CHAPTER 36

Techniques for Sulcus Fixation of Single-Piece Acrylate IOLs

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Most, if not all, intraocular lenses (IOLs) available in the United States are labeled by the US Food and Drug Administration for implantation wholly within the capsular bag in adults. Aside from polymethyl methacrylate (PMMA) IOLs designed for anterior chamber placement, there are no on-label options for placement of an IOL where the capsular bag is deficient or absent. Techniques have evolved for placement of 3-piece IOLs in the posterior chamber using methods other than in-the-bag fixation. Examples of these are discussed elsewhere in this book and include iris fixation, sulcus fixation by transscleral suture, and intrascleral direct haptic fixation. While 3-piece IOLs are generally well tolerated in the sulcus, they are still associated with a relatively high incidence of partial or complete dislocation. One reason is that the haptic-to-haptic diameter of posterior chamber IOLs (PC-IOLs) designed for compression within the capsular bag are shorter that the diameter of the ciliary sulcus (scleral spur to scleral spur). Alternatively, the PC-IOL may subluxated through a large central posterior capsular opening or a significant zonular dehiscence.

Problematically for nonintracapsular fixation is the fact that the most popular PC-IOLs are of the single-piece acrylate design (both hydrophobic and hydrophilic). These include almost all toric and multifocal IOLs and all extended depth of focus IOLs approved in the United States.

In this chapter, we will describe the technique and rationale for fixation of single-piece acrylate IOLs in the absence of capsular bag support; these techniques now make it possible to implant advanced technology IOLs when intracapsular bag fixation cannot be employed.

Controversy

Placement of single-piece IOLs in the ciliary sulcus in instances of compromised capsular support has historically been discouraged. Several studies have shown that these lenses, once in the ciliary sulcus, can become unstable, decenter, and ultimately lead to chafing of the posterior aspect of the iris. This may cause recurrent iridocyclitis, transillumination defects, secondary intraocular pressure (IOP) elevation, pigment dispersion glaucoma, intraocular hemorrhages, and cystoid macular edema (Figure 36-1).[1-6] The larger and thicker sized haptics, planar shape of the optic, and the overall shorter diameter of single-piece IOLs can all contribute to posterior chafing of the iris and lens decentration.[7] Therefore, the conventional advice is to avoid placing single-piece lenses in the ciliary sulcus.

It is worth noting that there may be differences in the biocompatibility of hydrophilic vs hydrophobic acrylate IOLs. Rather than a smooth surface, the latter have a more textured finish, which can contribute to iris chafing. In addition, the sharp square edges of the optic may cause chafing if there is IOL tilt, as is often the case with unsupported sulcus IOLs of any type.[9] Our experience overall is that IOLs that were designed for placement in the capsular bag frequently do not fare well in the sulcus. In the 1970s and 1980s when sulcus fixation was the norm, the haptic-to-haptic diameter was significantly larger, taking into account the larger diameter of the sulcus vs that of the capsular bag. However, these lenses now have a shorter haptic-to-haptic diameter that may be too short for sulcus fixation. As a result, these capsular bag IOLs may

Chang DF, ed. *Advanced IOL Fixation Techniques: Strategies for Compromised or Missing Capsular Support* (pp 261-269).

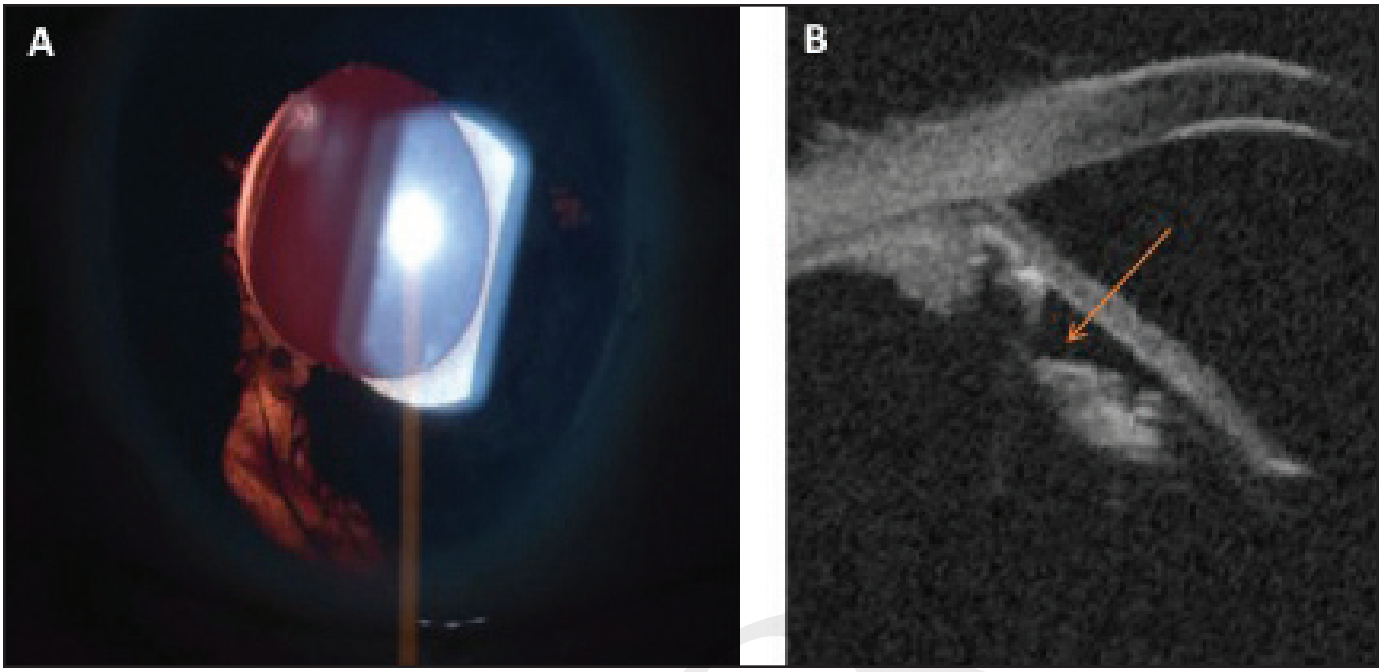

Figure 36-1. (A) Slit-lamp photograph of a single-piece IOL in the sulcus with transillumination defects inferiorly in the area of haptic and posterior iris chafing. (B) Ultrasound biomicroscopy reveals contact between the IOL haptic and the posterior iris (orange arrow).

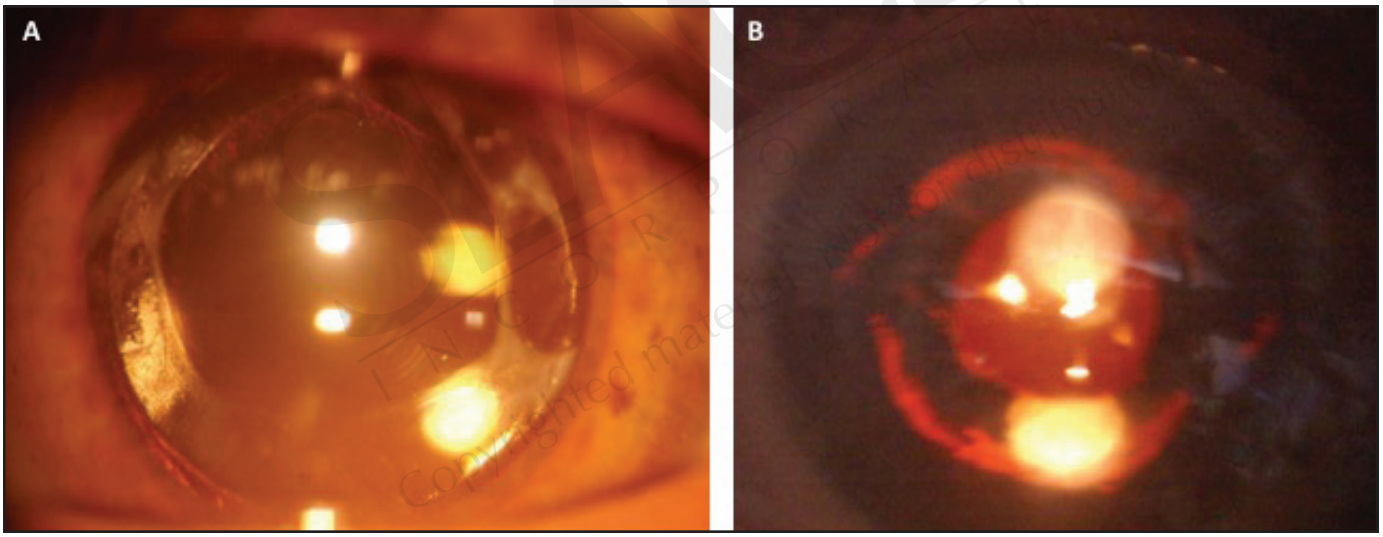

Figure 36-2. (A) Dramatic transillumination defects after in-the-bag implantation of a single-piece IOL with concurrent trabeculectomy. (B) Pristine in-the-bag placement of this single-piece IOL with no evidence of optic or haptic dislocation.

decenter or chafe the posterior iris causing transillumination defects and chronic inflammation, hyphema, and increased IOP. UGH syndrome refers to this constellation of uveitis, glaucoma and hyphema.[8]

Some authors suggest that single-piece IOLs should never be placed in the sulcus. However, other studies have suggested that single-piece IOLs can be tolerated in the ciliary sulcus without development of inflammatory complications.[8] Further examination of this issue shows that the problems associated with sulcus placement are specifically attributable to chafing—the apposition of and friction between the anterior IOL surface and the posterior iris.

It should parenthetically be noted that placing a single-piece IOL within the capsular bag can occasionally be associated with chafing complications. For example, we recently reported a combined phacotrabeculectomy case[10] with significant transillumination defects that closely resembled the position and shape of the optic and haptics of a single-piece IOL that had been placed in the capsular bag (Figure 36-2). We postulate that despite proper anatomic positioning of the IOL in the capsular bag, postoperative hypotony and forward displacement of the iris-lens diaphragm caused posterior iris chafing and development of transillumination defects.

If there is iris apposition of a single-piece IOL in the sulcus, the precise mechanism of chafing is unclear. It could primarily be due to pupillary movement or IOL movement, or both. What if a single-piece PC-IOL could be fixated posteriorly enough within the ciliary sulcus so that it neither moves nor contacts the iris?

In the landscape of modern IOL implant technology, premium single-piece IOLs, namely toric, multifocal, and extended depth of focus, are being used routinely to achieve desired visual results. However, in cases of inadequate capsular support, there has been an unmet need for techniques to permit safe and effective use of these lenses. Alternative methods of IOL fixation, such as direct iris suture fixation of 3-piece IOLs, may be proinflammatory, causing unintended sequelae such as chronic cystoid macular edema.[11] Interestingly, however, a technique one of us (KJR) developed, in which a 3-piece IOL may be sutured to the anterior iris, causes few if any problems.

In this chapter, we aim to describe novel techniques developed by or used by one of the authors (KJR) to allow for implementation of single-piece IOLs. These techniques expand the anterior segment surgeon's options for sulcus IOL fixation, facilitate use of advanced technology IOLs (toric, multifocal, toric multifocal, and extended depth of focus) that are not available in a 3-piece design, as well as in a whole host of challenging surgical cases without adequate capsular support, while reducing the risk of postoperative complications. The techniques discussed include internal scleral fixation, intrascleral fixation with externalization of haptics, and optic capture techniques. Our findings have shown that these techniques are robust methods to implement single-piece IOLs in the ciliary sulcus in patients with compromised posterior capsular support.

Techniques

INTERNAL SCLERAL FIXATION OF SINGLE-PIECE PC-IOLS

With internal scleral fixation techniques, sutures are used to stabilize and attach the haptics of single-piece PC-IOLs to the internal scleral wall at the level of the ciliary sulcus. This is intended to immobilize the IOL and keep it posterior enough to prevent contact with the iris.[12] There are 3 variations of this technique.

Through the Loop Fixation

The enVista IOL (Bausch + Lomb) is a single-piece aspheric, hydrophobic, acrylic IOL with a strut between the haptic and the optic, forming an encircled opening on the proximal aspect of each haptic. We pass a polytetrafluoroethylene CV-8 (ePTFE; Gore-Tex) or 9-0 polypropylene suture through this opening. A 180-degree marker is used externally to identify positions for ideal placement of sutures from each haptic. A partial-thickness scleral flap or a scleral groove starting 2 mm posterior to the limbus is fashioned at each of these locations. The suture needles can be passed ab interno through the sulcus so that it exits at the limbus on either side of the IOL haptics at the base of the groove or beneath the flap. The suture tension is adjusted so the IOL is well centered before tying it down to the scleral wall. Care must be taken to avoid overtightening the sutures to the point of inducing corneal astigmatism. Optionally, the knot can be rotated so that it is tucked within the adjacent sclera.

Through the Haptic Suture Fixation

In this original technique, both long tapered needles of a double-armed 9-0 polypropylene suture are used to pierce the tip of one haptic. Care must be taken to place the needle through the center of the haptic thickness, to avoid tearing the soft acrylic material. We have found that the ideal double-armed placement of this suture is approximately one-third of the way between the optic-haptic junction and the haptic tip (closer to the optic). Since the haptic is thicker along its anterior surface than along the anteroposterior (parallel to the IOL plane) surface, we have found that passing the needle from anterior to posterior allows a more secure fixation to the haptic. The same suture preplacement is performed for the opposite haptic. The needles can then be passed using the same technique described previously to exit at the limbus on either side of each IOL haptic, and the suture can be tied down to the scleral wall once the IOL is positioned in the ciliary sulcus. Again, attention should be focused on fixating the IOL posteriorly enough to ensure that there is no contact with the iris. Excessive fixation suture tension may decenter the IOL and must be avoided.

Case 1 (Figure 36-3). Our first use of this technique was in a 35-year-old woman with congenital rubella syndrome: microcornea, aniridia, cataract, and advanced glaucoma that was well controlled on topical medication. This patient had surgery for her congenital cataract at 2 years. Despite limited visual potential, she desired a cosmetic improvement as well as a realistic optimization of her vision. One of us (KJR) placed a HumanOptics Artificial Iris under a compassionate use exemption along with a single-piece acrylate IOL (Tecnis Monofocal, Johnson & Johnson Vision). After preparation of scleral grooves (as in the previous case), a 9-0 polypropylene suture was preplaced through the proximal portion of each haptic in double-armed fashion. These sutures were passed through a 3.0-mm incision, exiting under the scleral groove. The IOL was inserted and centered, and the proximal haptic's sutures were passed through the proximal scleral groove. A similar technique was used to secure the artificial iris, after trephining it to the appropriate size. The patient achieved satisfactory cosmetic improvement and a modest improvement in her visual acuity.

This first case demonstrated the reliability of suturing through the haptic, but the presence of an interposed artificial iris and the absence of central iris tissue did not address the issue of safety in a patient with an intact iris. The technique needed to be proven in a patient with more normal anatomy and an intact iris.

Case 2. A 56-year-old man was referred for cataract surgery. He gave a history of penetrating injury decades earlier from a sharp object. He had a corneal scar with 5 diopters of corneal astigmatism. Potential acuity meter testing revealed 20/40 predicted postoperative acuity. The patient underwent cataract surgery with insertion of an acrylic toric IOL (Tecnis

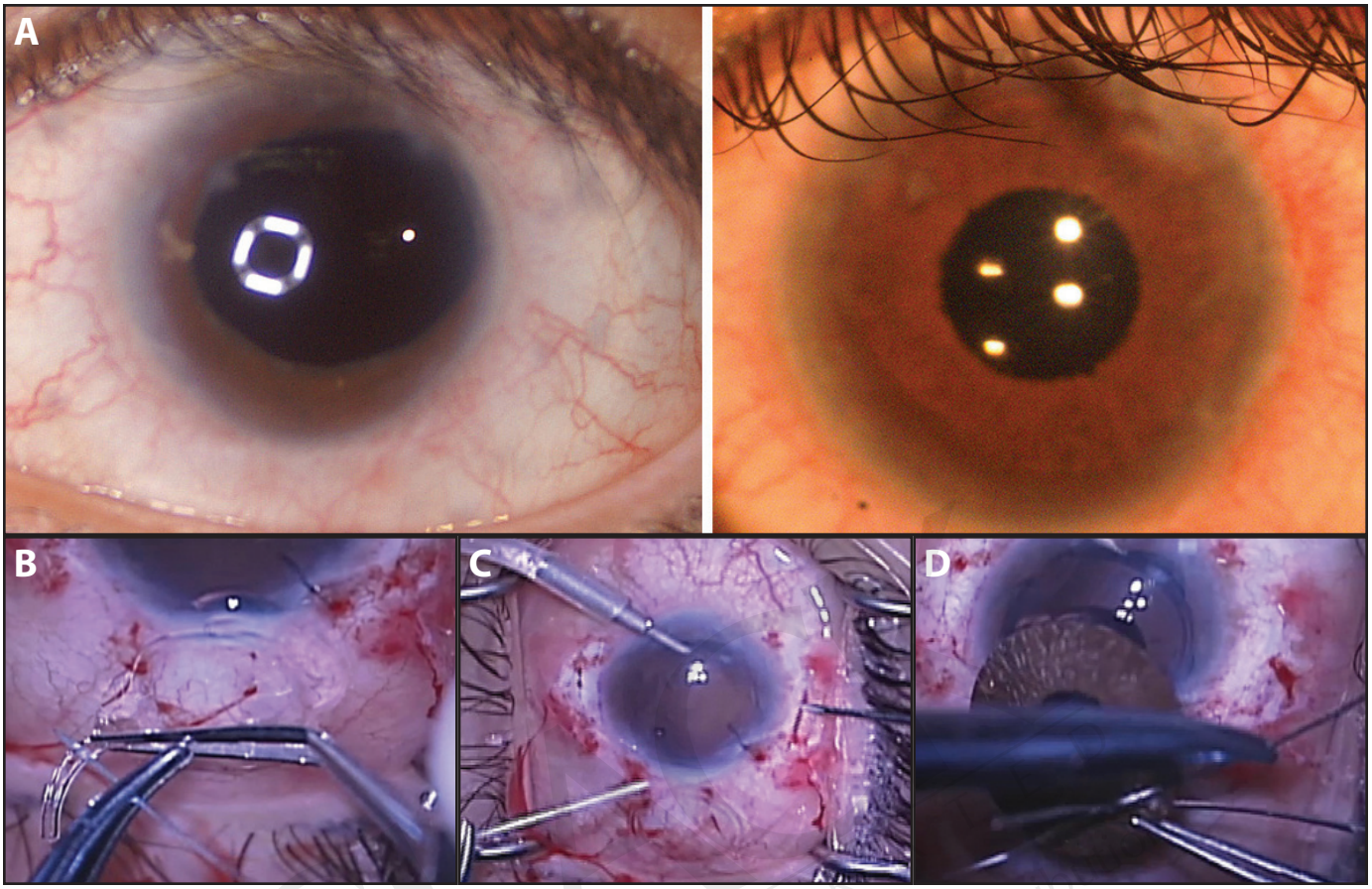

Figure 36-3. Video stills detailing use of through the haptic suture scleral fixation technique in a patient with congenital rubella who underwent implantation of an artificial iris prosthesis and single-piece IOL in the ciliary sulcus. (A) Pre- and postoperative appearance. (B) 9-0 polypropylene suture needle pierces the midperipheral haptic, double-armed. (C) The needle is passed into the anterior chamber and out through a scleral pocket. (D) The same technique is used to fixate the artificial iris (HumanOptics).

Toric, Johnson & Johnson Vision). One week postoperatively, the patient noted pain and decreased vision. Endophthalmitis was diagnosed, and the vitreoretinal consultant surgeon decided to explant the IOL while performing a therapeutic vitrectomy and injection of antibiotics. Prior to this intervention, a discussion about the postoperative rehabilitation of the patient determined that no clear path existed because a toric IOL would be the only way to correct the large amount of astigmatism, but it was deemed that saving the eye took precedence.

After successfully recovering from the endophthalmitis, the potential acuity remained 20/30 or better. Due to the fixed full-thickness scar, corneal refractive surgery was not an option and the only IOLs available for large vector toric implantation were single-piece acrylate lenses (Figure 36-4A). Accordingly, the patient was offered the option of having a single-piece toric IOL with suture fixation.

During surgery, the 180-degree steep corneal meridian was marked, and an additional mark was made at a 20-degree offset (Figure 36-4B) to compensate for the final placement of the sutures, which would be offset a corresponding distance counterclockwise from the steep meridian tick marks on the IOL. The procedure was performed as described previously. After appropriate healing, the patient attained 20/30 uncorrected vision with a residual of -0.25 cylinder (Figure 36-4C).

Around the Haptic Suture Tie

A further variation of the direct haptic fixation technique is to simply tie the suture material (Gore-Tex or 9-0 polypropylene) around the proximal aspect of the haptics. We believe that the suture slightly crimps the haptic because the acrylic material of the single-piece IOL haptics is softer than the PMMA haptics of 3-piece IOLs. Therefore, the suture is more secure around these haptics than around those on most 3-piece IOLs (which are pliant and cylindrical) and is less likely to slip or dislodge. We again stress that attention to retroplacement of the IOL away from the iris is important.

Case 3. A 59-year-old woman presented with a decentered monofocal IOL. She desired an extended depth of focus lens after explantation of her malpositioned IOL. A single-piece extended depth of focus IOL was implanted in the sulcus with polypropylene suture tied around the haptics and the patient's best corrected visual acuity was 20/60 postoperatively (Figure xxxA-C).

Case 4. This technique was used by us for secondary IOL implantation in a patient with Marfan syndrome. He was aphakic after undergoing cataract surgery/lensectomy as a child, but become contact lens intolerant. An extended depth of focus toric IOL (Tecnis Symphony Toric, Johnson & Johnson Vision) was implanted (sequentially) bilaterally. He

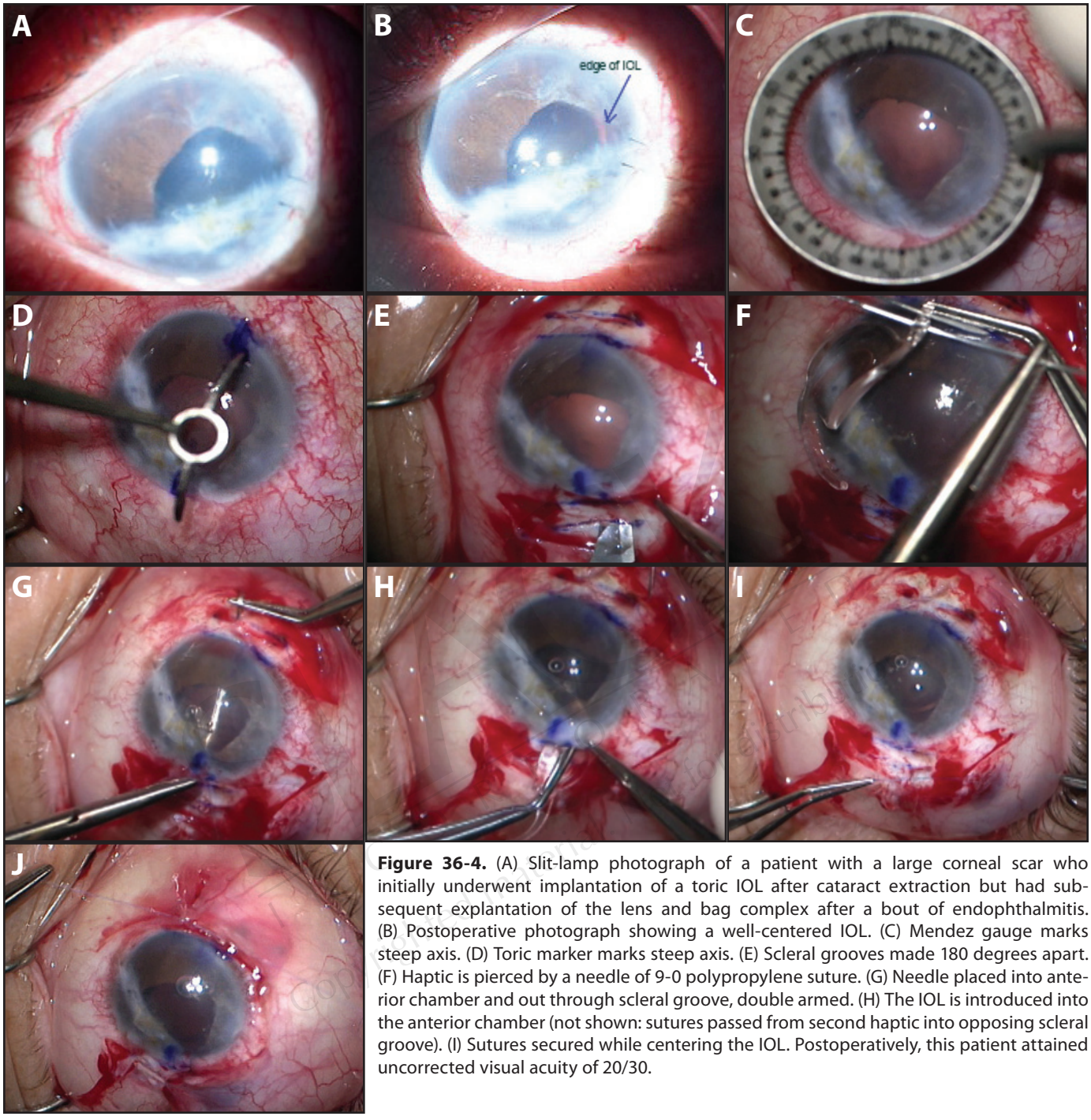

Figure 36-4. (A) Slit-lamp photograph of a patient with a large corneal scar who initially underwent implantation of a toric IOL after cataract extraction but had subsequent explantation of the lens and bag complex after a bout of endophthalmitis. (B) Postoperative photograph showing a well-centered IOL. (C) Mendez gauge marks steep axis. (D) Toric marker marks steep axis. (E) Scleral grooves made 180 degrees apart. (F) Haptic is pierced by a needle of 9-0 polypropylene suture. (G) Needle placed into anterior chamber and out through scleral groove, double armed. (H) The IOL is introduced into the anterior chamber (not shown: sutures passed from second haptic into opposing scleral groove). (I) Sutures secured while centering the IOL. Postoperatively, this patient attained uncorrected visual acuity of 20/30.

regained 20/25 uncorrected visual acuity (distance) and J3 near OU (Figure 36-5).

EXTERNAL/INTRASCLERAL FIXATION WITH EXTERNALIZATION OF HAPTICS

In the external/intrascleral haptic fixation technique, the haptics of a single-piece IOL are fixated to the scleral wall through scleral tunnels to ensure centration and stability of the IOL in the sulcus. This technique is similar in concept to both the glued IOL[13,14] and Yamane intrascleral fixation techniques[15] that have been previously described in the literature for 3-piece IOLs with PMMA haptics. This technique was developed after our concerns with the Yamane technique of haptic slippage from the scleral tunnels due to their narrow girth and to enable implantation of advanced technology IOLs.[16]

In this technique, a sharp blade is used to fashion a 1.5-mm scleral tunnel or sleeve. A single-piece hydrophobic acrylic IOL is injected through a clear corneal incision, with the distal haptic positioned in the sulcus and with the proximal haptic temporarily remaining exteriorized. A scleral marker is used to place a pair of marks 180 degrees apart. Using this as a guide,

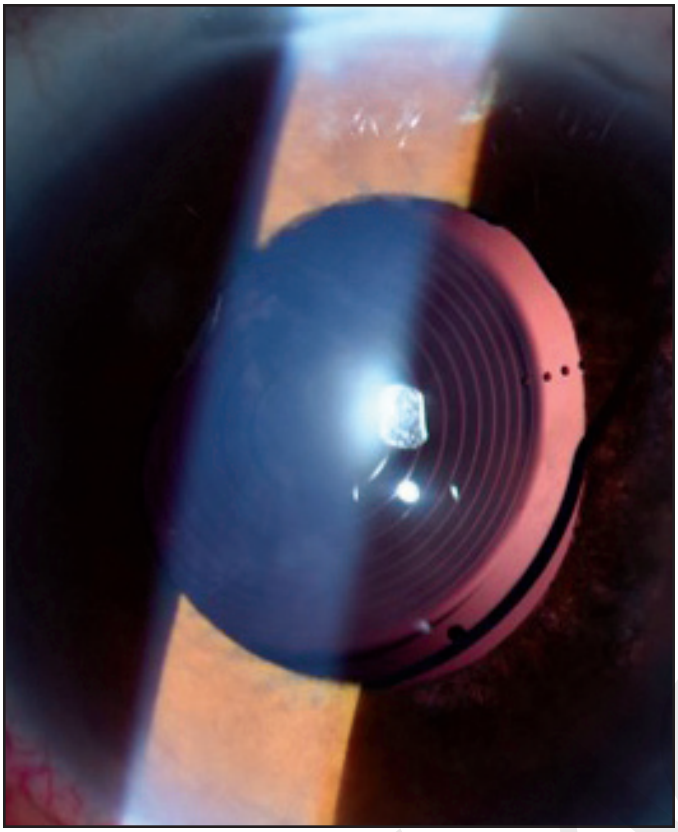

Figure 36-5. Slit-lamp photograph of a patient with Marfan syndrome who underwent implanation of a toric extended depth of focus IOL in the ciliary sulcus using the around the haptic suture scleral fixation technique.

a paired scleral sleeve is fashioned 2 mm posterior and parallel to the limbus at each of the 2 locations 180 degrees apart. A 23-gauge side-port blade is used to make the sleeves approximately 5 mm in length. The ciliary sulcus is entered at the entrance of the sleeve. Specially designed claw forceps (KJR design, Epsilon USA) are placed through the scleral sleeve and into the sulcus, grasping the distal haptic in a handshake technique, and the haptic is pulled through the sclera sleeve (Figure 36-6). The proximal haptic is similarly secured. Both haptics are externally grasped and repositioned to ensure lens centration. Once the haptic and IOL are centered, a suture is placed through the sclera around the haptic and tied, burying the knot within the sclera. Both haptics are subsequently trimmed if necessary to ensure they are entirely within the scleral sleeves.

OPTIC CAPTURE

In the less common instance where an IOL is already in the sulcus but the anterior capsular opening is of sufficiently small size to capture the lens, an optic capture technique can be used to place a single-piece IOL in the sulcus. The optic of the single-piece IOL is captured in the capsular bag while the haptics remain in the sulcus. When implementing this technique, it is critical that the anterior capsular opening is not too large as to cause the IOL to dislocate once optic capture is attempted. It should be noted that leaving single-piece haptics in the sulcus with the optic behind the capsulorrhexis is controversial and discouraged by many surgeons because of the potential for the haptics to contact and chafe the iris. Again, we emphasize that adequate clearance between the posterior iris surface and the IOL optic be observed. A shallow retroiridal/capsular bag space would therefore contraindicate this approach. Adequate clearance can be observed directly using an intraocular endoscope.

Case 5. A 74-year-old patient presented with a symptomatic Z-syndrome following Crystalens (Bausch + Lomb) implantation (Figures 36-7A and B). The IOL was explanted leaving behind the flanges from the remaining haptic plates. These flanges were then used as a paperclip to secure the optic of a single-piece extended depth of focus IOL (Symfony, Johnson & Johnson Vision) in a modified optic capture, with the haptics placed in the ciliary sulcus (Figure 36-7C). The patient achieved uncorrected visual acuity of 20/40 distance and J3 near postoperatively with stable IOL (Figure 36-7D).

Pre- and Postoperative Assessment

Careful pre-, intra-, and postoperative assessment of patients is paramount in the success of these techniques. Preoperatively, optical coherence tomography and ultrasound biomicroscopy may assist the clinician in identifying the problematic location of the IOL position. Intraoperatively, endoscopy, using the probe of the endoscopic cyclophotocoagulation instrument, can be used to directly visualize the optic and haptic position. In addition, B-scan ultrasound can be used prior to placement of the IOL to determine the exact location of the sulcus. With this technique, the surgeon visualizes the sulcus using coaxial illumination and the transillumination of the endoscopic probe can be used to mark the sclera in the exact optimal location. With experience, this step is not required, but remains useful in small and large eyes, where the sulcus may be in an unanticipated location.

Postoperatively, ultrasound biomicroscopy may be helpful to verify that the IOL is not in contact with the posterior surface of the iris (Figure 36-8). Clinical signs of ocular inflammation on postoperative examination, especially if persistent iris-IOL touch is noted on imaging, can suggest clinically important iris-IOL touch and needs to be identified and treated promptly.

Conclusion

Fixation of single-piece IOLs in the ciliary sulcus can be a safe and effective technique for primary or secondary IOL implantation using the techniques described in this chapter. These techniques include internal scleral fixation, intrascleral fixation with externalization of haptics, and optic capture techniques, all permitting excellent postoperative IOL stability and visual results. Critical to the success of these techniques is placement of the single-piece IOL to avoid decentration or torque and so that it does not have dynamic apposition with

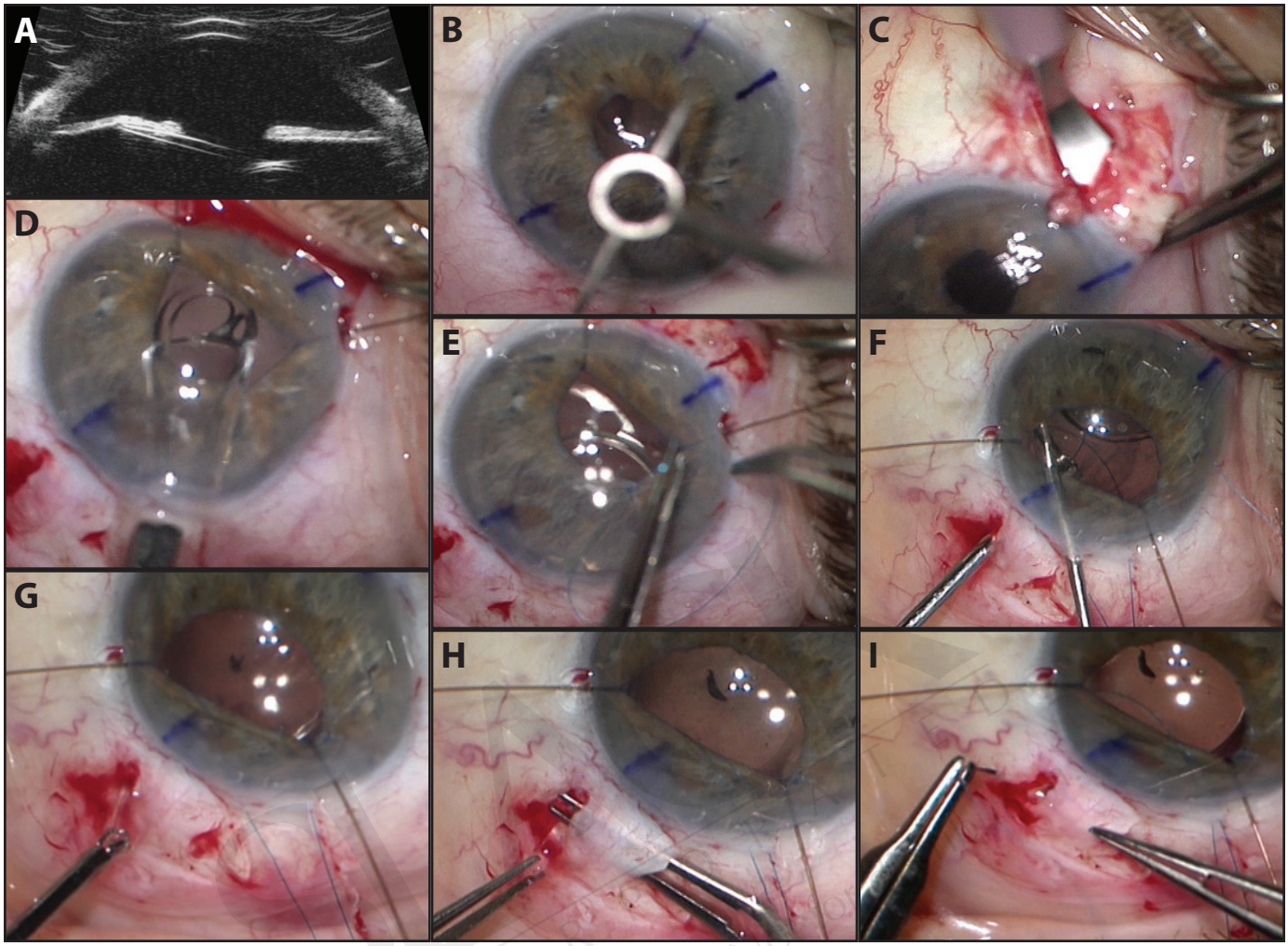

Figure 36-6. (A) Ultrasound biomicroscopy shows IOL tilt. The 3-piece IOL had been sutured to the posterior iris, but the patient developed chronic cystoid macular edema. (B) Toric markings made 180 degrees apart. A second set of marks is offset by the distance of the externalized haptic tunnel. (C) A scleral sleeve is made. (D) A single-piece acrylic IOL is placed with the trailing haptic externalized at the wound. (E) A safety suture is looped around the trailing haptic. (F) Custom-designed grasping forceps are introduced adjacent to the scleral sleeve, and a second instrument handshakes the haptic to the grasping forceps. (G) The haptic is externalized. (H) Forceps are placed in the scleral sleeve and the haptic is pulled through. (I) A 9-0 polypropylene suture is passed through the sclera around the haptic for additional stability.

the posterior iris. Implementation of these novel techniques can permit implantation of toric multifocal and extended depth of focus IOLs that are only or primarily available in a single-piece acrylate platform in challenging surgical cases without adequate capsular support. Further studies may be indicated to evaluate this suite of techniques in a range of patients with varying ocular comorbidities and clinical circumstances.

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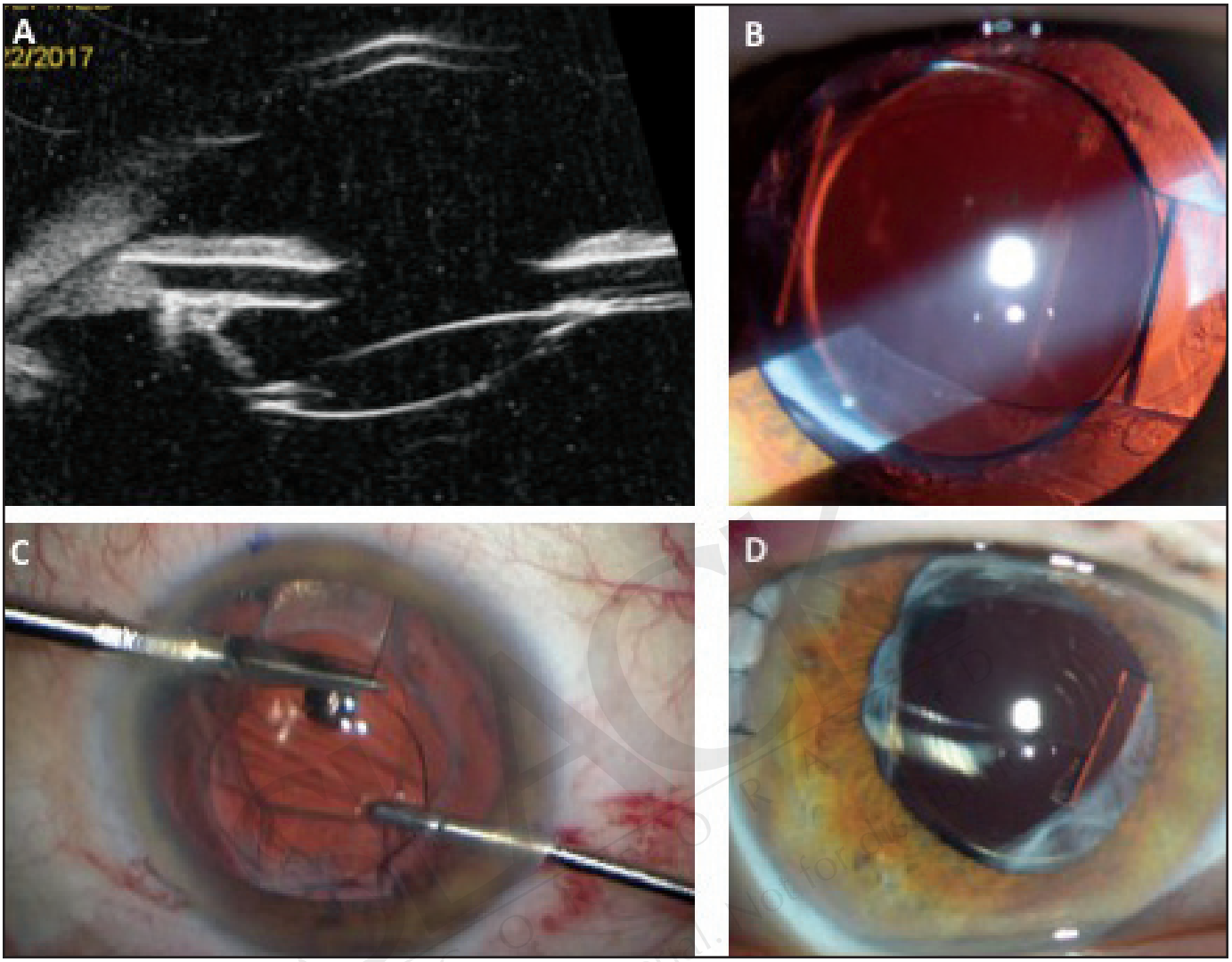

Figure 36-7. (A) Ultrasound biomicroscopy and (B) slit-lamp photograph showing symptomatic Z-syndrome after Crystalens implantation. (C) Amputation of the hinges. The IOL was explanted, leaving the flanges from the remaining haptic plates, and the flanges were used as a paperclip to secure the optic of a single-piece extended depth of focus IOL in a modified optic capture, with the haptics in the ciliary sulcus. (D) Postoperative photo showing a centered single-piece IOL behind the Crystalens hinge "stumps."

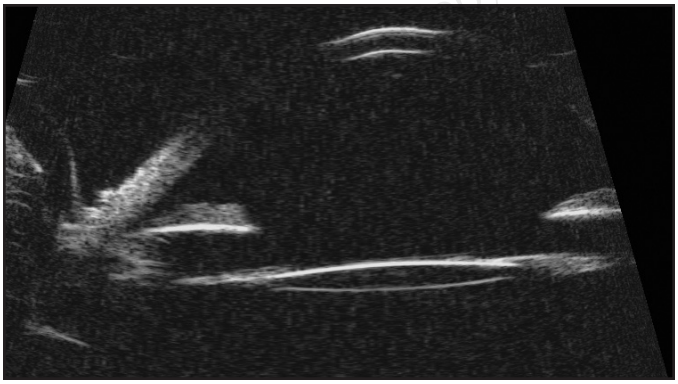

Figure 36-8. Ultrasound biomicroscopy image showing excellent position of the IOL optic and haptic in the ciliary sulcus with no contact with the posterior iris surface, following external/intrascleral fixation.

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