Surgical extraction of lenticular material and intraocular lens (IOL) placement is accomplished as a single procedure resulting in a centered IOL stably supported by the native capsular bag. There are, however, many circumstances that compromise this ideal, necessitating alternative surgical options to enable stable IOL placement and optimal visual outcome. When Endocapsular or IOL placement in sulcus is not possible, the options for IOL fixation include:

1. Fixation to the sclera (with sutures/glue)
2. Fixation to the iris by suturing or iris claw
3. Support by the anterior chamber angle

Each method has strengths and weaknesses with respect to surgical difficulty, operative time and intraoperative and/or post-operative complications. Long-term follow-up of anterior chamber IOLs has indicated high rates of complications including bullous keratopathy, uveitis, glaucoma, hyphema, and cystoid macular edema. Iris-fixated or iris-claw IOLs can lead to microhyphema, chronic pigment release from the iris, which can cause inflammation, Spontaneous iris disenclavation etc. Because of advances in microsurgical techniques and instruments, sutured/glued scleral fixed IOL implantation can be performed with good post-operative outcome.

Mimura et al suture fixed the IOL to sclera at the ciliary sulcus. Gabor et al described a sutureless technique for sulcus fixation of a PC IOL using permanent incarceration of the haptics in a scleral tunnel parallel to the limbus, which combines the control of a closed-eye system with the postoperative axial stability of the PCIOL. Glued intrascleral haptic fixation of an intraocular lens (IOL) as a technique for posterior chamber IOL (PC IOL) fixation in eyes with absent or insufficient capsule support was first described in 2008 by Agarwal et al. The technique has evolved over time and its application has been extended to varied scenarios and also as part of combined surgeries.

### Indications of scleral fixed IOL

The basic indication for scleral, iris, or anterior chamber angle fixation is lack of capsular support. This occurs when the capsule becomes damaged or dislocated, or is inherently weakened as part of an underlying disease process. Common causes of capsular damage include trauma and complicated cataract surgery. Severe infectious or inflammatory processes such as endophthalmitis or uveitis may also compromise capsular strength. Marfan’s syndrome, homocystinuria, Weill-Marchesani syndrome, sulfite oxidase deficiency, and pseudoexfoliation syndrome are some of the diseases that alter zonular integrity and therefore capsular stability.

### Trauma

Severe blunt ocular trauma or penetrating injury may result in loss of capsular support. All of the major fixation techniques have been reported in cases of post-traumatic cataract extraction and IOL implantation. If injury to the iris occurs, angle supported or iris-sutured fixation may not be tenable. Most recent series have described scleral fixation strategies for IOL placement after trauma with deficient capsular support as the standard procedure with good postoperative outcome.

### Complicated Cataract Surgery

Alternate fixation strategies are often needed following complicated cataract surgery. IOL placement may be considered at the same time as complicated cataract extraction, or as a secondary procedure at a later date. Capsular weakness is not always recognized at the time of complicated cataract surgery, which may lead to late IOL dislocation.
**Ectopia lentis**

Crystalline lens subluxation occurs in more than 60% of patients with Marfan syndrome. It is also seen in Homocystinuria, Weill-Marchesani syndrome, Sulfite oxidase deficiency, Hyperlysinemia etc. Subluxation is initially managed with spectacle or contact lenses. When visual acuity is no longer correctable with these approaches, surgical lens removal with IOL implantation is indicated. SFIOL implantation has yielded good results in such cases.

**Lens Replacement/Exchange**

In some cases, a previously placed IOL may be dislocated or cannot be retained, and surgery is required for IOL removal and replacement. Other indications for lens replacement include IOL damage, excessive residual lens material, and an IOL model that is not amenable to suturing or other means of extracapsular fixation (e.g., plate haptic). Another potential indication for lens replacement is pseudophakic bullous keratopathy (PBK). This complication occurred more frequently in certain older AC-IOL models. Although the incidence of PBK is lower in newer AC-IOL lenses, they should be removed if there is endothelial decompensation or if there is shallow anterior chamber depth (< 3mm). These cases with deficient posterior capsule have shown good results with SFIOL implantation.

Kjeka et al carried out a retrospective analysis of 91 eyes of 81 patients who underwent implantation of posterior chamber lenses with transcleral sutures. Sixty-eight eyes (74.7%) were aphakic at the time of surgery. In 10 patients (11.0%) an intracapsular cataract extraction and in six patients (6.6%) a pars plana lensectomy was performed prior to the fixation of the posterior chamber intraocular lens. In seven eyes (7.7%) a previously implanted IOL was removed. The primary diagnosis was a luxated crystalline lens in 11 eyes (12.1%), congenital/juvenile cataract in nine eyes (9.9%) and other forms of cataract in 71 eyes (80.0%).

Kumar et al. evaluated the records of patients with a primary glued foldable IOL for intraoperative capsular loss or subluxated lens or secondary glued foldable IOL for aphakia. The study comprised 208 eyes (185 patients). The indications for implanting glued IOLs were aphakia (96 eyes), subluxated cataract (34 eyes), and intraoperative capsule loss (78 eyes). Of 78 eyes with intraoperative inadequate posterior capsule, 70 (89.7%) and 6 (7.7%) had posterior capsule rupture during phacoemulsification of the nucleus and IOL implantation, respectively. The remaining 2 eyes (2.6%) had posterior capsule rupture during intraoperative zonular dialysis. Of 208 cases, 130 (62.5%) were elective procedures and 78 (37.5%) were unplanned (after complicated cataract surgery).

Kumar et al exchanged anterior chamber lenses with glued trans-scleral intraocular lens in complicated eyes. Thirty-eight eyes with mean follow-up of 24.1 ± 15.4 months (range, 8 to 60 months) were analyzed. The indications were corneal decompensation (39.4%), malpositioned AC IOL (28.9%), uveitis (15.7%), glaucoma (13.1%), and broken haptic (2.6%). Of the 11 malpositioned AC IOLs, 19% eye had haptic–endothelial touch and 2 (18.1%) eyes had subconjunctival extruding haptics. More than 2 indications were present in 3 (7.9%) eyes and 2 indications were present in 14 (36.8%) eyes.

**Technique**

**Sutured Scleral Fixation**

For sutured trans-scleral fixation, after small peritomy, two scleral incisions are made, at 3 o’clock and 9 o’clock positions, 2 mm from the limbus and parallel to limbus. Lamellar dissection is performed towards the limbus to create a scleral groove of nearly 0.5 mm with a crescent blade (Alcon Laboratories, Fort Worth, TX). A 6 mm superior corneal groove is prepared. Entry into the anterior chamber is made using 2.75 mm keratome (Alcon Laboratories, Fort Worth, TX). A straight needle 9-0 prolene suture is introduced through the nasal groove. It is docked into a 26 G needle introduced through the corneal incision and pulled out (Figure 1). This end of the prolene suture is then tied around the eyelet of one haptic of the IOL (Figure 2). The other end of the 9-0 prolene is introduced into a 26 G needle introduced through the corneal incision and pulled out (Figure 1). This end of the prolene suture is then tied around the eyelet of one haptic of the IOL (Figure 2). The other end of the 9-0 prolene is introduced.
through the corneal incision, docked into a 26 G needle introduced from the scleral tunnel and pulled out. The same procedure is repeated at the temporal scleral tunnel. The corneal incision is then enlarged to the full length (6mm) and the IOL is introduced into the posterior chamber behind the iris in the presumed position of sulcus. The prolene suture knots are tied on both sides and IOL centration adjusted (Figure 3). The knots are slipped into the scleral groove. The conjunctiva is closed with 8-0 vicryl suture and the corneal wound is closed with two interrupted 10-0 monofilament nylon sutures.

**Sutureless Scleral Fixation**

Sutureless technique for sulcus fixation of a PC IOL using permanent incarceration of the haptics in a scleral tunnel parallel to the limbus was first described by Gabor et al. Glued intrascleral haptic fixation of an intraocular lens (IOL) as a technique for posterior chamber IOL (PC IOL) fixation in eyes with absent or insufficient capsule support was first described in 2008 by Agarwal et al.

Commonly used technique for glued IOL implantation is as follows. The conjunctiva is dissected along the 3 and 9 o’clock positions and the sclera is cauterized to prevent bleeding. Following cautery, a caliper is used to mark the sclera at 2 points, 1.5 mm and 3.0 mm from the limbus and 1.5 mm apart (Figure 4). Two radial incisions are made between the 1.5 mm and 3.0 mm points. Lamellar dissection is performed with a crescent blade between the incisions. The lamellar dissection is extended beyond the radial incision and continued until the angle of the blade is reached (Figure 5). Using a vannas scissors, the roof of the dissection is cut at the fornix side between the incisions to create a limbus-based scleral flap. In a similar fashion, the flap is created on the other side. The direction of the
crescent blade during lamellar dissection is opposite to that of the other side so the tunnels created adjacent to the flaps are in opposite directions. A MVR blade entry is made under the flaps on both sides and IOL is injected in to anterior chamber (Figure 6&7). As soon as first haptic comes out of injector in AC, it is caught with SFIOL forceps and externalized under the flap. Now assistant holds the leading haptic with a forceps and surgeon externalizes the trailing haptic on the other side of the flap. After the haptics are externalized from the sclerotomy site, they are placed in the adjacent scleral tunnel (Figure 8&9). At this stage, the degree of IOL centration is assessed and if decentration is noted, it is corrected by varying the degree of tuck of either haptic into the scleral pockets. The scleral bed is dried with sponge. Fibrin glue is then applied to the scleral bed under the flap and the mouth of the adjacent tunnel, and the flap is repositioned. The conjunctiva is also closed with glue (Figure 10&11).

As this technique has evolved, it is clear that one of the key steps in the successful use of “glued IOL surgery” is the externalization of the IOL haptic without causing breakage, disfigurement, or any kinks within the IOL haptic. Agarwal et al described the so-called ‘handshake technique’ for handling and externalizing the IOL haptic7. It is very important that the haptic is grasped at the tip whenever it is manoeuvred through the sclerotomy site under the scleral flap. A specialized forceps has been developed to prevent damage to the haptics during this part of the procedure. In this technique, the IOL haptic is transferred from one forceps within the eye to a second forceps that is placed through the sclerotomy site under the scleral tubercle of the scleral tunnels. Once the scleral tunnels have been created, the tires can be removed one at a time, allowing the distal haptics to be threaded into the scleral tunnels followed by fibrin fixation of the scleral flap (Figure 13).

Sutureless scleral fixation is theoretically compatible with multiple different IOL types and does not require specialized haptics containing suture eyelets. Recent studies have reported the use of fibrin-glue assisted techniques combined with DSAEK and as a means for fixation of IOL-iris prosthesis in aniridia.

Special situations

Multifocal glued IOL

Glued IOL procedure can be performed with multifocal (diffractive or refractive) IOL’s9. Good centration is mandatory in multifocal IOL’s to provide the best corrected vision without optical disturbances. An image processing with Matlab version 7.1 (Mathworks, Inc) can be done to quantify decentration. Ultrasound biomicroscopy can also be used to note the position or tilt of IOL on each visit.

The steps to follow in a multifocal IOL:

- Scleral flaps should be exactly 180 (use RK marker & pen).
- Scleral tucking should be manipulated to bring perfect centration.
- Proper white to white diameter measurement on table for optic diameter.
- Preoperative angle kappa can be taken into consideration.

Pediatric glued IOL

Nowadays most of the pediatric cataract surgeries are combined with IOL implantation. Ectopia lentis, congenital cataract with luxation or traumatic cataract are often associated with zonular weakness. Pediatric glued IOL in these eyes have shown promising results. Here in the
pediatric eyes, the two straight sclerotomies with a 22G needle are made under the existing scleral flaps about 1 from the limbus and the flaps size is reduced to 2–2.5 mm.

**Glued iris prosthesis**

The glued iris prosthesis (e.g., PMMA aniridia IOL of OV lens Style ANI5, Intra Ocular Care, Gujarat, India) consist of the optic which has a central clear zone (clear optic zone) with a peripheral opaque or pigmented annulus. The haptics are also made of PMMA with acute angulations and they have an eyelet for prolene suture placement during externalized as in regular glued IOL technique and the tips are then inserted in the scleral tunnel, followed by fibrin glue application on the scleral flap bed.

Kumar et al determined the outcomes after glued aniridia intraocular lens (IOL) and glued IOL with iridoplasty in eyes with combined lens capsular and iris deficiency. Eleven eyes underwent glued aniridia IOL and 16 eyes underwent glued IOL with iridoplasty. Postoperatively, pigment dispersion on the IOL (n = 1) and raised intraocular pressure was seen in the glued aniridia IOL group and chronic uveitis (n = 1), cystoid macular edema (n = 1), and hyphema (n = 1) in the glued IOL with iridoplasty group. The CDVA remained unchanged in 14 eyes (51.8%) and improved in 13 eyes (48.1%). There was a difference in postoperative CDVA (P = .001) between eyes with glued aniridia IOL and glued IOL with iridoplasty. There was no IOL decentration, retinal detachment, corneal decompensation, or endophthalmitis. There was reduction in glare and photophobia.

**Glued intraocular lens with corneal surgeries**

Glued IOL procedure can be combined with various corneal surgeries like penetrating keratoplasty, Descemet’s stripping automated endothelial keratoplasty (DSAEK) or Femtosecond Laser assisted keratoplasty. Prakash et al (Cornea. 2010 Nov; 29(11): 1315-9) reported a surgical technique for managing postsurgical aphakia with endothelial decompensation. The technique comprised of femtosecond laser-assisted Descemet stripping automated endothelial keratoplasty (DSAEK) with fibrin glue-assisted sutureless posterior chamber intraocular lens (IOL) implantation—glued IOL. Three eyes (of 3 patients) underwent the technique. The donor lenticules were created on a 60-kHz femtosecond laser platform (Intralase; Abbott Medical Optics, Santa Ana, CA). Two partial-thickness scleral flaps and sclerotomies were made in host. After this, the Descemets was scored and stripped. A 3-piece 6.5-mm posterior chamber IOL was inserted, and its haptics were externalized through the sclerotomies. The haptics were then tucked into intrascleral pockets. The donor lenticule was inserted into the anterior chamber and unfolded. Air tamponade and pull suture manipulations were used to stabilize and centre it. The partial-thickness scleral flaps
were apposed with fibrin glue. The uncorrected and best-corrected visual acuities improved in all cases. There were no donor dislocations. The average donor endothelial cell loss was 27.7% at 6 months.

Prakash et al. described a technique comprising of femtosecond laser-assisted penetrating keratoplasty and AC IOL exchange with fibrin glue-assisted sutureless posterior chamber intraocular lens (PC IOL) implantation. This new triple procedure combined the unique benefits of the femtosecond laser and the glued IOL, leading to stable wound configuration, decreased open-sky time, and less pseudophacodonesis, and less risk for the suture-related complications of transscleral suture fixation. Sinha et al also combined glued IOL with DSAEK, and penetrating keratoplasty concluded that the IOL fixation was strong enough to sustain the manipulation required for corneal procedures.

**Glued intraocular lens scaffold**

The IOL scaffold technique was described in 2011 to prevent nuclear fragment drop into the vitreous in the presence of a PCR. This technique combined the glued IOL technique and the IOL scaffold. Here, in case of intraoperative PCR, a three-piece foldable IOL is placed (by glued IOL method) behind the existing PCR and the phacoemulsification is completed above the IOL. Thus, the IOL acts as an 'artificial posterior capsule'. We have performed this method in three eyes. Except for the early postoperative corneal oedema, there were no major complications encountered.

**Repositioning the decentred IOL**

Glued IOL technique can be used for recenteration of decentred IOL. The luxated IOL, decentered scleral fixed IOL or suture scleral fixed IOL are usually repositioned. In all these conditions the same IOL can be repositioned by glued IOL method. The IOL explantation is prevented, thereby the surgical risk of inflammation, suture induced astigmatism and infection is decreased.

**Complications and their management**

**IOL related complications**

Intraocular lens decentration was seen in 3.3% of cases in a study by Divya A K et al. During repositioning, it was noted that improper intrascleral haptic tuck was the reason for IOL decentration. Unequal haptic tuck on both scleral tunnels will lead to late IOL decentration. Undue pressure on the haptic tip can cause haptic deformation and later dislodgement. The overall diameter of the IOL can also affect the centration of the IOL. An especially large diameter can provide better IOL centration.

Haptic-related complications seen in the late postoperative period include haptic displacement (2%), haptic tip extrusion (0.5%) and subconjunctival haptic (1.5%). Depth of scleral tunnel is important factor, which minimises haptic tip extrusion or displacement over a long period.

The postoperative corneal edema probably due to wound-assisted implantation (Cartridge tip of the injector at the corneolimbal wound during IOL insertion) was seen in some cases; this can be prevented by placing the cartridge over the pupil plane during IOL insertion.

**Suture related complications**

In sutured SFIOL, externalized suture and knots can increase risk for suture or tissue erosion and endophthalmitis. Sutured scleral fixation involves passing sutures through uveal tissue, which may lead to retinal detachment or intraocular haemorrhage. Risks are higher in myopes, hypertensives, or patients on anticoagulants.

**Macular edema**

In a 1-year follow-up study of rigid poly (methyl methacrylate) glued IOLs by Kumar DA et al, resolved macular edema (7.5%) was the most common late complication while in recent studies with glued IOL technique this incidence is much lower (1.9%).

**Glaucoma**

Postoperative glaucoma was also seen frequently in eyes with sutured IOLs (40%) compared with eyes with glued IOLs (16%). McAllister et al reported that the most common postoperative complication was ocular hypertension (30.5%). Sinha et al reported no significant anterior or posterior segment inflammation, and normal IOP in their short-term follow up.

**Postoperative inflammation**

Ganekal et al reported postoperative inflammation in 48% of eyes with a sutured IOL compared with 16% of eyes with a glued IOL. Externalized suture and knots can increase risk for suture or tissue erosion and endophthalmitis. Late IOL dislocation or tilt is also a potential concern with scleral fixation techniques. Sutureless scleral fixation requires sclerotomy and externalization of haptics through uveal tissue, which may induce intraocular haemorrhage.

**Scleral weakness**

IOL stability relies upon the formation of intrascleral scar tissue surrounding the haptic. There is a potential for torsional forces to be exerted on the haptic and/or the scleral tissue. Caution should be exercised in eyes with history of Scleritis or conditions associated with scleromalacia.

**Conclusion**

Fixation of a PC IOL in the setting of inadequate capsule support is often difficult. Techniques that allow IOL fixation without placement of sutures, such as the fibrin glue-assisted scleral fixation technique, are a way to provide...
adequate fixation of these IOLs in the posterior chamber. Modifications of this technique have led to safer methods of handling and externalizing the IOL haptics, as well as ways of keeping the haptics in the proper position. They have also led to the possible use of a fibrin glue-assisted scleral fixated IOL as scaffolding to allow safer removal of remnant nuclear fragments following a posterior capsule tear or placement of a sutureless scleral-fixated PC IOL following the use of perfluorocarbons to float the nucleus out of the vitreous\(^\text{39}\). Glued IOL procedure can be done as a primary procedure or secondary IOL implantation in eyes with deficient capsular support. Monofocal (single piece/multipiece), multifocal or aniridia IOL’s can be implanted. The suture related and corneal endothelial complications are prevented via this procedure. Recently introduced modifications in the glued IOL (Handshaking technique, use of 23G infusion, silicone stoppers/tires, foldable glued IOL etc.) help in easy learning and wider use of the technique for various indications.

References