opposite CCI and prolene needle is brought out from the other side by railroad technique passing in front of the iris. Thus we have both the threads on one side of the wound one behind and one on top of the iris and lens haptics.

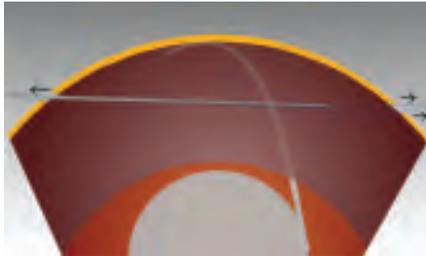


Fig. 4.36. A knot is given and an instrument is introduced from the opposite side, so as to slide the knot to the appropriate position.

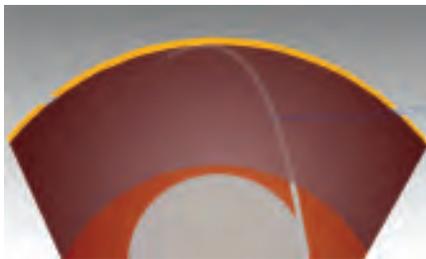


Fig. 4.37. The knot is finalized and the threads cut. Similar procedure is repeated on the opposite haptic.

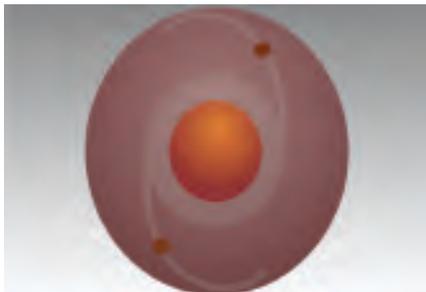


Fig. 4.38. Final position.

7. Now tie the triple knot outside the wound. Push the tied knot into the AC. Sinsky hook or double dialer is introduced from the opposite incision to pull the knot on the iris while maintaining gentle traction in the opposite direction on both the threads outside the eye.
8. Second and third knots are given the same way to firmly anchor the haptic behind the iris.
9. Suture is cut by Vannas just above the iris.
10. Same technique is repeated on the other side.

Technique 2 (Figs. 4.39–4.43)

In this technique only one side port incision is required but it needs 9-0 or 10-0 curved prolene needle. If curved needle is not available

surgeon can make straight needle curved by himself. In this technique instead of using rail road technoiqye surgeon takes out the needle by perforating the cornea from the other side. If the needle is not sharp it becomes difficult. Then threads are brought out as demonstrated in the picture and tied.

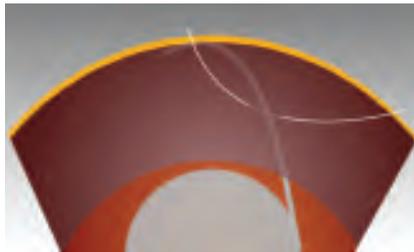


Fig. 4.39. Alternative. A curved 9-0 needle is passed from the corneal incision and behind the iris haptic elevation, and re-emerges soon after. The curved 9-0 needle now re-emerges from the cornea at a different site.

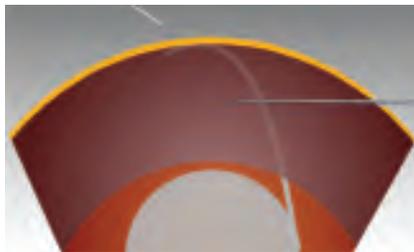


Fig. 4.40. An instrument is used to hook the thread (Siepser's technique).



Fig. 4.41. Now the thread is brought out from the initial wound.

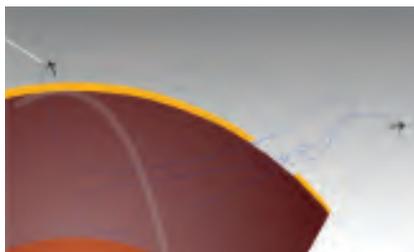


Fig. 4.42. The threads are externalized and a double knot as shown is placed.



Fig. 4.43. The threads are pulled so as to position the knot. A similar knot is placed again by repeating the above steps. The opposite haptic is similarly fixated.

Iris fixation of iris fixated IOL

These IOLs are very easy to fix.

- IOL is placed in the AC over the iris.
- IOL is gripped at the centre, and one end of the IOL is placed behind the iris and lifted up to identify the site of enclavation.
- Having a firm grip at the optics and ensuring the centration of IOL, a fine enclavation rod or an iris reposer pushes the iris tissue down to have a pincer like grasp of the IOL, on the iris.
- Same procedure is repeated on the other side.

7. Glued IOL

The glued IOL technique is a relatively new method for fixing a posterior chamber IOL in an eye without a capsule, which has been popularized by Dr. Amar Agarwal⁷.

TECHNIQUE

1. 2 points are marked 180° apart, fornix based conjunctival flaps are raised and light cautery is applied (Fig. 4.44). It is essential to mark, as improper placement of haptics can lead to a decentered IOL.
2. After light cautery, limbus based partial thickness scleral flaps are raised, 2.5 × 3 mm and 500 μ in depth (Fig. 4.44).
3. Main port is made for insertion of IOL, which depends upon the type of IOL we will be placing. Foldable IOLs are preferred over non-foldable IOLs, as a sutureless surgery with a limbal or clear corneal incision is possible.
4. Choice of IOL: Any 3-piece IOL would be preferable. AMO Sensor IOL is a very good option, because of the slow release of the IOL through the cartridge.

5. Formation of AC: When we are going to place the IOL the eyeball has to be reasonably pressurized either by:
 - (a) Viscoelastics
 - (b) Anterior chamber maintainer – through limbus
 - (c) Infusion via pars plana route – if pars plana vitrectomy is done, for removal of dislocated nucleus, the infusion port can be used for the IOL implantation.

6. IOL insertion and externalization of haptic: V-Lance knife is introduced at the base of the bed of the scleral flap 1.5 mm from the limbus (Fig. 4.45). The V-lance should be just behind the iris, and if by any chance it is in front of the iris it can be positioned again so that it enters the eye behind the iris. Same procedure is repeated on the other side. This wound is used both to introduce the vitrectomy pick or MST forceps in the eye as well as to externalize the haptic.

Foldable IOL is loaded and advanced to an extent that a small tip of the haptic is outside the cartridge. Cartridge is passed into the AC by the surgeon; the assistant holds the exposed tip by MST forceps. Surgeon injects the IOL and assistant externalizes the leading haptic and holds it there (Figs. 4.45 and 4.46).

The commonest mistake that occurs here is breakage, damage or distortion of the haptic, if the forceps is not holding the tip of the haptic or there is loosening of the grip due to poor quality of the forceps.

A firm grasp is maintained by the assistant on the externalized haptic so that it does not become internalized due to traction on the trailing haptic (Fig. 4.47). Now, a MST forceps is placed inside the AC, and another MST forceps holds the trailing haptic of the IOL, close to the tip and brings it into the AC (Fig. 4.48). Now, another forceps holds the tip of the haptic and externalizes it (Fig. 4.49).

7. Haptic fixation: The haptic needs to be placed into a pocket made at the same level as the base of the flap, in the direction of the natural direction of the haptic (Fig. 4.44). 26 G needle or V-lance can be used to create a scleral pocket, on both sides, in which the loop can be guided in (Fig. 4.50). Because of good IOP, it's easier to create these pockets before entering the AC.

IOL centration is checked; a little pull on the haptic to readjust the IOL may be required.

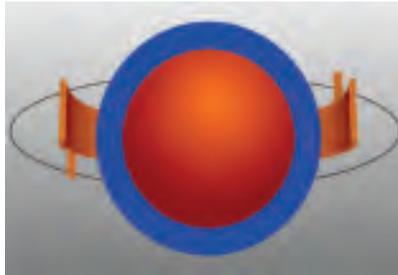


Fig. 4.44. 2 points are marked 180° apart, fornix based conjunctival flaps are raised and light cautery is applied. Limbus based partial thickness scleral flaps are raised, 2.5 × 3 mm and 500 μ in depth. 26 G needle or V-lance is used to create a scleral pocket, on both sides, in which the loop can be guided in later.



Fig. 4.45. V-Lance knife is introduced at the base of the bed of the scleral flap 1.5 mm from the limbus. This wound is used both to introduce the MST forceps in the eye as well as to externalize the haptic. Surgeon injects the IOL and the assistant holds the leading haptic with MST forceps.



Fig. 4.46. Now the assistant externalizes the leading haptic and holds it there.



Fig. 4.47. One MST forceps is placed inside the AC, and another MST forceps holds the trailing haptic of the IOL, and brings it into the AC.



Fig. 4.48. Now the MST forceps are relocated to the tip of the haptic after pulling the haptic with another MST forceps.



Fig. 4.49. The loop is externalized.

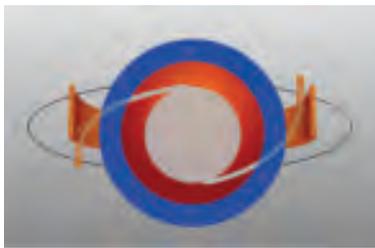


Fig. 4.50. Both the loops are guided into the scleral pockets with the help of MST forceps.



Fig. 4.51. Glue is applied at the base of the flap and scleral flaps are pressed and stuck over it, one by one on both the sides. Conjunctiva above can be sutured or can be fixed with glue.

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8. Glue fixation: Once the IOL is in centre, glue is applied at the base of the flap and scleral flaps are pressed and stuck over it, one by one on both the sides (Fig. 4.51). Glue provides strong closure over the area and also closes the V-lance opening. Conjunctiva above can be sutured or can be fixed with glue.
9. After the IOL has been positioned, pupil is constricted and any vitreous is looked for. Tricort can be used to stain the vitreous. If present a thorough vitrectomy is done.

SPECIAL POINTS

1. 3-Piece IOL with prolene haptic preferred.
2. Single piece PMMA IOLs can also be used – though more chances of breakage.
3. Large optic PMMA IOLs preferred.
4. In case of a dropped IOL: The IOL can be brought into the AC after thorough pars plana vitrectomy. The haptics are held and externalized as described earlier.

Advantages of glued IOL

- (i) Better fixation
- (ii) Better centration
- (iii) Pseudo tilting
- (iv) No phacodonesis
- (v) Faster technique.

Disadvantages of glued IOL

- (i) Special forceps needed
- (ii) Glue needed
- (iii) Higher cost due to glue and special forceps.

Summary

Choice of IOL depends upon the extent of the capsular damage, the availability of IOLs, instruments and the expertise of the surgeon. If reasonable centration of the IOL can be ensured, then in the bag fixation or sulcus fixated IOL, with or without optic capture would be ideal.

If there is extensive capsular damage, then we have no choice but to go for ACIOL, SFIOL, Glued or Iris fixated IOL. ACIOL is the fastest,

easiest and can be done even without proper vitrectomy, as insertion of ACIOL causes least pull on the vitreous. Secondary vitrectomy can be performed if there is increased IOP, inflammation, distortion of the pupil, CME etc. Specifically designed Iris fixated IOL are also a good option, because the time taken is same as for ACIOL.

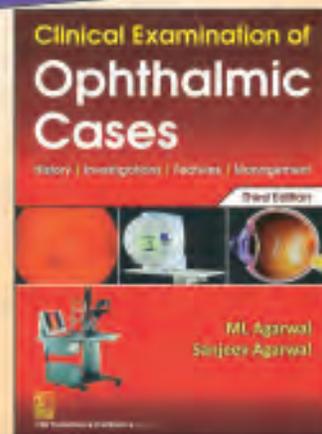
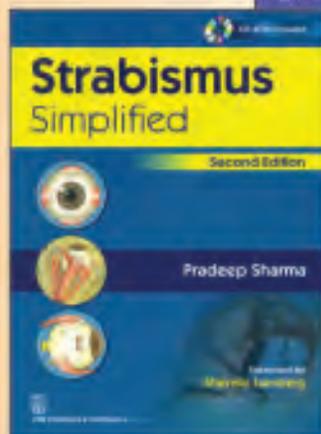
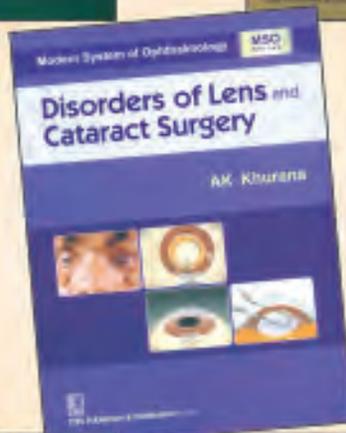
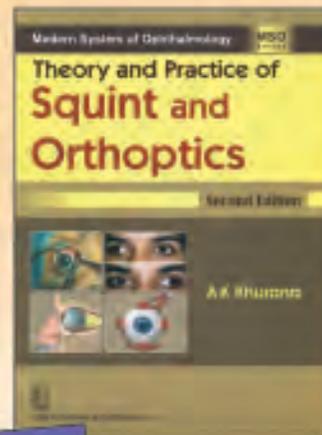
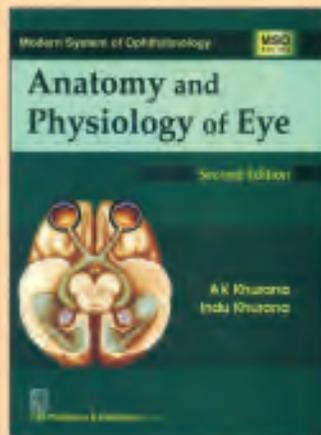
Ideal technique in such cases, as of now, looks to be the glued IOL, which provides excellent centration and fixation, with no pseudo-phacodonesis. This technique needs special instruments and glue which are expensive. SFIOL serves the same purpose but is more time consuming.

5. FINAL VITRECTOMY AND CLOSURE

It is very important to ensure that there is no vitreous in the wound or AC. After putting the IOL constrict the pupil with preservative-free intracameral pilocarpine and inject diluted Tricort in the AC. Final vitrectomy is done by removing each and every strand of the vitreous. At this time a small iridectomy can also be performed with vitrectomy cutter.

Closure

It is absolutely important to have watertight wound in case of PCT⁸. The incidence of endophthalmitis is higher in patients with PCT. Not only one should suture the main incisions but also large, distorted and leaking side port.





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The experienced cataract surgeon may be competent to continue with surgery in the presence of a posterior capsular tear. However, once it has been identified that a nuclear fragment has dropped into the vitreous cavity, it should be accepted that referral to a vitreoretinal surgeon will be necessary.

ROLE OF CATARACT SURGEON

The preoperative management of eyes with posteriorly dislocated lens matter begins in the hands of the cataract surgeon. The posterior segment surgeon would require corneal clarity and good visibility in order to remove the posteriorly dislocated lens matter, and the anterior segment surgeon's initial management should facilitate this. A few basic guidelines for the cataract surgeon are:

- Do not chase after the falling nuclear fragments and avoid unnecessary manipulations, in order to avoid vitreous traction and a consequent retinal detachment or CME. If retinal detachment occurs, a simple surgery will become unnecessarily complicated.
- Do an anterior vitrectomy and ensure that there is no vitreous in the wound. If the required instrumentation to do a good anterior vitrectomy is not available then it should be left for the posterior segment surgeon to do it.
- If soft lens matter is present in the anterior chamber it should be carefully removed with the suction mode of the cutter after doing

anterior vitrectomy. It is important to retain good capsular support, and in case it is difficult to clear the residual lens matter in the anterior chamber it should be left for the posterior segment surgeon who would be able to remove it more easily from the posterior approach.

- Avoid unnecessary damage to the corneal endothelium and iris to prevent corneal haze and inflammation.
- IOL placement: In previous years, dropped nuclei had to be removed from the limbal route after bringing them to the anterior chamber. Now with the availability of the fragmatome it is possible to safely emulsify them within the vitreous cavity and removal through the anterior route is very rarely done except sometimes in case of an exceptionally rock hard black cataract. Therefore, the cataract surgeon should implant an IOL (in the sulcus with optic capture, scleral fixated, or glued), but only if it is stable. If the stability or centration of the lens is questionable, it should not be implanted. Insertion of an ACIOL should also be avoided before pars plana lensectomy to avoid the risk of its posterior dislocation and corneal damage.
- In case the intraocular lens dislocates into the vitreous after implantation, do not try to remove it, as traction on vitreous base may cause retinal tear/RD. Also, do not place a second IOL if the first one is in the vitreous.
- Suture the corneal wound with 10-0 nylon, even if it appears to be “self-sealing”, to ensure a stable, non-leaky chamber for the posterior segment surgeon. If necessary suture the side port as well.
- Start frequent corticosteroid antibiotic drops and cycloplegic drops and make sure the intraocular pressure is well controlled.

Every cataract surgeon should have an **arrangement for referral**, with a vitreoretinal surgeon and establish a protocol regarding the initial management of the patient. In case a vitreoretinal surgeon is available in the same hospital, and provided there is adequate corneal clarity, the pars plana lensectomy can be done in the same sitting as the cataract surgery. In case a vitreoretinal surgeon is not available, or if the cornea is hazy the surgery can be deferred for as long as 3 weeks with no difference in the visual outcomes.

The information that would be helpful for the vitreoretinal surgeon includes the amount and type of retained lens matter, any manoeuvres performed while attempting to retrieve it, the hardness of the lens matter, the presence or absence of intraocular lens, the amount of capsular support and the calculated IOL power in case an IOL has not been implanted.

ROLE OF POSTERIOR SEGMENT SURGEON

The vitreoretinal surgeon first needs to assess the patient and make a judgement about the amount and hardness of lens matter present and the urgency with which intervention is required.

INITIAL EXAMINATION

The cataract wound should be checked for any leak. The corneal clarity with particular reference to Descemet's fold is assessed and AC reaction and intraocular pressure evaluated. Indirect ophthalmoscopy will confirm the presence of lens matter in the vitreous cavity. Cortical matter will appear white and fluffy and nuclear matter will appear yellowish brown with well-defined borders, unless it is surrounded by cortical matter. The examination should also look for peripheral retinal tears, retinal detachment or choroidal detachment.

In case direct visualization of the fundus is not possible due to corneal haze, severe AC reaction, lens matter in the pupillary area or associated vitreous hemorrhage, a B Scan ultrasonography should be done. The lens matter would appear hyperechoic and may show acoustic shadowing and mobility with ocular movement.

INDICATIONS FOR SURGERY

The complications of a dropped nucleus may include raised intraocular pressure (IOP), uveitis, corneal edema, cystoid macular edema, and retinal detachment. Therefore, with improved instrumentation, in the present era, even the smallest nuclear fragment is preferably removed.

Sometimes, eyes with a small amount of cortical matter may be treated conservatively provided there is no inflammation and rise of intraocular pressure. However, they would need a close and prolonged follow up, as delayed uveitis, secondary glaucoma and CME may occur and require a late pars plana vitrectomy with removal of the lenticular matter.

TIMING OF SURGERY

In case adequate corneal clarity is present and a vitreoretinal surgeon is available, the removal of lens fragments should not be delayed. If the cornea is hazy and would interfere with visualization, the surgery would have to be deferred till the cornea regains its clarity. Delaying it by 2 to 3 weeks will not cause any damage to the eye, as long as inflammation and IOP are controlled.

Eyes with retinal tears, retinal detachment, uncontrolled intraocular pressure or severe inflammation will need early intervention.

OPERATIVE TECHNIQUE

The management of posteriorly dislocated lens matter by the vitreoretinal surgeon entails –

1. Pars plana vitrectomy
2. Removal of retained lens matter
3. Intraocular lens management
4. Management of associated complications e.g. Dropped IOL, Retinal detachment.

1. PARS PLANA VITRECTOMY

A three port pars plana vitrectomy (PPV) is the procedure of choice in eyes with retained lens matter and the standard of care today is microincision vitreous surgery (23 G or 25 G). One of the ports has to be enlarged to 20 G in case a fragmatome needs to be used (23 G fragmatome is not easily available as yet).

Before starting vitrectomy, ensure a well-sealed cataract wound and a stable anterior chamber, so that there is no chamber collapse and iris prolapse during insertion of the cannula as well as during the surgery. In case the wound is leaky do not hesitate to give additional sutures.

Port creation – The 23 G microcannulae are inserted through the conjunctiva (3–4 mm posterior to the limbus) using a trocar, in a two-step entry. After insertion through the sclera, the microcannulae are held by the collar to stabilize them while withdrawing the trocar. The first microcannula is inserted into the inferotemporal quadrant, and the infusion cannula is inserted into the external opening of the micro-

cannula. The infusion is turned on only after visualizing the tip of the microcannula in the vitreous cavity. Two other microcannulae are inserted in the superotemporal and superonasal quadrants for a three port vitrectomy.

If lens matter in the pupillary axis prevents visualization of the infusion cannula, a 23 G butterfly cannula connected to an infusion bottle can be introduced through one of the superior ports and the vitreous cutter used through the other port to clear the lens matter in the pupillary area. The infusion is opened once the infusion cannula can be visualized in the vitreous cavity.

Anterior vitrectomy

The vitrectomy probe is first advanced to the pupillary area to cut any bands of vitreous in the anterior chamber connecting with the posterior vitreous. The lens matter retained under the iris, within the residual lens capsule, is removed with suction mode of the probe. Care should be taken not to damage the capsule in order to facilitate future IOL implantation. If an IOL has already been implanted, the cortical matter surrounding it should be removed, and vitrectomy done just below the lens. Next focus on the posterior segment. Visualisation during surgery may be hampered by corneal edema or a small pupil. The pupil can be dilated using adrenaline, mechanical stretching, hooks or pupillary expansion devices. Wide angle viewing systems are used to give a proper view. First try to visualize the dropped lens fragments and their relation to the vitreous as well as the status of the posterior hyaloid, before starting vitrectomy.

Core vitrectomy

Start by removing the central vitreous (core vitrectomy). Also clear the vitreous immediately in front of the ports, and then assess whether a PVD is present or not.

PVD induction

If not present, a PVD should be induced at this stage, if possible, by positioning the cutter just in front of the optic disc and then increasing the suction to engage the posterior hyaloid. The cutter is then drawn up slowly, keeping the maximum suction. If PVD is induced a shiny reflex will be seen moving forward together with the vitreous cutter. This manoeuvre may have to be repeated several times before a PVD is

induced. Triamcinolone acetonide can be used to stain the vitreous before PVD induction for better identification and a complete removal. A bulky nucleus sitting on the cortical vitreous may not allow PVD induction at this stage. In this case it can be done towards the end, after removing the nucleus.

2. REMOVAL OF RETAINED LENS MATTER

Removal of small or soft lens fragments

These can be removed with the cutter (approx 800 cuts/min). The light pipe can be used to crush the pieces and feed them into the cutter. For cortical matter suction alone may be used intermittently.

Removal of large / hard nuclear fragments or entire nucleus

A special phacofragmatome is used in these cases. A phacofragmatome is similar to a phaco probe without an infusion sleeve and has a longer needle length. As the fragmatome is 20 G (23 G fragmatome is not easily available), one of the superior sclerotomies has to be enlarged with a 20 G MVR blade, after making a localized peritomy.

Before the nucleus is tackled with the fragmatome it should be ensured that a complete vitrectomy has been done and the nucleus is completely free from any vitreous. This is to avoid any vitreous fibrils from being sucked into the fragmatome and causing vitreous traction. Following this the softer epinuclear matter present around the nucleus is aspirated with the cutter to uncover the hard centre.

The phacofragmatome is then introduced into the vitreous cavity. Aspiration alone is used to engage the nucleus/nuclear fragments and gently lift them from the posterior vitreous cavity. Once they are elevated into the mid vitreous cavity the ultrasound power is turned on to emulsify them.

Settings for phacofragmatome

- **Power:** 20% to 50% depending on the hardness of the nucleus. Use minimum power required to prevent chattering and flying of the nuclear pieces away from the fragmatome tip.
- **Vacuum:** 150–200 mm Hg. Increase the bottle height before starting phacofragmentation to prevent hypotony, as it has a large bore size.

- **Mode:** Pulse mode with 10–20 pulses/min. The pulse mode also prevents repulsion of the nuclear fragments. As there is no capsular bag to provide counter resistance the nuclear pieces tend to be repelled by the ultrasonic energy and repeatedly fall back.

The endoilluminator can be used to support the nucleus from behind while it is being emulsified. A good technique is to spike the nucleus on the endoilluminator and in a cartwheel manner use the fragmatome to emulsify the nucleus. Try to work towards the light pipe without dislodging it, so that there is minimal need for reengaging the nucleus. (A lighted pick can also be used to stabilize the nucleus instead of the endoilluminator.) If the fragmatome tip goes through and through into the nucleus, the endoilluminator can be used to push it off the nucleus. It can also be used to crush and feed smaller fragments into the port.

In case the fragments fall down, stop suction immediately to prevent hypotony, and activate it only when the tip is occluded by a fragment. If milky fluid is released during fragmentation then wait for a moment for the media to clear up before continuing.

Alternative technique – A fluid needle can be used to aspirate and hold the nuclear pieces in the mid vitreous cavity while it is emulsified by the fragmatome. A chandelier light is used for illumination.

Sometimes if a PVD has not been induced before, small lens pieces get stuck to the posterior hyaloid. A PVD should be induced at this stage. When these pieces are lifted up with the posterior hyaloid they can be removed with the cutter. Very small pieces stuck to the retinal surface can also be removed with the fluid needle. In the end a peripheral examination with scleral depression should be performed and a peripheral vitrectomy done to eliminate peripheral vitreous traction. Also check for small pieces that can get entrapped at the vitreous base. In case a break/tear is detected, endolaser should be done around it. After all the retained lens matter is removed, the anterior chamber should be irrigated to remove any fragments that may be trapped in the angle. It is important to remove all of the lens fragments to prevent post-op inflammation, phacolytic glaucoma or CME.

Role of Adjunctive Perfluorocarbon Liquid (PFCL)

Some surgeons prefer to inject a small amount of PFCL after vitrectomy and before using the fragmatome, for the following purposes:

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1. It protects the macula from contusion injuries which may be caused by the impact of lens pieces that fall posteriorly during fragmentation.
2. It causes the lens pieces to float on its surface, reducing risk of retinal damage during manipulating these pieces off the retinal surface.
3. It forms a protective layer over the posterior pole and may reduce the risk of damage from the ultrasonic energy of the phacotome.

Only a small amount of PFCL should be injected, to extend till the arcades. Overfill can hamper with removal, because the meniscus of the bubble tends to cause displacement of the lens fragments towards the retinal periphery and vitreous base, making their retrieval difficult. Care should be taken to remove all the PFCL at the end of the surgery.

Removal of Rock Hard Black cataracts

In case of a rock hard black cataract where a prolonged and difficult phacofragmentation is expected, or in cases where the fundal view is compromised due to a hazy cornea, the nucleus can be brought into the AC and then delivered from a limbal incision. An adequate sized limbal corneal incision is first made and then sutured with 10-0 nylon. After core vitrectomy and PVD induction, PFCL is injected upto the level of sclerotomies (two vials would be needed for this) so that the nucleus is pushed up to the level of the pupil. Viscoelastic is then injected into the AC and the nucleus is manoeuvred into the AC using a membrane pick introduced from the pars plana incision and another instrument from the paracentesis. Limbal sutures are then cut to deliver the nucleus. Surgery is completed with resuturing of limbus, completion of vitrectomy and removal of PFCL.

3. IOL MANAGEMENT

After closing the two superior ports, the infusion is left in place in case an IOL is to be implanted, and removed only after IOL implantation. If an IOL was inserted at the time of cataract surgery, it may require repositioning, if decentered. Sometimes, more than one IOL may be encountered in such eyes – these need to be removed through the limbus. If an IOL was not placed it can be inserted now into the sulcus. In case inadequate capsular support is present, a scleral fixated or glued IOL can be considered. ACIOL can also be inserted provided the pupil constricts well with pilocarpine.

If there is significant corneal edema, choroidal detachment or haemorrhage, the IOL placement should be deferred.

4. MANAGEMENT OF ASSOCIATED COMPLICATIONS

Dislocated IOL with retained lens matter

Posteriorly dislocated IOL along with a dropped nucleus may occur due to improper identification of capsular damage or due to incorrect positioning of the lens. The IOL is tackled after removal of the dropped lens matter and is either repositioned or explanted.

The IOL can be lifted with a retinal pick forceps and brought into the anterior chamber. If a three-piece IOL is present, it can then be manipulated into the sulcus if adequate capsular support is present, or may be glued to the sclera if the capsule is inadequate. Single piece IOL or IOLs with broken haptics or plate haptics are generally explanted and replaced with the appropriate IOL.

Retinal detachment

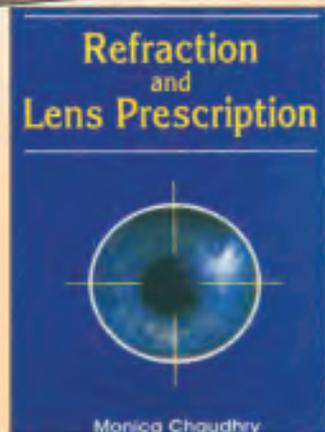
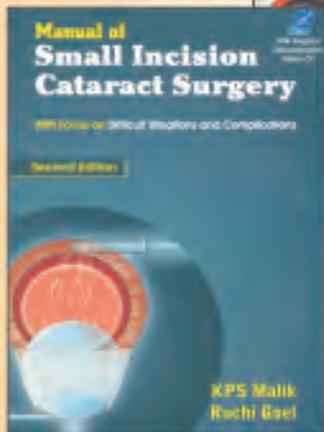
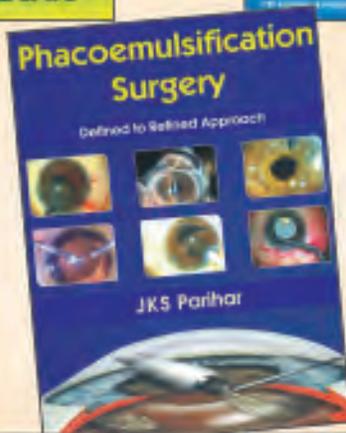
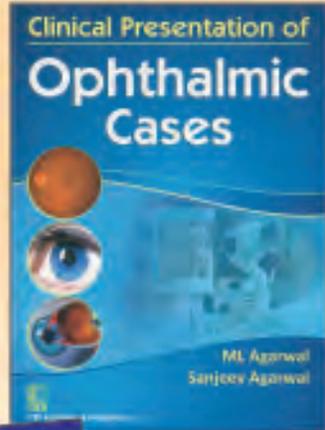
If the eye with the dislocated lens fragments also has an associated rhegmatogenous retinal detachment and/or choroidal detachment, PFCL is injected after doing a vitrectomy to flatten the retina. After doing a vitrectomy, perfluorocarbon liquid (PFCL) is injected to flatten the retina. The lens matter floats over the PFCL and can be removed in the anterior vitreous with the fragmatome. After removal of the lens, endolaser is performed around the break. PFCL air exchange is done followed by gas or silicone oil injection.

POST-OPERATIVE MONITORING

After removal of retained lens matter the patient should be closely followed for signs of inflammation, increase in IOP, CME and signs of peripheral retinal tears or detachment are managed appropriately.

PROGNOSIS

A good percentage of patients (44% to 68%) obtain 6/9 or better visual acuity after pars plana vitrectomy done for the management of retained lens matter. Improved surgical techniques and instrumentation have improved the safety and visual outcomes of this procedure.





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P C T
MANAGEMENT

Suggested Readings

- Manual of Phaco Technique, Text and Atlas, by Dr. Harbansh Lal.
- A Guide to phacoemulsification: AIOS CME series (No. 21). Dr. Harbansh Lal.
- Phacoemulsification: Principles and Techniques, 2nd Ed., Lucio Buratto.
- Phacodynamics: Mastering the Tools and Techniques of Phacoemulsification Surgery, Barry S. Seibel.
- Mohammad Zare et al. Risk Factors for Posterior Capsule Rupture and Vitreous Loss during Phacoemulsification. *J Ophthalmic Vis Res.* 2009 October; 4 (4): 208–212.
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- Complications in Phacoemulsification: Avoidance, Recognition and Management, William J. Fishkind.
- Posterior Capsular Rupture: A Practical Guide to Prevention and Management, Amar Agarwal.
- Preoperative neodymium:YAG anterior capsulotomy in intumescent cataract: preventing extension of the capsular tear to the lens periphery. PMID: 12954318.
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