cleral fixation of intraocular lenses (IOL) is preferred by many surgeons in eyes with insufficient capsular support for numerous reasons, including placement of the IOL in the nearly original/natural position of the crystalline lens and minimal damage of the corneal endothelium.\textsuperscript{1,2} Sutured scleral fixation IOL techniques are associated with disadvantages such as technical difficulty, necessity for intraocular manipulation, late IOL dislocations, suture-related complications, and posterior segment complications.\textsuperscript{1,3-5} In a histologic study, it was shown that IOL stability mainly depends on the durability of non-absorbable sutures instead of fibrous encapsulation or secure placement of the haptics into the sulcus.\textsuperscript{4} Sutured IOL dislocations most probably result from suture fatigue or inadvertent removal of the sutures.\textsuperscript{1,3-5} Sutureless intrascleral fixation methods are newer and have been developed to eliminate the suture-related complications of sutured scleral fixation methods such as suture-induced inflammation or infection and IOL dislocation or subluxation due to suture degradation or suture breakage. Sutureless intrascleral fixation methods aim for intrascleral haptic fixation to achieve stability of the IOL. Various methods of sutureless scleral fixation have been described. Using a needle, a blade, or a trochar, sclerostomies are created in all techniques for intraocular access. Some surgeons prefer to create scleral tunnels, whereas others use scleral flaps for scleral fixation of haptics. The stability of IOLs is attained by the scar tissue formed around the haptics.

CONCLUSIONS: Short-term results of these new methods are acceptable; studies including more cases with longer follow-up are needed to determine their long-term success.

\textsuperscript{7-20} These can be categorized into two groups: methods that use a scleral tunnel without creating scleral flaps (surgeries performed with a needle or a blade, transconjunctival methods, and methods performed with a scleral lamellar incision) and methods that create scleral flaps (fibrin glue and sutures without fibrin glue).
<table>
<thead>
<tr>
<th>Study</th>
<th>Eyes (n)</th>
<th>Follow-up (mo)</th>
<th>Techniques</th>
<th>Intraoperative Complications (%)</th>
<th>Early Postoperative Complications (%)</th>
<th>Late Postoperative Complications (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gabor &amp; Pavlidis, 2007</td>
<td>5</td>
<td>3</td>
<td>Scleral tunnel with 24-gauge needle</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scharioth et al., 2010</td>
<td>63</td>
<td>6.8</td>
<td>Scleral tunnel with 24-gauge needle</td>
<td>N/A</td>
<td>Corneal edema (7.94), persistent IOP elevation (3.17), spontaneous IOL dislocation (3.17), minimal vitreous hemorrhage (3.17), cystoid macular edema (1.59), persistent hypotony (1.59), iris capture of IOL (1.59), traumatic IOL subluxation (1.59)</td>
<td></td>
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<tr>
<td>Wilgucki et al., 2015</td>
<td>24</td>
<td>12</td>
<td>Scleral tunnel with 23-gauge trochar system</td>
<td>N/A</td>
<td>Vitreous hemorrhage (8), elevated IOP (4), hypotony (4), conjunctival hemorrhage (4)</td>
<td></td>
</tr>
<tr>
<td>Akimoto et al., 2015</td>
<td>25</td>
<td>3</td>
<td>24-gauge catheter and scleral tunnel with 30-gauge needle</td>
<td>–</td>
<td>Limited vitreous hemorrhage (8), ocular hypertension (8), cystoid macular edema (4), iris capture (4)</td>
<td></td>
</tr>
<tr>
<td>Totan &amp; Karadag, 2012</td>
<td>8</td>
<td>5 to 8</td>
<td>Trochar-assisted transconjunctival</td>
<td>No</td>
<td>Iris capture of IOL (8.6), transient ocular hypertension (6.7), cystoid macular edema (2.9)</td>
<td>N/A</td>
</tr>
<tr>
<td>Yamane et al., 2014</td>
<td>35</td>
<td>10.1</td>
<td>Scleral tunnel with 27-gauge needle and lamellar scleral dissection</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agarwal et al., 2008</td>
<td>10</td>
<td>1.5</td>
<td>Scleral flap and fibrin glue</td>
<td>Haptic breakage (0.4), deformed haptics (0.9), hyphema (0.4)</td>
<td>Corneal edema (5.7), anterior chamber cells 2+ (2.4), epithelial defect (1.9), anterior chamber cells 4+ (1.4), anterior chamber cells 3+ (0.9); transient raised IOP (0.4), hyphema (0.4), IOL decent (0.4)</td>
<td>Optic capture (4.3), decented IOL (3.3), cystoid macular edema (1.8), haptic extrusion (1.9), pigment dispersion (1.9), subconjunctival haptic (1.4), corneal opacity (1.4), scleral thinning (0.9), persistent corneal edema (0.4), glaucoma (0.4), uveitis (0.4)</td>
</tr>
<tr>
<td>Kumar et al., 2013</td>
<td>208</td>
<td>16.7</td>
<td>Scleral flap and fibrin glue</td>
<td>Haptic breakage (0.4), deformed haptics (0.9), hyphema (0.4)</td>
<td>Corneal edema (5.7), anterior chamber cells 2+ (2.4), epithelial defect (1.9), anterior chamber cells 4+ (1.4), anterior chamber cells 3+ (0.9); transient raised IOP (0.4), hyphema (0.4), IOL decent (0.4)</td>
<td>Optic capture (4.3), decented IOL (3.3), cystoid macular edema (1.8), haptic extrusion (1.9), pigment dispersion (1.9), subconjunctival haptic (1.4), corneal opacity (1.4), scleral thinning (0.9), persistent corneal edema (0.4), glaucoma (0.4), uveitis (0.4)</td>
</tr>
<tr>
<td>Kim et al., 2015</td>
<td>16</td>
<td>10.1</td>
<td>Scleral flap and fibrin glue</td>
<td>Haptic breakage (0.4), deformed haptics (0.9), hyphema (0.4)</td>
<td>Corneal edema (5.7), anterior chamber cells 2+ (2.4), epithelial defect (1.9), anterior chamber cells 4+ (1.4), anterior chamber cells 3+ (0.9); transient raised IOP (0.4), hyphema (0.4), IOL decent (0.4)</td>
<td>Optic capture (4.3), decented IOL (3.3), cystoid macular edema (1.8), haptic extrusion (1.9), pigment dispersion (1.9), subconjunctival haptic (1.4), corneal opacity (1.4), scleral thinning (0.9), persistent corneal edema (0.4), glaucoma (0.4), uveitis (0.4)</td>
</tr>
</tbody>
</table>

IOL = intraocular lens; N/A = not available; IOP = intraocular pressure
## TABLE 2
Comparison Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Eyes (n)</th>
<th>Follow-up (mo)</th>
<th>Intraoperative Complications (%)</th>
<th>Postoperative Complications (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kumar et al., 2011</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glue technique single-piece PMMA IOL</td>
<td>152</td>
<td>9.7</td>
<td>Hyphema (1.31)</td>
<td>Early postoperative (&lt; 1 month): IOL decentration (1.97), macular edema (1.97); late postoperative (&gt; 1 month): optic capture (2.63), pigment dispersion (1.97), chronic macular edema (1.97)</td>
</tr>
<tr>
<td>Glue technique three-piece foldable IOL</td>
<td>21</td>
<td>6</td>
<td>–</td>
<td>Subconjunctival haptic (19), decentration (4.8), resolving vitreous hemorrhage (14.3), optic capture (14.3)</td>
</tr>
<tr>
<td><strong>Totan &amp; Karadag, 2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transconjunctival trochar-assisted</td>
<td>12</td>
<td>6 to 15</td>
<td>–</td>
<td>Transient corneal edema (16.6), transient ocular hypertension (8.3), subconjunctival hemorrhage (16.6), minimal transient vitreous hemorrhage (8.3)</td>
</tr>
<tr>
<td>24-gauge needle</td>
<td>17</td>
<td>9 to 18</td>
<td>Conjunctival laceration (23.5)</td>
<td>Transient corneal edema (11.7), transient ocular hypertension (11.7), subconjunctival hemorrhage (11.7)</td>
</tr>
<tr>
<td><strong>Abbey et al., 2015</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transconjunctival trochar cannulas</td>
<td>15</td>
<td>12</td>
<td>Haptic dislocation during surgery (20)</td>
<td>Cystoid macular edema (13.3), secondary glaucoma (6.3), vitreous hemorrhage (6.3), hypotony (13.3), presumed endophthalmitis (6.3)</td>
</tr>
<tr>
<td>Scleral tunnel with microvitreoretinal blade</td>
<td>8</td>
<td>12</td>
<td>–</td>
<td>Secondary glaucoma (25), vitreous hemorrhage (12.5)</td>
</tr>
<tr>
<td><strong>Ohta et al., 2014</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y fixation (intrascleral) fixation</td>
<td>44</td>
<td>–</td>
<td>–</td>
<td>IOL dislocation and tilt (5), temporary IOP increase (9), vitreous hemorrhage (6), retinal detachment (2)</td>
</tr>
<tr>
<td>Sutured fixation</td>
<td>40</td>
<td>–</td>
<td>–</td>
<td>IOL dislocation and tilt (18), temporary IOP increase (13), vitreous hemorrhage (18), cystoid macular edema (3), retinal detachment (3)</td>
</tr>
<tr>
<td><strong>Saleh et al., 2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutureless intrascleral haptic fixation</td>
<td>8</td>
<td>14</td>
<td>Haptic breakage (12.5)</td>
<td>Conjunctival erosion due to haptic exposure (12.5), macular edema (25)</td>
</tr>
<tr>
<td>Retropupillary iris-claw IOL</td>
<td>18</td>
<td>18</td>
<td>No</td>
<td>Macular edema (16.6), disenclavation (5.5)</td>
</tr>
</tbody>
</table>

PMMA = polymethylmethacrylate; IOL = intraocular lens; IOP = intraocular pressure
METHODS THAT USE SCLERAL TUNNEL WITHOUT CREATING SCLERAL FLAPS

Surgeries in this group can be categorized into three subgroups.

SUTURELESS INTRASCLERAL FIXATION IOL IMPLANTATION PERFORMED WITH A NEEDLE OR A VITREORETINAL BLADE

Gabor and Pavlidis\(^7\) were the first to describe sutureless intrascleral fixation IOL implantation. In this technique, a pars plana vitrectomy is performed and a corneal incision is made. Then, two sclerotomies are performed 1.5 to 2 mm posterior to the limbus and 180° away from each other with a 24-gauge needle. Scleral tunnels of 2 to 3 mm length and parallel to the limbus are formed from these sclerotomy sites with a 24-gauge needle. A three-piece foldable IOL is injected through the corneal incision. While holding onto the IOL, each of the haptics is removed from the eye through the sclerotomy site with...
25-gauge forceps and inserted into the scleral tunnel (Figures 1-2). This technique allowed the authors to perform the scleral fixation technique with no suture-related complications. In a subsequent four-center retrospective study using a similar technique, the authors observed 63 patients and reported on intermediate-term results. Postoperative complications included transient corneal edema in 7.9%, elevated intraocular pressure (IOP) in 3.2%, spontaneous IOL dislocation in 3.2%, vitreous hemorrhage in 3.2%, cystoid macular edema in 1.6%, persistent hypotony in 1.6%, iris capture of IOL in 1.6%, and traumatic IOL subluxation in 1.6% of patients.

Prenner et al. revised this technique and used a 23-gauge trochar system instead of a 24-gauge needle for scleral tunnel formation after a 270° conjunctival peritomy and published 1-year results in 24 patients. Short-term complications included vitreous hemorrhage in 8%, elevated IOP in 1 eye, and hypotony in 1 eye. As for long-term complications, spontaneous IOL dislocation developed in 3 eyes, iris capture developed in 1 eye, and cystoid macular edema developed in 1 eye. The authors later emphasized that one should be careful about the long-term stability of these IOLs. Extensive peritomy, especially when combined with scleral cautery, is

Figure 2. (A) Opening of sclerotomy with a 24-gauge needle, 1.5 mm from the limbus, parallel to the iris plane. (B) Implantation of a standard three-piece foldable intraocular lens into the anterior chamber. (C-F) Capture and removal of the haptic tip by a 25-gauge serrated retinal forceps entering from sclerotomy openings assisted by a 23-gauge serrated retinal forceps entering from the opposite corneal paracentesis. (G) Preparation of a 3-mm scleral tunnel parallel to the limbus by a 24-gauge needle starting from the sclerotomy and extending to the distal end. (H-I) Haptics placement into the scleral tunnel.
likely to make further conjunctival interventions more difficult for these complicated eyes. Additionally, cauteryization may increase the risk of scleromalacia later in life.\textsuperscript{11} Thompson et al. reported a case of ghost cell glaucoma in an eye operated on with this technique.\textsuperscript{12} They found that the iris and the IOL were in mechanical contact and managed it with IOL removal.

In their experimental study, Akimoto et al.\textsuperscript{13} modified the technique by using a 24-gauge catheter needle to engage the lens haptics. They customized the 24-gauge catheter to suit the eye, entered the intraocular space from the previously formed sclerostomy, and exited through the corneal incision. Then they placed the lens haptic, which was loaded on the cartridge, on the tip of the catheter and the IOL was inserted into the eye. The other haptic was attached to the catheter that was inserted through the other sclerostomy. Once the IOL was placed in the eye, the catheters and the haptics were removed from the scleral incision and the haptics disengaged from the catheters. They used a 27- or 30-gauge needle for scleral tunnel formation 1 mm from the sclerotomy. Finally, the haptics were inserted into scleral tunnels.\textsuperscript{13} In this technique, the step involving the placement of the second haptic on the catheter and removal from the eye is harder, increasing the possibility of damaging the surrounding tissues.\textsuperscript{14} Akimoto et al. later modified this technique to use a 30-gauge ultrathin needle with the catheter needle while externalizing the second haptic. This modified technique was performed on 25 eyes of 24 patients. As for complications, limited vitreous hemorrhage was reported in 2 eyes, ocular hypertension in 2 eyes, ocular hypotension in 1 eye, and iris capture in 1 eye.\textsuperscript{15}

The method that was first described by Gabor and Pavlidis and performed with a 24-gauge needle prevented suture-related complications and achieved good IOL stability.\textsuperscript{7,8} Entry to the sclerotomy and the scleral tunnel are adjacent to each other and therefore placement of the haptic may not be easy. Thus, one should be careful while inserting the IOL haptics into the scleral tunnel using this technique.\textsuperscript{16}

**Transconjunctival Approaches**

In the literature, the transconjunctival approach was first described with our technique.\textsuperscript{17} In our technique, we access the intraocular space with one entry on each side by forming a 3-mm scleral tunnel 1.5 mm from and parallel to the limbus. During the tunnel preparation, the sclera is entered transconjunctivally at a flat (approximately 10°) angle using the 23- or 25-gauge vitrectomy trocar, 180° from each other, preloaded with the overlying microcannula. The trocar is then removed, leaving the microcannula in place. The trochar cannulae are left inside the scleral tunnel and a vitrectomy is performed through these cannulae. We then grasp one haptic of the three-piece foldable IOL, which was inserted through a clear corneal incision, with forceps that pass through the corneal incision. The haptic is grasped with 23- or 25-gauge forceps that go through the microcannula. The haptic is externalized from the eye together with the cannula. These steps are repeated for the other haptic. This way, haptics are placed intra-sclerally (Figure 3). Finally, a transconjunctival safety suture is placed at the scleral tunnel entry site around the haptic with a 10-0 nylon suture. This suture is removed at 1 week postoperatively.\textsuperscript{16,17} In a later study, we compared 17 eyes operated on with a 24-gauge needle against 12 eyes operated on with the trochar technique.\textsuperscript{16} In the 24-gauge needle technique, transient corneal edema was observed in 2 eyes, elevated IOP in 2 eyes, subconjunctival hemorrhage in 2 eyes, and conjunctival laceration in 4 eyes. In the trochar technique, transient corneal edema was observed in 2 eyes, IOP increase in 1 eye, subconjunctival hemorrhage in 2 eyes, and minimal vitreous hemorrhage in 1 eye. Other than requiring more extensive conjunctival incisions in the 24-gauge needle technique, complications were similar in the two methods.\textsuperscript{16}

Abbey et al.\textsuperscript{18} compared 15 cases operated on with this technique with 8 cases in which a scleral tunnel was formed with a microvitreoretinal knife. In the trochar technique, haptic dislocation was observed in 20% of eyes as an intraoperative complication. Postoperatively, they found cystoid macular edema in 2 eyes, secondary glaucoma in 1 eye, vitreous hemorrhage in 1 eye, hypotony and choroidal detachment in 2 eyes, and suspicious endophthalmitis in 1 eye. In the scleral tunnel with a microvitreoretinal blade technique, secondary glaucoma was observed in 2 eyes and vitreous hemorrhage was observed in 1 eye. They reported significant improvement in vision with minimal complications using both techniques.\textsuperscript{18}

Minimal conjunctiva is violated in the transconjunctival technique, allowing a large portion of the conjunctiva to be used in later surgeries.\textsuperscript{16-20} Also, because no cauteryization is performed, there is no possibility of cautery-related scleromalacia.\textsuperscript{21} The operating time is shorter because the conjunctiva is not opened separately, no cauteryization is performed, and no scleral flap is formed. However, the need for specific tools for this technique is a disadvantage.\textsuperscript{16,17} Another disadvantage of this technique is the increased predisposition for endophthalmitis and hypotony because of transconjunctival application. We placed a safety suture to prevent these complications and to ensure IOL stability in the early postoperative period.\textsuperscript{16,17}
Sutureless Intrasceral Fixated IOL Implantation Performed With a Scleral Incision

In Gabor and Pavlidis’s technique described above, insertion of the haptic is difficult because the entry sites of the sclerotomy and scleral tunnel are adjacent. Therefore, the chance of damaging the IOL haptics while inserting them into the scleral tunnel is higher. The following methods were developed to make inserting the haptics into the scleral tunnel easier and safer.

Yamane et al. performed lamellar sutureless intrasceral fixation IOL implantation with the help of a 27-gauge needle in 35 eyes. The authors first created entries for a 25-gauge vitrectomy and then performed 1.5-mm long half-thickness lamellar scleral incisions parallel to the limbus after opening the conjunctiva. They performed two 1.5-mm long scleral tunnel incisions starting at these two lamellar incisions with a 27-gauge needle. They then entered the eye through sclerotomies with 27-gauge needles, externalized both haptics from the eye, and inserted the haptics 1.5 mm into the scleral tunnels (Figure 4). Later, they performed a peripheral iridectomy. Postoperatively, iris capture was reported in 8.6%, transient ocular hypertension in 5.7%, and cystoid macular edema in 2.9% of eyes. Using a 1.5-mm scleral incision made the insertion of IOL haptics into the scleral tunnel easier when compared to the 24-gauge needle method. However, inserting only 1.5 mm of the haptics into the scleral tunnel may not be enough support for long-term IOL stability.

In their Y-fixation method, Ohta et al. made two Y-shaped scleral incisions 2 mm away from the limbus and 180° opposite to each other after opening the conjunctiva. A scleral flap in the shape of a...
small triangle was created. Then, a scleral tunnel was formed from the open end of the Y-incision parallel to the limbus. A three-piece foldable IOL was injected into the anterior chamber and the haptics were externalized through the sclerotomies with 25-gauge forceps. Haptics were inserted into the scleral tunnel with forceps and fixated onto the scleral bed with 8-0 nylon sutures. Afterward, the scleral flaps and conjunctiva were closed with 8-0 polyglactin 910 sutures. Forty-four eyes of 40 patients who were operated on with this technique were assessed retrospectively and these eyes were compared to 40 eyes of 36 patients that underwent IOL implantation with sutured scleral fixation. Among patients operated on with the
Y-fixation method, IOL dislocation/tilt was observed in 5%, elevated IOP in 9%, vitreous hemorrhage in 6%, and retinal detachment in 2%. Among patients in the suture-fixation group, IOL dislocation/tilt was observed in 18%, elevated IOP in 13%, vitreous hemorrhage in 18%, cystoid macular edema in 3%, and retinal detachment in 3%. The authors noted that there were significantly fewer complications in the Y-fixation group. However, this suture was made of non-absorbable material and was not removed after the surgery. Therefore, this technique is really a modified sutured intrascleral posterior chamber IOL fixation. Matsui et al. presented a case that developed haptic exposure 4 months after IOL fixation using the Y-fixation method and reported that this complication may result from poor surgical technique or scleral fragility.

**SUTURELESS INTRASCLERAL FIXATION IOL IMPLANTATION PERFORMED WITH A SCLERAL FLAP FIBRIN GLUE**

In the fibrin glue-assisted sutureless intrascleral fixation IOL procedure that was described by Agarwal et al., two limbus-based scleral flaps are formed 180° away from each other. A vitrectomy is performed and two sclerotomies are formed 1.5 mm away from the limbus under the scleral flap with a 22-gauge needle. Then, haptics are externalized from the eye with forceps and inserted into the previously formed scleral tunnels with a 26-gauge needle. However, this suture was made of non-absorbable material and was not removed after the surgery. Therefore, this technique is really a modified sutured intrascleral posterior chamber IOL fixation. Matsui et al. presented a case that developed haptic exposure 4 months after IOL fixation using the Y-fixation method and reported that this complication may result from poor surgical technique or scleral fragility.

![Figure 5. Sutureless intrascleral fixation intraocular lens implantation performed via making a scleral flap.](image_url)

(A) Limbus-based scleral flaps. (B) Sclerotomy is formed 1.5 mm away from the limbus under the scleral flap with a 22-gauge needle. (C) Scleral tunnel is formed with a 26-gauge needle. (D) Implantation of a standard three-piece foldable intraocular lens into the anterior chamber. (E-H) Capture and removal of the haptics tip by a forceps entering from sclerotomy. (I-J) Haptics placement into the scleral tunnel.
is grasped with forceps that are placed through the sclerotomy sites before the optic part leaves the cartridge and the whole IOL is inserted into the eye as the other haptic stays within the corneal incision. The first haptic, which is caught with the forceps through the sclerotomy site in a “handshake” fashion, is externalized from the eye and is held with the help of an assistant. The other haptic is held with forceps that pass through the corneal incision and are moved into the eye. This haptic is transferred to forceps that enter through the other sclerostomy in a similar fashion. Finally, the forceps, which pass through the corneal incision, are removed. This allows the second haptic to be externalized. The authors reported that the operation time was shorter and the risk of IOL dislocation into the vitreous during the surgical maneuvers that are performed while externalizing the haptics from the eye was decreased.\(^\text{28}\)  

Narang\(^\text{29}\) modified this assistant-dependent haptic externalization technique and described a no-assistant haptic externalization technique using vector forces and IOL positioning to keep the leading haptic from slipping into the eye while the trailing haptic is externalized. This method was performed on 45 cases and no intraoperative complications were reported.\(^\text{29}\) Bei-ko and Steinert\(^\text{30}\) modified Agarwal et al.’s technique and prevented dislocation by attaching the externalized haptic to a silicone tire, eliminating the need for an assistant. The silicone tire or stopper was obtained from an iris retractor set or a capsule support system.\(^\text{30}\)  

Kumar et al.\(^\text{31}\) assessed 210 eyes on which they performed glued IOL implantation. Among the 152 eyes in which a single-piece polymethylmethacrylate IOL was implanted, hyphema was observed in 1.31%, decentration in the early postoperative period in 1.97%, cystoid macular edema in 1.97%, optic capture in the late postoperative period in 2.63%, pigment dispersion in 1.97%, and cystoid macular edema in 1.97%. Only 21 of the 58 eyes in which a three-piece foldable IOL was implanted were followed for a minimum of 6 months; thus, only these 21 were included in the study. Subconjunctival haptic was encountered in 4 eyes, IOL decentration in 1 eye, resolving vitreous hemorrhage in 3 eyes, uveitis in 4 eyes, and optic capture in 3 eyes.\(^\text{31}\)

In another study, a glued IOL implantation was performed in 208 eyes. As for intraoperative complications, an IOL haptic was broken and immediately replaced with another IOL in 1 eye. Haptic tips were deformed in 0.9% of eyes but were inserted into the scleral tunnel. Hyphema was seen in 1 eye and resolved spontaneously in 48 hours. Early postoperative complications were seen in 13.9% of eyes. Late postoperative complications were seen in 18.7% of eyes (Table 1). Overall, 16 eyes (7.7%) required a reoperation. Reoperations included IOL repositioning in 3.3%, haptic repositioning in 2.4%, conjunctival suturing in 0.9%, and pars plana vitrectomy in 0.8% of eyes.\(^\text{32}\)  

Kim et al.\(^\text{33}\) analyzed short-term results of 16 eyes of 16 patients who underwent simultaneous dislocated three-piece IOL rescue and sutureless intrascleral fixation. The authors created scleral flaps and a sclerotomy with a 22-gauge needle, and performed a 23-gauge pars plana vitrectomy. Haptics were grasped with 23-gauge forceps and externalized through the sclerotomy. The externalized haptic was then placed into the scleral tunnel created with a 26-gauge needle. Flaps were closed with fibrin glue. Vitreous hemorrhage developed in 1 patient and resolved spontaneously in 1 week. Iris capture was seen in 1 eye and transient ocular hypertension in 1 eye. The authors reported that intrascleral haptic fixation of three-piece IOLs with the sutureless intrascleral fixation technique without IOL exchange is a safe method.\(^\text{33}\)  

Techniques that use fibrin glue in closing scleral flaps and conjunctiva may result in postoperative hypotony. There is also a theoretical chance of transmission of infectious agents from certain forms of fibrin glue and thus appropriate informed consent of patients should be obtained before surgery.\(^\text{24}\)

**Sutures Without Fibrin Glue**

Most of the surgical steps in this technique are the same as the methods that use fibrin glue. However, in the last step the scleral flap is closed with a suture instead of fibrin glue.\(^\text{34,35}\)  

Saleh et al.\(^\text{35}\) analyzed 26 eyes of 23 patients. Patients were divided into two groups: 8 eyes of 8 patients underwent the sutureless intrascleral fixation IOL implantation procedure and 18 eyes of 15 patients underwent posterior-fixated iris-claw lens surgery. One patient in the sutureless intrascleral fixation IOL group had an intraoperative complication (a haptic broke and a posterior iris-claw lens was implanted), whereas no intraoperative complications were observed in the posterior-fixated iris-claw lens group. Postoperative complications were most common during the first 3 months. In the sutureless intrascleral fixation IOL group, 1 patient had a conjunctival erosion due to haptic exposure. Two other patients developed postoperative cystoid macular edema. In the posterior-fixated iris-claw lens group, there were 3 cases of postoperative cystoid macular edema, and 1 patient sustained posttraumatic disenclavement of the iris-claw IOL that required surgery. Surgically induced astigmatism was higher in the posterior-fixated iris-claw lens group, but this finding was not statistically significant.\(^\text{35}\)
IOLS FOR SUTURELESS INTRASCLERAL FIXATION METHODS

There are IOLs that have been specially developed for sutureless intrascleral fixation surgeries thus far. Three-piece foldable IOLs are most commonly used for these operations.\textsuperscript{7-10,13-20} Monoblok and polymethylmethacrylate lenses are used in a limited number of studies.\textsuperscript{31,32} but three-piece foldable IOLs are generally preferred.\textsuperscript{7-10,13-20} The most preferred haptic formation in these lenses is long C-loop haptics. When short haptics or J-loop haptics are used, there is a smaller intrascleral portion of haptic and maintaining IOL stability is more difficult. In fact, when these haptics are used, the first haptic often dislocates intraoperatively while the second haptic is placed. The most commonly used three-piece foldable IOLs have clear or blue polymethylmethacrylate, polyvinylidene fluoride, polyimide, and polypropylene haptics.\textsuperscript{7-10,13-20} Currently, there is no IOL developed for sutureless intrascleral fixation IOL, three-piece IOLs designed for in-the-bag placement are generally used. For eyes with long axial length or large white to white measurements, scleral fixation of IOL haptics will be more difficult because the haptics are not long enough. Thus, IOL dislocations will be seen more frequently in those eyes.\textsuperscript{36} Spontaneous intraocular haptic breakage has also been reported in two three-piece IOLs with polyimide haptics in the long term.\textsuperscript{37} Thus, surgeons should be cautious about haptic breakage in the long term because the fixation of the IOL is maintained only by haptics.

CONCLUSION

Sutureless intrascleral fixation methods aim for intrascleral haptic fixation for the stability of IOLs. Whether a needle, a blade, or a trochar is used, sclerostomies are created in all techniques for intraocular access. Some authors prefer to create scleral tunnels, whereas others use scleral flaps for scleral fixation of haptics. The stability of IOLs is obtained by the scar tissue formed around the haptics. Consequently, it is crucial to be careful in cases with a history of scleritis or scleromalacia. Although avoiding sutures for scleral fixation in these methods prevents suture-related complications, the reports in the literature include a limited number of cases and the follow-up periods are short. Short-term results of these new methods are acceptable; however, studies including more cases with longer follow-up are needed to establish whether they are also successful in the long term.

AUTHOR CONTRIBUTIONS

Study concept and design (RK); data collection (HUC, HB); analysis and interpretation of data (RK, CJR); writing the manuscript (RK, HUC); critical revision of the manuscript (RK, HB, CJR); administrative, technical, or material support (RK, HUC)

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