International Journal of Multiphysics
Volume 18, No. 3, 2024
ISSN: 1750-9548

An Overview on Sutureless Scleral-Fixated IOL

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Abstract:

Scleral-fixated intraocular lenses (SFIOLs) are important options for visual rehabilitation in eyes lacking adequate capsular support. Traditional sutured SFIOL techniques have been associated with suture-related complications such as erosion, breakage, lens dislocation, and endophthalmitis, prompting the development of sutureless scleral fixation methods. Several techniques have evolved, including scleral flap-based and flapless approaches, with continuous modifications aiming to improve lens stability, surgical safety, and postoperative outcomes.

Keywords: Aphakia; Scleral-fixated intraocular lens; Sutureless scleral fixation; Yamane technique; Glued intraocular lens; Carlevale lens; Intrascleral haptic fixation; Complications.

Introduction:

Management of aphakia in the absence of adequate capsular support remains a surgical challenge. Although anterior chamber intraocular lenses and iris-fixated intraocular lenses have been used for visual rehabilitation, scleral-fixated intraocular lenses (SFIOLs) have gained preference because they provide a more physiologic posterior chamber lens position and reduce corneal endothelial compromise and angle-related complications. Conventional sutured SFIOL techniques have demonstrated good long-term outcomes; however, they may be associated with suture-related problems including suture erosion, degradation, breakage, intraocular lens dislocation, and endophthalmitis, prompting continuous refinement of fixation approaches **(1,2).**

To overcome limitations associated with sutured fixation, sutureless scleral fixation techniques have emerged as an important advancement in secondary intraocular lens implantation. These techniques aim to preserve the advantages of posterior chamber fixation while avoiding suture-induced complications and improving long-term stability. Progressive innovations in surgical maneuvers, haptic fixation methods, and lens design have expanded the role of sutureless approaches in complex aphakia cases with encouraging anatomical and visual outcomes **(3).**

Among the major breakthroughs in this field was the introduction of glued intrascleral haptic fixation, which provided secure haptic fixation through scleral tunnels combined with biological glue-assisted stabilization. Subsequent modifications have focused on simplifying surgical steps, improving lens centration, minimizing intraoperative manipulation, and reducing postoperative complications. More recently, specially designed lenses for sutureless fixation, such as the Carlevale lens, have further broadened the spectrum of available surgical options **(4, 5).**

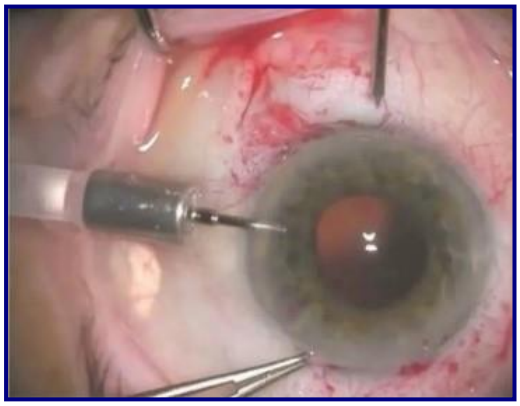
Sutureless implantation has the advantages of SFIOLs while avoiding suture-related complications. There have been several modifications since the inception of sutureless techniques. They can be broadly divided into two groups: techniques using scleral tunnel with scleral flaps and techniques using scleral tunnel without scleral flaps **(1).**

Techniques of sutureless SFIOL using scleral tunnel with scleral flaps:

1. In the Scharioth technique:

A 25-gauge pars plana vitrectomy is performed, then the cannulas are plugged, and the eye is prepared for intrascleral haptic fixation. Two ab externo 23-gauge ciliary sulcus sclerotomies are performed 1.5 to 2 mm from

the limbus 180 degrees apart (a). Limbus parallel 23-gauge intrascleral Scharioth tunnels are performed in a counterclockwise manner from the sclerotomies at 50% depth, exiting through the conjunctiva after 2 to 3 mm (b). Then, 25-gauge end-gripping forceps externalize the leading haptic, which is subsequently pass through the Scharioth tunnel (c). The same technique is repeated with the trailing haptic **(Figure 1) (2)**.



A

B C

Figure (1) Scharioth technique: a) two ab externo 23-gauge ciliary sulcus sclerotomies are performed 1.5 to 2 mm from the limbus 180 degrees apart, b) limbus parallel 23-gauge intrascleral Scharioth tunnels are performed in a counterclockwise manner from the sclerotomies at 50% depth, exiting through the conjunctiva after 2 to 3 mm, c) 25-gauge end-gripping forceps externalize the leading haptic, which is subsequently pass through the Scharioth tunnel **(2).**

2. In Glued IOL technique of sutureless SFIOL with scleral flaps:

In this procedure, two partial-thickness scleral flaps are created 180 degrees apart at 3 and 9 o'clock positions. Then, two ab externo sclerotomies are made under the scleral flaps 1.5 mm from the limbus using a 24 G needle. Scleral tunnels are made at the edge of the scleral flap near the sclerotomy sites with the help of a 26 G bent needle. A three-piece IOL is inserted through the main corneoscleral incision, and the leading haptic is externalized by micro forceps using a handshake technique. Similarly, the trailing haptic is externalized. Both haptics are tucked into their scleral tunnels respectively. The area is dried, and fibrin glue is placed under the scleral flaps. Deposition of the flap, and pressure is applied for 10-20 seconds. At the end, the corneoscleral incision is closed, and the conjunctiva is sutured**.** The glued IOL technique has the advantage of precise centering of the IOL, as we can adjust the length of the exteriorized haptic. It also allows the tilt of the IOL to be adjusted by altering the direction of the scleral tunnel **(Figure 2) (3).**

This techniqe usually requires an assistant to secure the leading haptic while the trailing haptic is being exteriorized. **Narang et al**., developed a no-assistant technique (NAT). Once the leading haptic is externalized,

the trailing haptic is flexed inside the eye. As it crosses the mid-pupillary plane close to the 6 o'clock position, vector forces extrude the leading haptic, minimizing chances of slippage back into the eye **(4).**

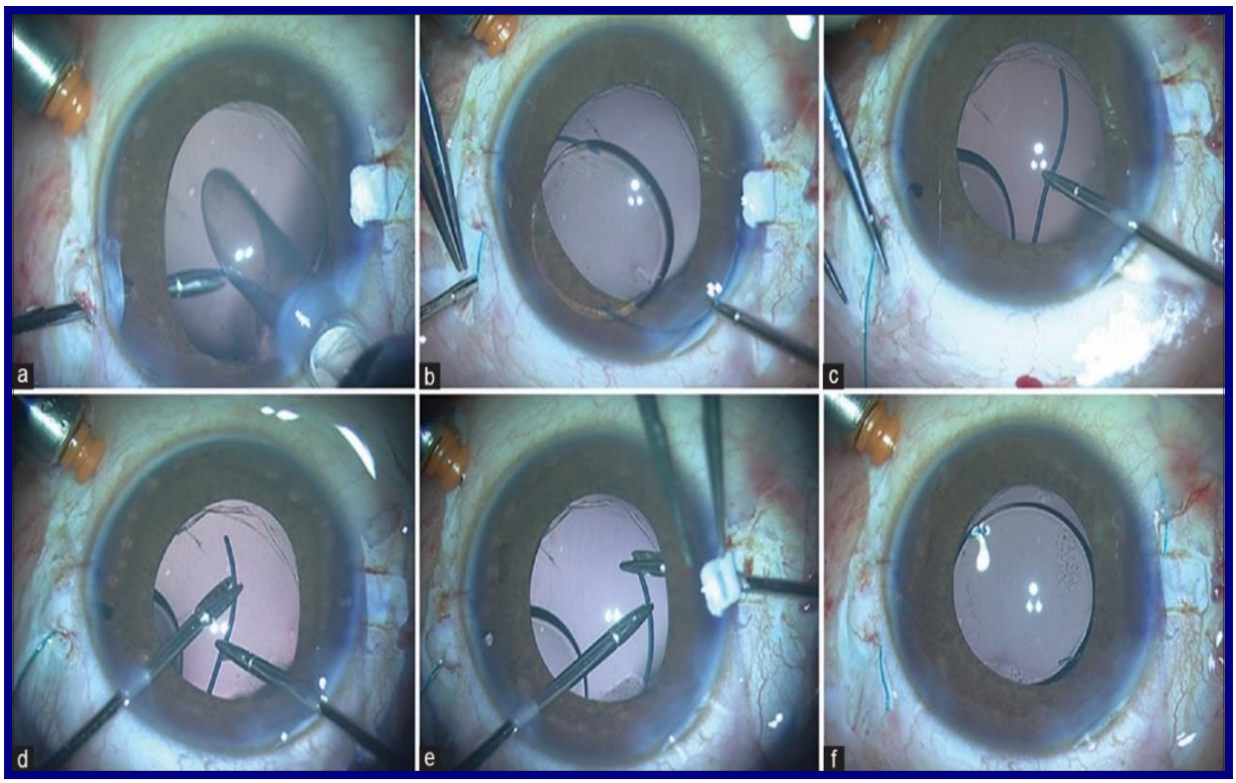
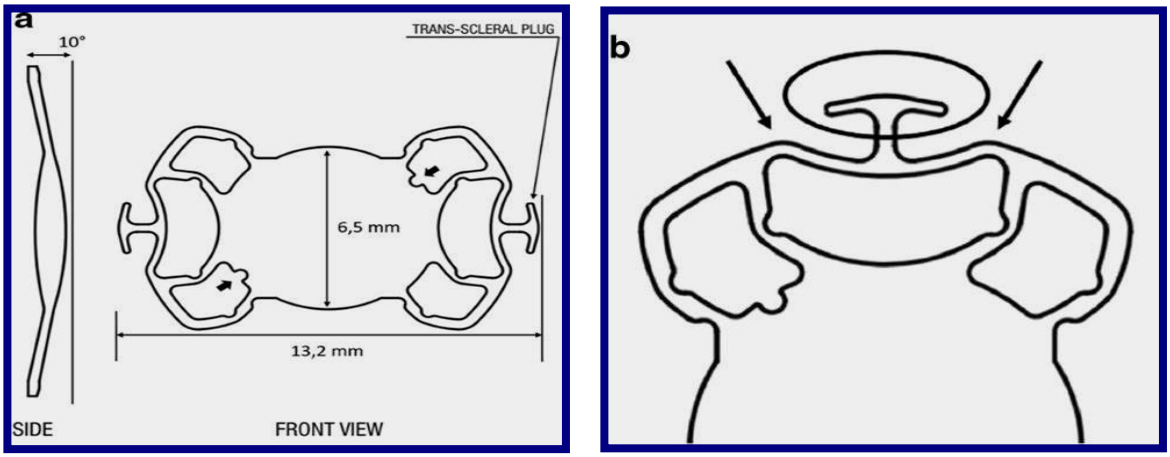


Figure (2): Glued suturless SFIOL: A three-piece IOL is inserted through the main corneoscleral incision, and the leading haptic is externalized by micro forceps using a handshake technique. Similarly, the trailing haptic is externalized. Both haptics are tucked into their scleral tunnels respectively. The area is dried, and fibrin glue is placed under the scleral flaps. Deposition of the flap, and pressure is applied for 10-20 seconds. At the end, the corneoscleral incision is closed, and the conjunctiva is sutured **(3).**

Other modifications of the glued IOL technique have been described. One modification involves the position of the initial scleral flaps. Partial-thickness scleral flaps are usually made at 3 and 9 o'clock positions if the white-to-white (WTW) distance is 11 mm or less. However, in special cases, such as Marfan syndrome, WTW distance may be 12 mm or more. In such situations, to make sure that an adequate length of the haptics can be externalized, the flaps are made at 6 and 12 o'clock positions, as the vertical diameter of the cornea is less than the horizontal **(4)**.

Another modification, the sclerostomy can be made 0.5 mm from the limbus instead of 1.5 mm. This shifts the IOL plane anteriorly, thereby allowing haptics to traverse a lesser distance and allowing greater haptic externalization. But, these modifications usually associated with complications, such as iridodialysis, intraoperative bleeding, and pigmentary disturbances. Some of these complications are preventable by doing a prior vitrector-assisted peripheral iridectomy **(4)**.

Recently a new design of the lens, also known as the **Carlevale lens (Figure 3)**, has been described. It is a 13.2-mm-long single-piece hydrophilic acrylic IOL with a 6.5-mm-wide optic plate featuring T-shaped harpoons protruding off the closed haptics to allow self-anchoring on the sclera without the need for sutures. However, a scleral flap is needed to cover the harpoons **(5).**



A B

Figure (3) Carlevale lens: a 13.2-mm-long single-piece hydrophilic acrylic IOL with a 6.5-mm-wide optic plate featuring T-shaped harpoons protruding off the closed haptics to allow self-anchoring on the sclera without the need for sutures **(5).**

Techniques of Sutureless SFIOL Using Scleral Tunnel Without Scleral Flaps:

Gabor and Pavlidis first described sutureless intrascleral haptic fixation by creating sclerostomies and scleral tunnels adjacent to each other using a 24 G needle without creating scleral flaps. The authors found that since the sclerotomy entry site and scleral tunnel were adjacent, it made tucking-in of haptics difficult **(6).**

1. **Flanged intrascleral intraocular lens fixation with double-needle technique.**

In the Yamane technique: which is a flapless, sutureless transconjunctival technique using a 30-gauge needle **(Figure 4)**. A three-piece IOL is inserted into the anterior chamber using an injector, the trailing haptic is kept outside to prevent dropping of the IOL into the vitreous cavity. An angled sclerotomy is made through the conjunctiva 2 mm from the limbus using a 30-gauge needle with an ultra-thin wall. The leading haptic is threaded into the lumen of the needle using forceps **(Figure 5)**. Then, a second sclerotomy is made with a second needle 180 degrees from the first sclerotomy. The trailing haptic is inserted into the lumen of the second needle in the same way as before. Then, both haptics are externalized onto the conjunctiva **(Figure 6)**. The ends of the haptics are cauterized using an ophthalmic cautery device to make a flange with a diameter of 0.3 mm **(Figure 7)**. At the end, the flange of the haptics is pushed back and fixed into the scleral tunnels and covered by the conjunctiva **(7).**

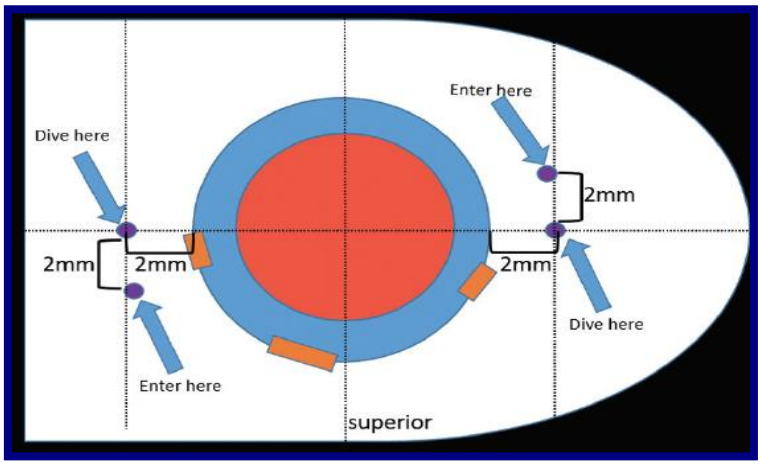


Figure (4) Surgical landmarks in Yamane technique: 2 limbal conjunctival marks were placed exactly 180° apart at 3 and 9 o'clock with ink pen or a simple visco-cannula, The 1st conjunctival mark was placed 2mm from

the limbal mark and the 2nd mark was placed 2mm away from the 1st one and parallel to the limbus, Similar marks were placed on the opposite side of the globe and in counter-clockwise direction **(7).**

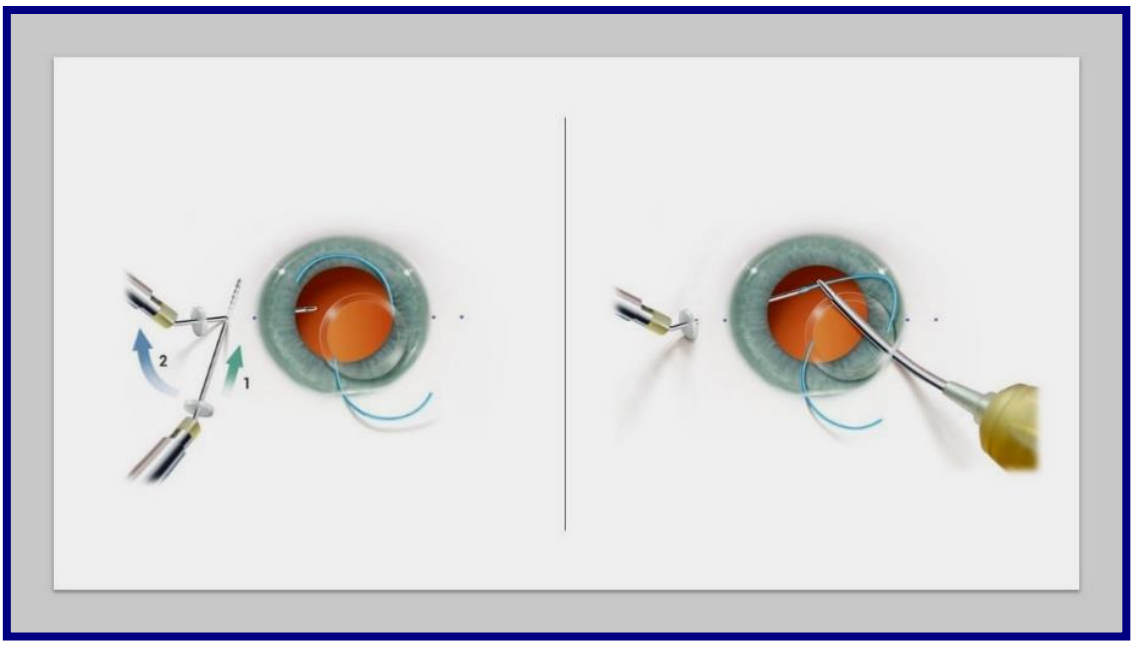


Figure (5) A three-piece IOL is inserted into the anterior chamber using an injector, the trailing haptic is kept outside to prevent dropping of the IOL into the vitreous cavity. An angled sclerotomy is made through the conjunctiva 2 mm from the limbus using a 30-gauge needle with an ultra-thin wall. The leading haptic is threaded into the lumen of the needle using forceps **(7).**

Figure (6) Simultaneous Externalization of both haptics

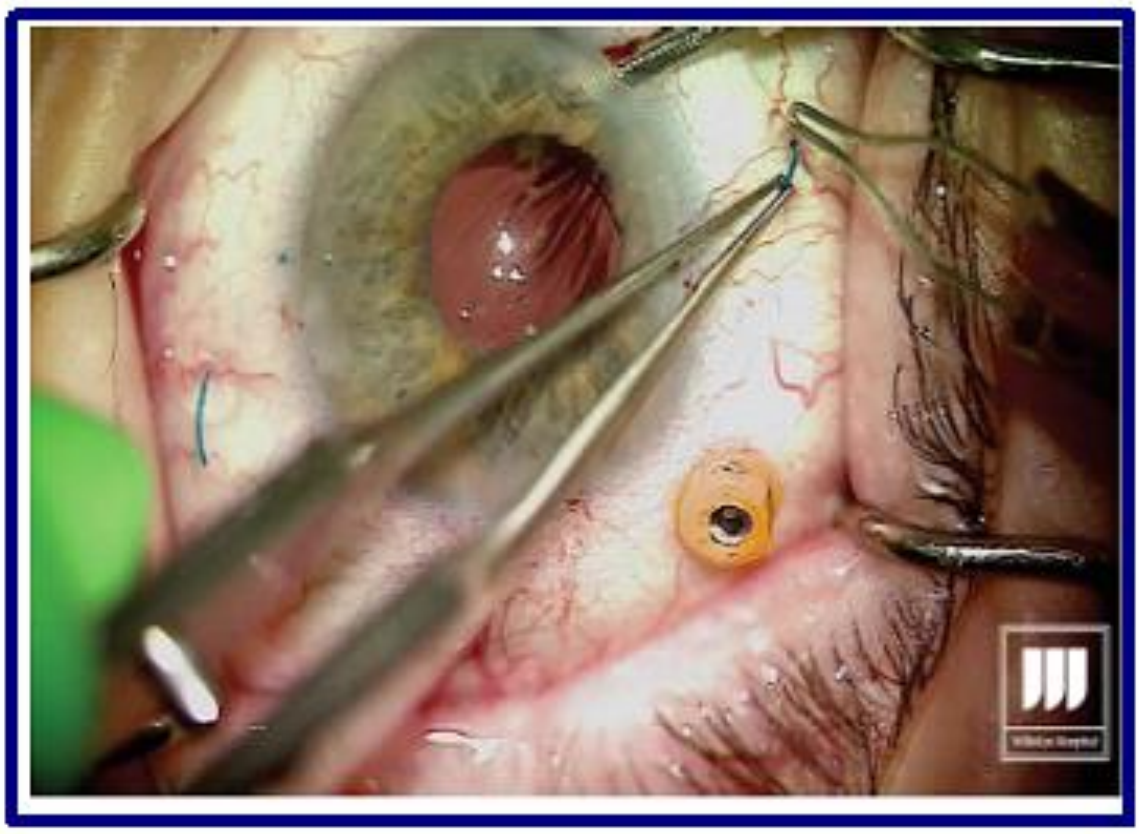


Figure (7): Haptics ends cauterization**:** The ends of the haptics are cauterized using an ophthalmic cautery device to make a flange with a diameter of 0.3 mm **(7).**

Modifications for simplifying the original Yamane's technique:

In the original Yamane technique, externalization of the trailing haptic is the most difficult step in the whole procedure. So, most of modifications that have been applied to the original technique are aimed to facilitate this step **(8).**

1. Using 27G needle:

Both 30G and 27G needles have an inner diameter of 0.2 mm allowing for smooth docking of the haptic, but 27G needle has 0.4 mm outer diameter compared to the ultrathin wall 30G needle used in the original Yamane's technique. So, a slightly larger flange is required with 27G needle **(9).**

2. Sequential haptic externalization (Leading haptic first):

The leading haptic is externalized and fixed first before manipulating the trailing haptic to avoid potential risks of the needle left inside the eye **(10). Hwang et al.,** postulated that fixing the leading haptic in the scleral tunnel will allow a favorable angle to dock the trailing haptic **(11).**

3. Trailing haptic first (Kim modification):

Kim modification is a major departure from the original Yamane's technique. In this modification, the leading haptic is injected and externalized via inferior corneal paracentesis at 6 o'clock using microforceps. After externalization of the trailing haptic, the leading haptic is re-internalized and docked **(Figure 8) (12).**

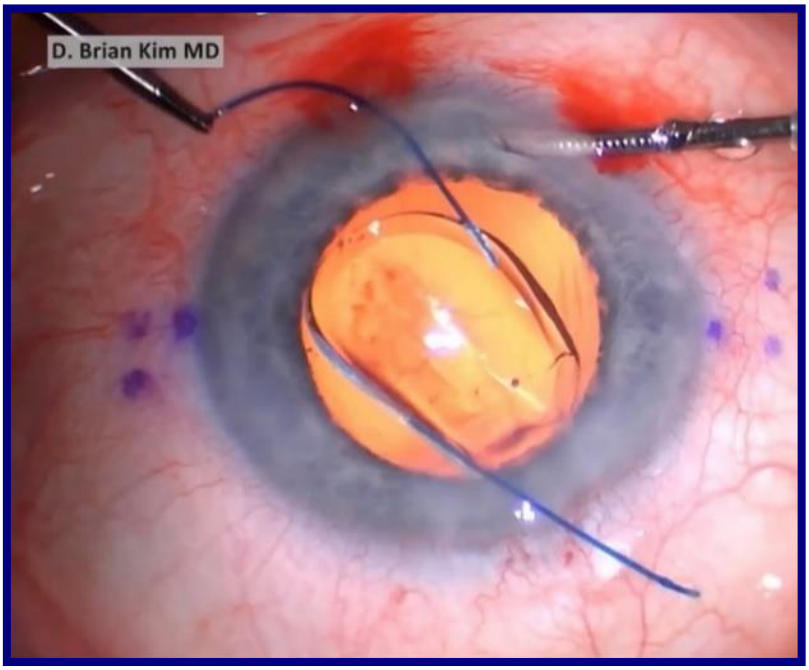


Figure (8) Kim modification: the leading haptic is injected and externalized via inferior corneal paracentesis at 6 o'clock using microforceps **(12).**

Externalization of the leading haptic prevents the IOL from dropping posteriorly into the vitreous cavity. In addition, sitting of the IOL in a more anterior plane makes it easier to dock the trailing haptic into the right-side needle lumen. The two needles are pulled out once both of the docked haptic-needle complexes are in place **(12).**

4. Docking the trailing haptic outside the corneal incision:

To facilitate threading of the trailing haptic, **Ifantides et al.,** published this modification. After externalization and fixation of the leading haptic, the second needle is externalized through the main corneal incision and docked into its lumen **(Figure 9) (8).**

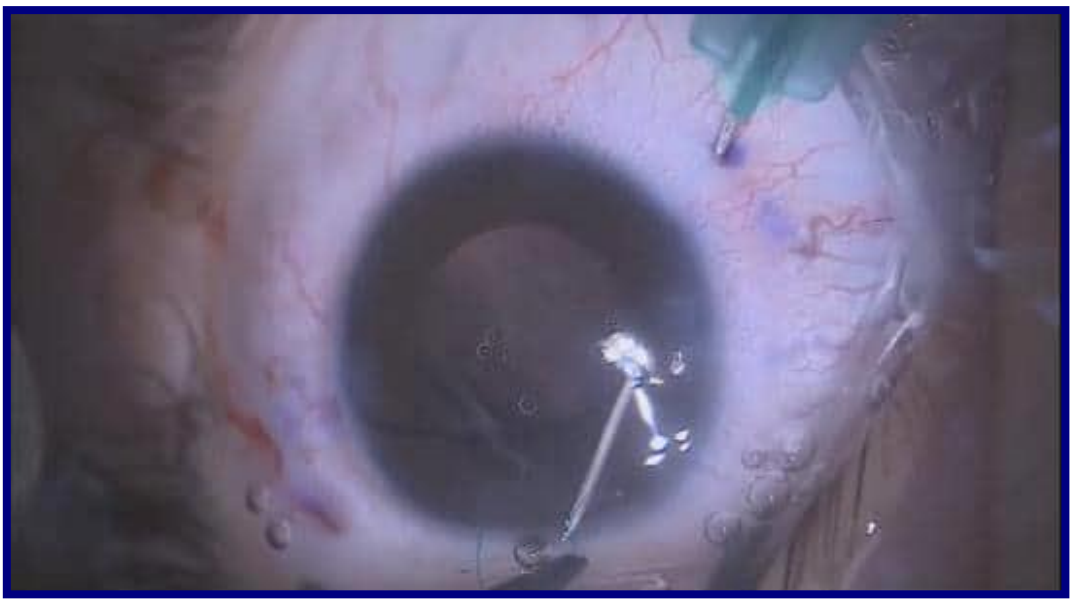


Figure (9): After externalization and fixation of the leading haptic, the second needle is externalized through the main corneal incision and docked into its lumen **(8).**

5. Trimming of the haptic:

Haptics trimming can be performed to achieve optimum IOL centration which provides more IOL stability and prevents its rotation **(13).** Also, it can be performed for repositioning of tilted IOL **(14).**

6. Suture-assisted haptic externalization:

To minimize anterior segment manipulation and haptic deformation, 8/0 absorbable sutures are used to tie knots at each haptic end. The sutures, not the haptics are inserted into the needles. The IOL is fixed by making a flange at the end of each haptic end **(15).**

7. Trocar-guided intrascleral flanged IOL fixation:

In this procedure, 27G trocars are used to perform the scleral tunnels, and the haptics are grasped and pulled out using 27G retinal forceps. Then, a sufficient flange is created at the haptic end **(Figure 10) (16).**

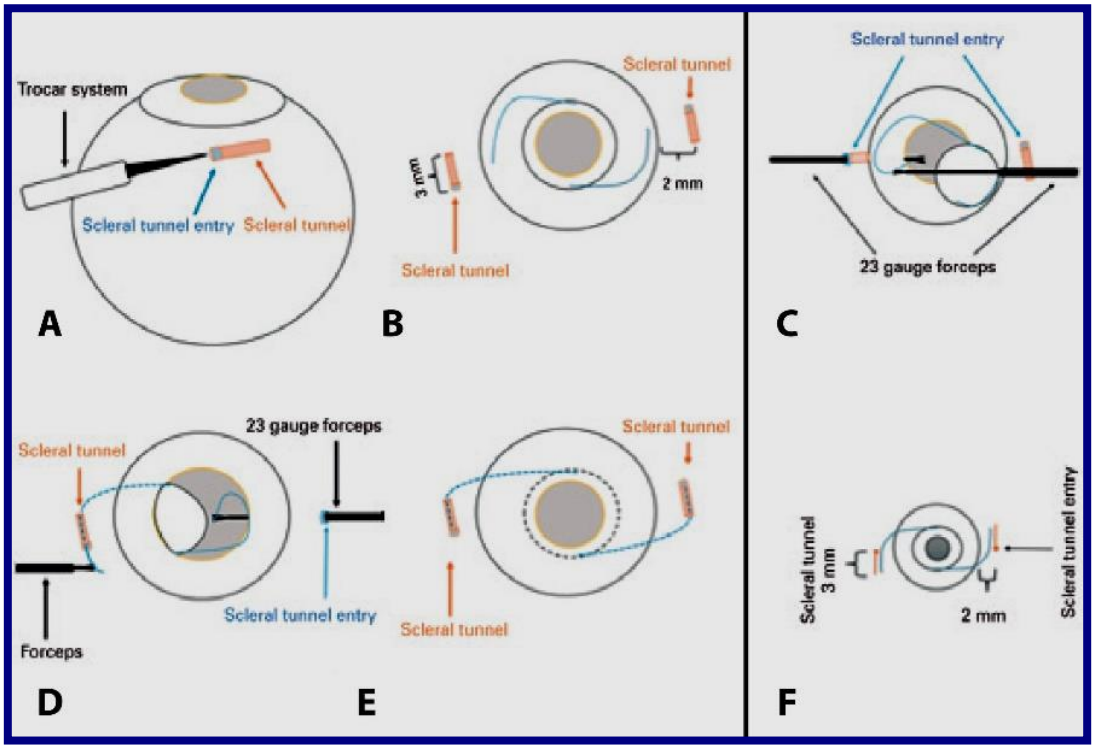


Figure (10) Trocar-guided intrascleral IOL fixation**:** 27G trocars are used to perform the scleral tunnels, and the haptics are grasped and pulled out using 27G retinal forceps. Then, a sufficient flange is created at the haptic end **(16).**

In 2020, Ahmed Samir et al. introduced an innovative technique for scleral fixation of single-piece foldable intraocular lenses (IOLs) using a double flanged 6/0 prolene suture. This novel approach aimed to achieve efficient transconjunctival intrascleral fixation of the IOL while ensuring improved visual outcomes. The procedure begins with the preparation of the lens. The fixation points for the 6/0 prolene suture on the haptics are determined based on the design of the IOL, specifically at the widest span of the haptics. A 30 gauge needle is passed through the haptic, and the 6/0 prolene suture is threaded through the lumen of the needle. The needle is then withdrawn, leaving the suture passing through the needle track and the haptic. Using a handheld ophthalmic cautery (Accu-Temp Cautery), the free end of the prolene suture on the inner side of the haptic is heated to form a terminal bulb (flange) that prevents the suture from slipping. This process is repeated for the other haptic. The IOL, now attached to two prolene sutures, is loaded into an injector with the sutures carefully positioned to remain distinguishable. A 2.4 mm clear corneal incision is created, and an anterior vitrectomy is performed to clear the visual axis of vitreous or capsular remnants and to release any iris adhesions, ensuring proper placement of the IOL. The anterior chamber is then filled with ophthalmic viscosurgical device (OVD) to facilitate the procedure. Using a 30-gauge

needle, transconjunctival scleral sclerotomies are made 2 mm posterior to the limbus. The needle is directed to emerge through the pupil. With the IOL injector held near the corneal incision, a micro-grasper or McPherson forceps is used to pass the prolene suture attached to the leading haptic into the lumen of the needle. The needle is withdrawn, externalizing the suture at the desired fixation site. This step is repeated for the other sclerotomy and haptic. After both sutures are externalized, the IOL is injected into the eye and gently centered under the iris by applying equal traction on the prolene sutures. The sutures are pulled snugly and held flush with the sclera using tying forceps. A handheld cautery is used to create terminal flanges at the external ends of the prolene sutures. These flanges are embedded into the scleral tracks and concealed under the conjunctiva. Finally, the OVD is washed out, and the corneal wound is sealed with an intrastromal suture. This technique offers a secure and efficient method for scleral fixation of 34 Double Flanged Fixated versus Trans-scleral Sutured Intraocular Lens for Correction of Aphakia foldable IOLs, with reduced surgical complexity and reliable centration of the lens. The double-flanged design ensures stability while minimizing the risk of complications

Complications:

Complications of sutured scleral-fixated IOL

- **Intraoperative complications:**

  1. **-Vitreous or Suprachoroidal hemorrhage**: vitreous hemorrhage usually occures in association with passing the polypropylene suture through the sclera 1.5 mm posterior to the limbus. The hemorrhage appeares to arise either from extraocular blood wicked into the eye through the puncture which is usually mild and stops after hemostasis, from the ciliary body or from suprachoroidal hemorrhage. The hemorrhage arises from extraocular blood usually resolves within 2 weeks after surgery (**17).**

- **Frequent suture breakage:** Using 10-0 polypropylene fixation sutures is less durable and may be associated with high risk of suture breakage and degradation-related complications. 9-0 and 8-0 polypropylene sutures have higher tensile strength, resulting in less suture breakage and degradation. The mechanism of polypropylene suture breakage has been attributed to both sutures cutting by haptic positioning and degradation of the material itself **(18, 19).**

Postoperative complications:

1. **Transient corneal edema:** the most common early postoperative complication is transient corneal edema. It occurs within the first 3 days after surgery. Usually, no patient sufferes from visual loss or requires secondary surgery **(20).**
2. **IOL dislocation:** before the advent of haptic suture eyelets, suture slippage from around the haptics was a contributor to IOL dislocation after sutured SFIOL implantation. The Alcon CZ70BD lens has become a popular choice for SFIOL cases because of its eyelets on each haptic through which suture can be passed **(21)**.
3. **IOL tilt and resultant astigmatism:** often with a 2-point fixation technique a lens that has only 2 eyelets is used. Therefore, it may be susceptible to lens tilt that can cause higher-order aberrations that cannot be corrected with spectacles **(21)**.
4. **Pseudophacodonesis & Pupillary capture of the PCIOL.**
5. **Ocular hypertension:** This may be due to OVD, hyphema, steroid induced, ocular trauma or pre-existing glaucoma **(22).**
6. **Hypotony**: removal of residual lens material, extensive vitrectomy, repair of large iris defects, and patient risk factors, such as peripheral vascular disease, glaucoma, aortic stenosis, and previous eye surgery **(23).**
7. **Retinal detachment, especially in patients with high myopia and Marfan syndrome:** Although Malbran's 1986 technique also used ab externo passes, most surgeons at the time were making large

corneal wounds or operating under an open sky to allow for suture passes to be made from inside the eye to outside the eye (ab interno). This was a blind maneuver that was associated with retinal detachment, hemorrhage, and unpredictable placement of the lens haptics **(21)**.

8. **Knot erosion through sclera & Endophthalmitis:** Knot erosion through the conjunctiva following sutured SFIOL surgery can be associated with endophthalmitis after the knots erode through the conjunctiva, as the suture provides a direct avenue for exogenous bacteria to enter the eye. To solve this problem, Lewis made triangular scleral flaps prior to entering the eye with his needle passes, and hinged scleral tissue was used to cover the suture knots at the end of the procedure **(24).**

- **Complications of suturless scleral-fixated IOL**

Intraoperative complications:

1. **Haptic rebound and IOL drop:** Haptic rebound and IOL drop are important intraoperative complications of SFIOL implantation that can prolong the surgery time and can also lead to other subsequent iatrogenic complications such as retinal breaks. IOL haptic can rebound or slip back into the vitreous cavity in two instances. The first instance is when the leading haptic is pulled during manipulation and threading of the trailing haptic, this can be prevented by using silicone stopper, first introduced by **Beiko and Steinert** and later modified by **Baskaran and colleagues (25, 26),** the second common instance of haptic rebound is when the leading haptic is being tucked into the scleral tunnel after removing the stopper **(27).**
2. **Other complications including**: vitreous hemorrhage, and hypotony were reported by Yamane at a low rate **(7)**

- **Postoperative complications:**

1. **Iris capture**: more in those who received IOL with optic diameter of 6 mm than those who received IOL with optic diameter of 7 mm. Also, more in younger patients. **Yamane et al**. created a peripheral iridotomy in all cases to prevent iris capture caused by reverse iris block, but there is a possibility that the size of the peripheral iridotomy was too small and not effective enough **(7).**
2. **IOL tilt/decentration:** Sequential haptic externalization (Leading haptic first) may cause decentration and tilting of the IOL **(10).** Inappropriate positioning of the insertion points and angles of the two needles may also cause decentration and tilting of the IOL **(28).**

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