GLUED PC IOL IMPLANTATION WITH INTRALAMELLAR SCLERAL TUCK IN EYES WITH DEFICIENT CAPSULE

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INTRODUCTION
Posterior capsular rent (PCR) \(^1\rightarrow^2\) can occur in early learning curve in phacoemulsification. Intraoperative dialysis or large PCR will prevent intraocular lens (IOL) implantation in the capsular bag. Implantation of IOL in the sulcus will be possible in adequate anterior capsular support. The first glued PC IOL implantation in an eye with a deficient capsule was done by the authors on 14th of December 2007. In eyes with inadequate anterior capsular rim and deficient posterior capsule, the new technique of IOL implantation is the fibrin glue assisted sutureless IOL implantation with scleral tuck.\(^3\)\(^4\)

SURGICAL TECHNIQUE
Under peribulbar anesthesia, superior rectus is caught and clamped. Localized peritomy and wet cautery of the sclera at the desired site of exit of the IOL haptics is done. Infusion cannula or anterior chamber maintainer is inserted. If using an infusion cannula, one can use a 23 G sutureless trocar and cannula. Positioning of the infusion cannula should be preferably in inferonasal quadrant to prevent interference in creating the scleral flaps. Two partial thickness limbal based scleral flaps about 2.5 mm × 3 mm are created exactly 180 degrees diagonally apart (Figures 1A and B). This is followed by 23 G vitrectomy via pars plana or sclerotomies with a capsule was done by the authors on 14th of December 2007. In eyes with inadequate anterior capsular rim and deficient posterior capsule, the new technique of IOL implantation is the fibrin glue assisted sutureless IOL implantation with scleral tuck.\(^3\)\(^4\)

FIBRIN GLUE
The fibrin kit the author used is Reliseal (Reliance Life Sciences, India). Another widely used tissue glue namely Tissueal (Baxter) can also be used. The fibrinogen and thrombin are first reconstituted according to the manufacturer’s instructions. The commercially available fibrin glue that is virus inactivated is checked for viral antigen and antibodies with polymerase chain reaction; hence the chances of transmission of infection are very low. With tissue derivatives, there is always a theoretical possibility of transmission of viral infections.

Reconstitution of Reliseal
It is available in a sealed pack, which contains freeze dried human fibrinogen (20 mg/0.5 ml), freeze dried human thrombin (250 IU/0.5 ml), aprotinin solution (1500 KIU in 0.5 ml), one ampoule of sterile water, four 21G needles, two 20 G blunt application needles and an applicator with two mixing chambers and one plunger guide. First, the aprotinin solution is taken in a 2 ml sterile syringe and mixed with the freeze dried fibrinogen and is then shaken by slow circular motion. The reconstituted vial is then placed in a preheated water bath of 37 degrees for not more than 10 minutes. Next, about 0.5 ml of water for injection is aspirated and injected into the vial of freeze dried thrombin followed by gentle agitation of the vial. Reconstitution is considered complete when no undissolved particles are visible. Both the reconstituted fibrinogen and the thrombin are loaded separately in two 2 ml sterile syringes and mounted on to the Reliseal applicator for use.

Then, the reconstituted fibrin glue thus prepared is injected through the cannula of the double syringe delivery system under the superior and inferior scleral flaps. Local pressure is given over the flaps for about 10-20 seconds for the formation of fibrin polypeptides.

Special Situations
In case of those patients who had a luxated IOL, similar lamellar scleral flaps as described earlier are made and the luxated IOL haptic is then grasped with the 23/25 gauge microforceps and externalized and glued under the sclera flaps (Figures 5A and B).

Advantages
This fibrin glue assisted sutureless PCIOL implantation technique would be useful in a myriad of clinical situations where scleral fixated IOLs are indicated, such as luxated IOL, dislocated IOL, zonulopathy or secondary IOL implantation.

No special IOLs: It can be performed well with rigid PMMA IOL. 3 piece PC IOL or IOLs with modified PMMA haptics. One, therefore, does not need to have an entire inventory of special SFIOLs with eyelets, unlike in sutured SFIOLs. In dislocated posterior chamber PMMA IOL, the same IOL can be repositioned, thereby reducing the need for further manipulation. Furthermore, there is no need for newer haptic designs or special instruments other than the 25 gauge forceps.

No tilt: Since the overall diameter of the routine IOL is about 12–13 mm, with the haptic being placed in its normal curved configuration and without any traction, there is no distortion or change in shape of the IOL optic (Figure 6). Externalization of the greater part of the haptics along its curvature stabilizes the axial positioning of the IOL and thereby prevents any IOL tilt.\(^5\)

FIGURES

**FIGURES 3A AND B:** Reconstituted fibrin glue (FG) injected beneath the scleral flaps over the haptics and scleral flaps (sf) closed

**FIGURES 4A TO C:** (A): Preoperative slit lamp image showing anterior subluxated IOL, (B): Day one postoperative period, (C): Three months after surgery

**FIGURES 1A AND B:** Scleral flaps (sf) of 2.5 × 3 mm made about 1.5 mm from the limbus. Two flaps 180 degrees diagonally apart

**FIGURES 2A AND B:** Image showing sclerotomy made with 22 G needle beneath the flaps Haptics exteriorized by 25 G forceps beneath the scleral flaps (sf)
Less pseudophacodonesis: When the eye moves, it acquires kinetic energy from its muscles and attachments and the energy is dissipated to the internal fluids as it stops. Thus,

fibrosis acts like a firm scaffold around the haptic which prevents movement along the long axis (Figure 9A). To further make the IOL rock stable, the author has started tucking the haptic tip into the sclera wall through a tunnel. This prevents all movement of the haptic along the transverse axis as well (Figure 9B). The stability of the lens first comes through the tucking of the haptics in the scleral pocket created. The tissue glue then gives it extra stability and also seals the flap down. Externalization of the greater part of the haptics along its curvature stabilizes the axial positioning of the IOL and thereby prevents any IOL tilt.

Steps of Surgery for a Glued IOL
It is to look at the various steps of surgery for a glued IOL (Figures 10 to 38). This shows the way that an injectable foldable IOL can be glued into an eye with no capsules.

Less UGH syndrome: The authors expect less incidence of UGH syndrome in fibrin glue assisted IOL implantation, as compared to sutured scleral fixed IOL. This is because; in the former, the IOL is well stabilized and stuck onto the scleral bed and thereby, has decreased intraocular mobility, whereas in the latter, there is increased possibility of IOL movement or persistent rub over the ciliary body.

No suture related complications: Visually significant complications due to late subluxation which is known to occur in sutured scleral fixed IOL may also be prevented as sutures are totally avoided in this technique. Another important advantage of this technique is the prevention of suture related complications, like suture erosion, suture knot exposure or dislocation of IOL after suture disintegration or broken suture.

Rapidity and ease of surgery: All the time taken in SFIOL for passing suture into the IOL haptic eyelets, to ensure good centration before tying down the knots, as well as time for suturing scleral flaps and closing conjunctiva are significantly reduced. The risk of retinal photic injury which is known to occur in SFIOL would also be reduced in this technique due to the short surgical time. Fibrin glue takes less time to act in the scleral bed and it helps in adhesion as well as hemostasis. The preparation time can also be reduced in elective procedures by preparing it prior to surgery as it remains stable up to four hours from the time of reconstitution. Fibrin glue has been shown to provide airtight closure and by the time the fibrin starts degrading, surgical adhesions would have already occurred in the scleral bed. This is well shown in the follow-up anterior segment OCT (Figure 7) where postoperative perfect scleral flap adhesion is observed.

Stability of the IOL Haptic
As the flaps are manually created, the rough apposing surfaces of the flap and bed heal rapidly and firmly around the haptic, being helped by the fibrin glue early on. The major uncertainty here is the stability of the fibrin matrix in vivo. Numerous animal studies have shown that the fibrin glue is still present at 4–6 weeks. Because postoperative fibrosis starts early, the flaps become stuck secondary to fibrosis even prior to full degradation of the glue (Figures 8A to D). The ensuing pseudophacodonesis is the result of oscillations of the fluids in the anterior and posterior segment of the eye. These oscillations, initiated by movement of the eye, result in shearing forces on the corneal endothelium as well as vitreous motion lead to permanent damage. Since the IOL haptic is stuck beneath the flap, it would prevent the further movement of the haptic and thereby reducing the pseudophacodonesis.9
**FIGURES 9A AND B: Stability of the IOL**

- **A:** Long axis movement is prevented by the tissue glue
- **B:** Transverse axis movement is prevented by the scleral tuck

- **FIGURE 10:** Aphakic case. No capsule seen
- **FIGURE 11:** Scleral markers applied on the cornea. This will help to get marks created on the cornea 180 degrees apart to make sclera flaps

**FIGURE 12:** Marks made on the cornea. Conjunctiva cut on either side of the marks

**FIGURE 13:** Scleral flaps made 180 degrees apart

**FIGURE 14:** Sclerotomy made 1 mm from the limbus under the sclera flap using a 20 G needle

**FIGURE 15:** 23 G vitrectomy to remove anterior and midvitreous

**FIGURE 16:** Clear corneal incision

**FIGURE 17:** Foldable 3 piece IOL being injected slowly. It is to note the cartridge is inside the eye. One should not do wound assisted as the injection might happen too fast. This can either break the IOL or push it so fast that it might go into the vitreous cavity

**FIGURE 18:** Foldable IOL injection continued with one hand. This injector has a pushing mechanism so one hand can be used. The other hand holds an end opening microrhexis forceps (23 G) and is passed through the sclerotomy under the sclera flap and is ready to grab the haptic

**FIGURE 19:** End opening forceps grabs the haptic tip

**FIGURE 20:** Forceps pulls the haptic while injection of the foldable IOL is continued

**FIGURE 21:** Haptic externalized

**FIGURE 22:** Assistant holds the haptic which is externalized

**FIGURE 23:** Trailing haptic is flexed into the anterior chamber. The other hand holds the end opening microrhexis forceps and is passed through the other sclerotomy under the sclera flap
FIGURE 24: End opening forceps ready to grab the haptic tip

FIGURE 25: Haptic caught

FIGURE 26: Haptic is gradually pulled towards the sclerotomy

FIGURE 27: Haptic externalized

FIGURE 28: Both haptics externalized and can be seen lying under the sclera flaps

FIGURE 29: Vitrectomy done at the sclerotomy site

FIGURE 30: 26 G needle makes a sclera pocket at the edge of the flap where the haptic is seen

FIGURE 31: Forceps holds the haptic and flexes it to tuck it inside the scleral pocket

FIGURE 32: Haptic in the sclera pocket

FIGURE 33: PC IOL stable

FIGURE 34: Infusion cut off and air fills the anterior chamber

FIGURE 35: Fibrin glue (Tiessel, Baxter) application

FIGURE 36: Scleral flap sealed

FIGURE 37: Fibrin glue applied on conjunctiva and clear corneal incison to seal them

FIGURE 38: Immediate postoperation on table
Posterior Capsular Rupture

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INTRODUCTION

Any breach in the continuity of the posterior capsule is defined as a posterior capsule tear. Intraocular capsular tear complications are the most common and can occur during any stage of cataract surgery. The incidence of posterior capsule complications is related to the type of cataract and conditions of the eye, increases with the grade of difficulty of the case, and furthermore is influenced by the surgeon’s level of experience. Timely recognition and a planned management, depending upon the stage of surgery during which the posterior capsule tear has occurred, is required to ensure an optimal visual outcome.

COMMON RISK FACTORS FOR POSTERIOR CAPSULAR RUPTURE (PCR)

• Intraoperative factors causing variation in anterior chamber depth
• Type of cataract
• Extended rhexis.

INTRAOPERATIVE FACTORS CAUSING VARIATION IN ANTERIOR CHAMBER DEPTH

Intraoperative shallow anterior chamber could be due to various reasons. It may be a tight lid speculum, tight drapes or pull from the recollecting bag. In all the above cases, one needs to remove the precipitating factors (to remove the speculum pressure and the tight drapes and collecting bags). Variation in the amount of space in the anterior and posterior chambers may result from changes in the intraocular pressure (IOP) due to an alteration in the equilibrium between inflow and outflow of fluid. Diminished inflow may be secondary to insufficient bottle height, tube occlusion or compression, bottle emptying, too tight incisions compressing the irrigation sleeve or the surgeon moving the phaco tip out of the incision, making the irrigation holes come out of the incision. Excessive outflow may be caused by too high vacuum/flow parameters or too large incisions with leakage. Another cause is the postocclusion surge. Use of air pump or gas forced infusion solves most of these problems of intraoperative shallow anterior chamber.

TYPE OF CATARACT

A higher incidence of posterior capsule tear with vitreous loss is associated with cataract with pseudoexfoliation, diabetes mellitus and trauma. Missing the diagnosis in a posterior polar cataract (Figure 1) can be catastrophic to the surgeon and the patient. It is frequently associated with a weakened or deficient posterior capsule. Posterior lenticulon, cataracts with persistent primary hyperplastic vitreous, cataracts following vitreoretinal surgery and morgagnian cataracts are some of the other types. In any intraoperative diagnosis of posterior polar cataract, it is to avoid hydrodissection with balanced salt solution (BSS). Hydrodissection may cause hydraulic perforation at the weakened area of the capsule, hence only a careful controlled hydrodissection is preferred. One can also make multiple pockets of viscoelastic injection around the nucleus. If a capsular tear does occur, a closed system should be maintained by injecting viscoelastic before withdrawing the phaco tip. This helps to tamponade the vitreous backwards where a capsular dehiscence is present.

EXTENDED RHEXIS

Extension of anterior capsule can occur as a complication in MICS also. During capsulorhexis, anterior capsular tears can cause posterior capsule tear by extending to the periphery. In a new method of managing this situation, a nick is made from the opposite side of the rhexis using a cystitome or vannas and the capsulorhexis is completed. The viscoelastic in the anterior chamber (AC) is then expressed out to make the globe hypotonous, following which a gentle hydrodissection is done at 90° from the tear, while pressing the posterior lip of the incision to prevent into the AC and no nuclear division techniques are tried in the bag. The entire nucleus is prolapsed into the anterior chamber and emulsified.

**STEPS FOR MANAGEMENT OF PCR**

Surgeon should be aware of the signs (Table 1) of posterior capsular tear. Posterior capsule tears can occur during any stage of phacoemulsification surgery. They occurred most frequently during the stage of nuclear emulsification, as reported by Mulhern et al (49%) and Osher et al and during irrigation--aspiration, as reported by Gimbel et al. Diminishing turbulence inside the eye. If the nucleus is soft, only a small residual amount remains, and there is no vitreous prolapse, the procedure may be continued. If vitreous is already present, special care must be taken for preventing additional vitreous prolapse into the anterior chamber or to the wound. Small residual nucleus or cortex can be emulsified by bringing it out of the capsular bag and can be emulsified in the anterior chamber with viscoelastic underneath the corneal endothelium. In case of a small PCR and minimal residual nucleus (Figure 2), a dispersive viscoelastic is injected to plug the posterior capsule tear. Subsequently, the nuclear material is moved into the anterior chamber with a spatula and emulsified. The recommended parameters are low bottle height (20-40 cm above the patient’s head), low flow rate (10-15 cc/ min), high vacuum (120–200 mm Hg) and low ultrasound (20–40%).

**TABLE 1 Signs of posterior capsular rupture**

- Sudden deepening of the chamber, with momentary expansion of the pupil
- Sudden, transitory appearance of a clear red reflex peripherally
- Apparent inability to rotate a previously mobile nucleus
- Excessive lateral mobility or displacement of the nucleus
- Excessive tipping of one pole of the nucleus

![FIGURE 2: Posterior capsular rupture. It is to be noted that the IOL sinking into the vitreous cavity. The white reflex indicates nuclear fragments also in the vitreous cavity. This patient was managed by vitrectomy, FAVIT (removal of the nuclear fragments) and the IOL repositioned in the sulcus.](image)

**VISCOEXPRESSION**

It is a method of removal of the residual nucleus by injecting viscoelastic underneath the nucleus to support it and the nucleus is expressed along with the viscoelastic.

**CONVERSION TO EXTRACAPSULAR CATARACT EXTRACTION (ECCE)**

If there is sizeable amount of residual nucleus, it is advisable to convert to a large incision ECCE to minimize the possibility of a dropped nucleus.

**ANTERIOR BIMANUAL VITRECTOMY**

Bimanual vitrectomy (Figure 3) is done in eyes with vitreous prolapse. Use 23 G irrigating cannula via side port after extending the side port incision. The irrigation bottle is positioned at the appropriate height to maintain the anterior chamber during vitrectomy. Vitrectomy should be performed with cutting rate (500–800 cuts per minute), an aspiration flow rate of 20 cc/min and a vacuum of 150–200 mm Hg.

**FIGURE 3: Bimanual vitrectomy is being performed in a posterior capsular tear with vitreous prolapse**

**ANTERIOR CHAMBER CLEARED OF VITREOUS**

Vitrectomy is continued in the anterior chamber and the pupillary plane. A rod can be introduced into the anterior chamber to check the presence of any vitreous traction and the same should be released. Complete removal of the vitreous from the anterior chamber can be confirmed if one sees a circular, mobile pupil (Figures 4A and B) and complete air bubble in the anterior chamber. The usage of the fiber of an endoilluminator, dimming the room lights and microscope lights, may be useful in cases of doubt, in order to identify vitreous strands. Another useful measure is the use of purified

**FIGURES 4A and B: Clinical photographs showing the change in the anterior chamber after complete removal of the vitreous from the anterior chamber. (A) Before vitrectomy, (B) After vitrectomy**

Three possible situations can happen in a posterior capsule rent namely:

- Posterior capsule tear with hyaloid face intact and nuclear material present
- Posterior capsule tear with hyaloid face ruptured without luxation of nuclear material into vitreous
- Posterior capsule tear with hyaloid face ruptured and luxation of nuclear material into vitreous.

Immediate precautions are to be taken not to do further hydrate the vitreous and not to increase the size of the PCR. The conventional management consists of prevention of mixture of cortical matter with vitreous, dry aspiration and anterior vitrectomy, if required. In addition, during phacoemulsification, low flow rate, high vacuum and low ultrasound are advocated if a posterior capsule tear occurs.

**REDUCE THE PARAMETERS**

Lowering aspiration flow rate and decreasing the vacuum will control surge and will allow the bottle to be lowered, diminishing turbulence inside the eye. If the nucleus is soft, only a small residual amount remains, and there is no vitreous prolapse, the procedure may be continued. If vitreous is already present, special care must be taken for preventing additional vitreous prolapse into the anterior chamber or to the wound. Small residual nucleus or cortex can be emulsified by bringing it out of the capsular bag and can be emulsified in the anterior chamber with viscoelastic underneath the corneal endothelium. In case of a small PCR and minimal residual nucleus (Figure 2), a dispersive viscoelastic is injected to plug the posterior capsule tear. Subsequently, the nuclear material is moved into the anterior chamber with a spatula and emulsified. The recommended parameters are low bottle height (20–40 cm above the patient’s head), low flow rate (10–15 cc/ min), high vacuum (120–200 mm Hg) and low ultrasound (20–40%).

**DRY CORTICAL ASPIRATION**

If there is only a small amount or no vitreous prolapse in the presence of a small capsular rent, a dry cortical aspiration with 23 G cannula can be performed.
triamicinolone acetate suspension (Kenalog) to identify the vitreous described by Peyman. Kenalog particles remain trapped on and within the vitreous gel, making it clearly visible.

**SUTURE THE WOUND**

In cases with vitreous loss with PCR, it is recommended to suture the corneal wound as a prophylaxis to prevent infection. One should remove any residual vitreous in the incision site in the main and side port with vitrector or manually with Vannas scissors. If necessary, one needs to insert a rod via the side port and pass it over the surface of the iris, to release them.

**IOL IMPLANTATION**

Depending upon the state of the capsular bag and rhexis, IOL is implanted (Table 2).

**TABLE 53.2 - IOL implantation in PCR**

- Insertion and rotation of IOL should always be away from the area of capsule tear
- The long axis of the IOL should cross the meridian of the posterior capsule tear
- Eyes with (< 6 mm) PCR with no vitreous loss, IOL can be placed in the capsular bag
- In the presence of a posterior capsule tear(>6 mm) with adequate anterior capsule rim, an IOL can be placed in the sulcus in deficient capsules, Glued IOL is a promising technique without complications of sutured scleral fixated or anterior chamber IOL

**IN THE BAG**

In the presence of a posterior capsule tear with good capsular bag, the IOL can be placed in the bag. Small PCR with no vitreous loss and good capsular bag, foldable IOL can be placed.

**IN THE SULCUS**

If the rent is large, if the capsular rim is available, then the IOL can be placed in the sulcus. The rigid IOL can be placed in the sulcus in large PCR over the residual anterior capsule rim with Mc Person forceps holding the optic. The "chopstick technique" is another method of placing IOL in sulcus. In this new chopstick forceps namely, 'Agarwal- Katena forceps' (Figures 5A and B) is used for IOL implantation.

This chopstick technique refers to the IOL being held between two flangs of the forceps. The advantage is the smooth placement of the IOL in the sulcus without excess manipulation. Moreover, the IOL implantation is more controlled (Figures 6A to D) with the forceps as compared to other methods. Small PCR with no vitreous loss and good capsular bag, foldable IOL can be placed (Figures 7A and B). In eyes with intraoperative miosis with PCR, IOL can be implanted with the pupil expansion with “Agarwal- modified Malyugin ring” method (Figures 8A and B). In this method, 12 a 6-0 polyglactic suture is placed in the leading scroll of the Malyugin ring and injected into the pupillary plane (Figures 9A and B). The end of the suture stays at the main port incision. Once in place, the ring produced a stable mydriasis of about 6.0 mm. Hereby, IOL can be implanted easily in the sulcus with visualization and this prevents the inadvertent dropping of the iris expander into the vitreous during intraoperative manipulation.

**DEFICIENT POSTERIOR CAPSULE**

Now recently Glued IOL 11-13 is easily performed in such cases with deficient posterior capsules. Scleral fixated posterior chamber lenses and anterior chamber IOLs 14,15 can also be implanted when the posterior capsule tear is large.

**Vitreous Traction**

Incomplete vitrectomy can produce dynamic traction on the retina leading to retinal breaks.
Retinal Detachment
Undetected long standing vitreous traction progresses to retinal break and detachment.

Macular Edema
Manipulation of vitreous will increase not only the traction transmitted to the retina but also the inflammation in the posterior segment and the risk of macular edema.

Vitritis
Over-enthusiastic use of viscoelastic into the vitreous can lead to sterile inflammation. Dropped minimal residual cortex can also present with postoperative vitritis.

IOL RELATED COMPLICATIONS
Improperly placed IOL in the sulcus can lead to lens induced astigmatism and tilt.

CONCLUSION
The occurrence of a posterior capsule tear during cataract surgery is one of the most serious complications. It is important for a surgeon to diagnose the occurrence of a posterior capsule tear at an early stage, to avoid further enlargement of the tear and associated vitreous complications. The primary goal of all the maneuvers is to remove the remaining nucleus, epinucleus, and as much as cortex possible without causing vitreoretinal traction.

REFERENCES
