



# Intraocular Lens Elongation Technique with Haptic Modification for Sulcus Implantation

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## Abstract

**Objectives:** To define a haptic modification technique to increase the overall length of the intraocular lens (IOL) and evaluate the postoperative outcomes of patients in whom this technique was applied.

**Materials and Methods:** The preoperative and postoperative characteristics of patients who underwent modified IOL implantation into the sulcus between May 2019 and December 2019 were evaluated. Modified Sensar AR40e lenses with hydrophobic acrylic optic and polymethylmethacrylate haptics were implanted to all eyes. Before implanting the IOL, the haptics were grasped with two toothless forceps and bent to elongate the total diameter of the IOL from 13.0 mm to 14.5 mm.

**Results:** The study included 11 eyes of 11 patients who underwent modified three-piece IOL implantation into the sulcus due to insufficient capsular support. The mean age of the patients was  $53.9 \pm 12.2$  years. The mean axial length was  $24.13 \pm 1.93$  mm. Sulcus implantation was required due to aphakia in 9 eyes and IOL dislocation in 2 eyes. No haptic breakage occurred during the IOL modification technique or implantation. The mean preoperative best corrected visual acuity (BCVA) was  $0.88 \pm 1.1$  logMAR, while postoperative BCVA was  $0.28 \pm 0.30$  logMAR. No IOL dislocation or decentration was observed during 6-month postoperative follow-up.

**Conclusion:** The larger diameter lenses obtained with this inexpensive and easily applicable technique may allow a more stable sulcus implantation in eyes with inadequate capsular support.

**Keywords:** Aphakia, ciliary sulcus, intraocular lens implantation, lens dislocation

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## Introduction

Ciliary sulcus implantation is one of the surgical options for the management of aphakia in eyes with a compromised capsular bag. Posterior capsular rupture with adequate anterior capsular support and zonular dehiscence are common indications of ciliary sulcus implantation. However, in the absence of anterior capsular support, sulcus implantation is known to be contraindicated, and in such cases, anterior chamber intraocular lens (IOL) implantation, iris fixation, or scleral fixation may be preferred based on the features of the eye.<sup>1,2</sup>

One-piece acrylic IOLs, which are manufactured for intracapsular placement, are poor choices for sulcus implantation. Their overall length is small for the ciliary sulcus, and their optics have no posterior angulation. These structural properties increase the risk of IOL dislocation and pupillary capture.<sup>3</sup> In addition, continuous iris chafing may cause secondary pigment dispersion, a transient increase in intraocular pressure, secondary pigmentary glaucoma, intraocular hemorrhage, iris transillumination defects, recurrent iridocyclitis, and uveitis-glaucoma-hyphema syndrome.<sup>4,5</sup> Moreover, these complications sometimes require surgical interventions such as IOL exchange and glaucoma surgery.

An IOL to be implanted into the ciliary sulcus should have an overall length of at least 12.5 mm to ensure a stable position and avoid IOL tilt and decentration. In addition, the IOL should have posteriorly angulated, thin looped haptics to prevent the complications associated with uveal tissue chafing. In this context, one-piece polymethylmethacrylate (PMMA) or three-piece acrylic or silicone IOLs are regarded as the best options for ciliary sulcus implantation.<sup>1</sup> However, in a recent study, it was suggested that sulcus-fixated three-piece IOLs with an overall length of 13 mm could also have a larger amount of tilt and decentration.<sup>6</sup>

Herein, we present a technique for haptic modification to achieve an IOL with an overall length of 14.5 mm in order to enable the haptics to rest snugly in the ciliary sulcus with adequate outward tension. This provides a more stable sulcus-implanted IOL without tilt and decentration, even in longer eyes that have minimal anterior capsular support.

## Materials and Methods

The medical records of patients who underwent modified and elongated three-piece IOL implantation into the sulcus in the Ophthalmology Department of Uludağ University between May 2019 and December 2019 were identified. Those with follow-up longer than 6 months were included in the study. In all cases, demographic characteristics and preoperative and postoperative ophthalmological findings were noted. The ophthalmological examination included best corrected visual acuity (BCVA) (expressed as logarithm of the minimum angle of

resolution [logMAR]), biomicroscopy, intraocular pressure, and funduscopy preoperatively and 6 months postoperatively.

The study adhered to the tenets of the Declaration of Helsinki and approval to review the patient data was obtained from the Institutional Review Board of Uludağ University (11.11.2020, 2020-20/11).

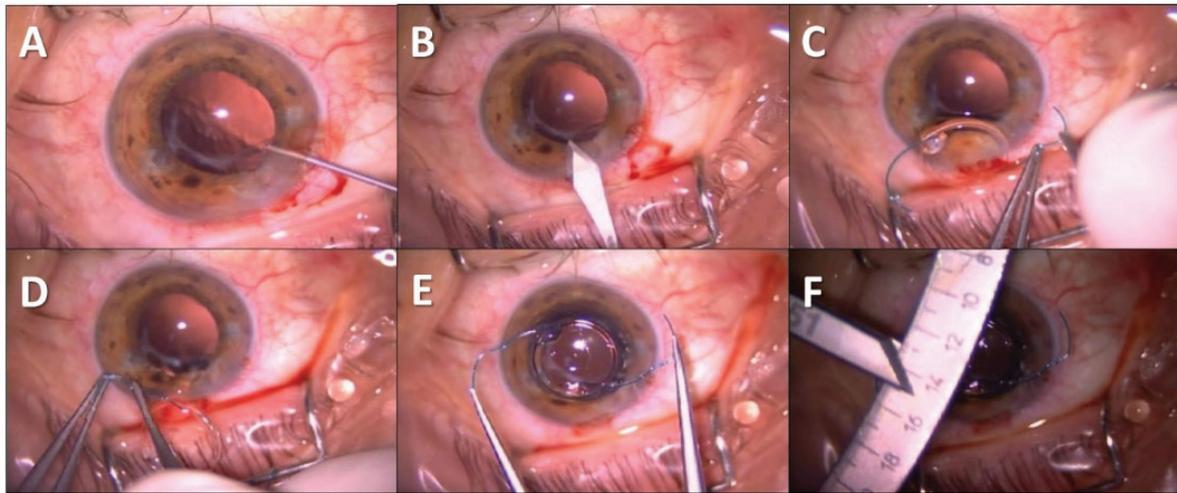
### Surgical Technique

Standard surgical asepsis was achieved, followed by peribulbar anesthesia with a 4 mL combination of 2% lidocaine and 0.5% bupivacaine. A corneal side port was created at the 10 o'clock position with a 20-gauge MVR knife. Through the side port, dispersive viscoelastic material (Viscoat® 40 mg sodium chondroitin sulfate-30 mg sodium hyaluronate) was injected into the anterior chamber (Figure 1A). A clear corneal incision was then made at the 12 o'clock position with a 2.2-mm slit knife (Figure 1B).

A three-piece, foldable, monofocal IOL (Sensar AR40e; Johnson & Johnson Vision, Santa Ana, CA, USA) was used for this novel technique. The IOL has a hydrophobic acrylic optic with posterior angulation of 5° and modified C loop PMMA haptics (Table 1). The technique was applied to each haptic under the surgical microscope. Firstly, two toothless forceps were used to grasp the haptic at two points corresponding to one-third (first junction, nearer to the IOL optic) and two-thirds (second junction, nearer to the end of the haptic) of the length of the haptic. The forceps at the first junction were held tight and fixed, while the other forceps at the second junction were pulled back in the opposite direction from the haptic's normal curve (Figure 1C). From this bending movement, the haptic became longer and curved, resembling a "gull wing" or a lower case "m". The same procedure was repeated for the other haptic (Figure 1D). This increased the overall length of the IOL to 14.5 mm (Figure 1E-F). The modified IOL was then inserted into the cartridge, with care taken to fold the lens in the originally posterior angulated position (Figure 2A-B). The modified IOL was introduced into the anterior chamber through the main corneal incision at 12 o'clock (Figure 2C). After the leading haptic was placed in the sulcus, the trailing haptic was gently pushed under the iris with clockwise rotation using a lens hook (Figure 2D-E). Finally, the IOL was centered with better stabilization due to the modified elongated haptics, which provided sufficient outward tension to rest snugly in the ciliary sulcus. The surgery concluded with corneal hydration after removing the viscoelastic (Figure 2F).

At postoperative sixth months, all patients were evaluated with ultrasound biomicroscopy (UBM) to evaluate IOL position (Figure 3A-B).

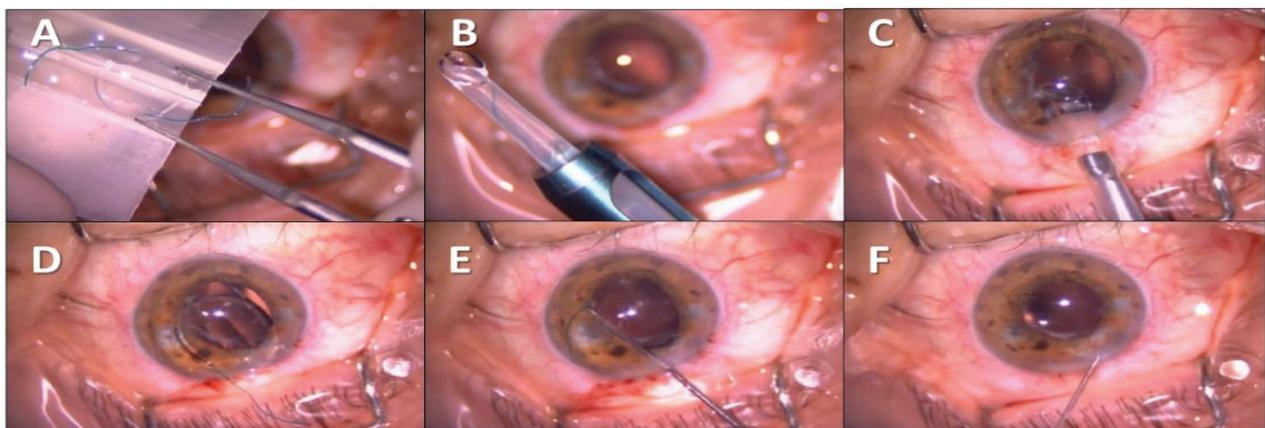
To clarify the technique, the twisting points on the haptics are illustrated in Figure 4A, and the difference in length between the original and modified IOLs is shown in Figure 4B.



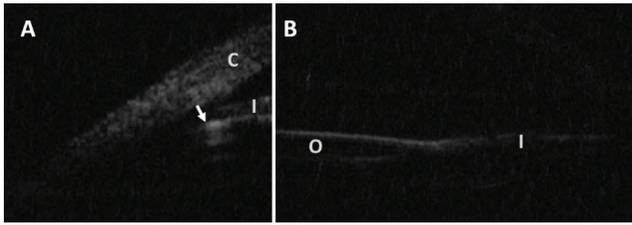
**Figure 1.** A) Viscoelastic material is injected into the anterior chamber. B) A clear corneal incision is made with a 2.2 mm slit knife. C) One haptic is grasped by two toothless forceps at one-third and two-thirds of the length of the haptic. While the forceps at the first junction are held tight and fixed, the forceps at the second junction are pulled backward in the opposite direction of haptic’s normal curve. D) The same procedure is repeated for the other haptic. E) The haptics are thus elongated, resembling a “gull wing.” F) The overall length of the lens is increased to 14.5 mm

Table 1. Characteristics of the intraocular lens used in this technique	
	<b>Sensar AR40e</b>
<b>Optic characteristics</b>	
Power	+6.0 to +30.0 diopters
Diameter	6 mm
Shape	Biconvex
Material	Hydrophobic acrylic, UV-blocking
A-constant	118.4
Theoretical ACD (mm)	5.2
Refractive index	1.47
<b>Haptic characteristics</b>	
Overall length (mm)	13.0

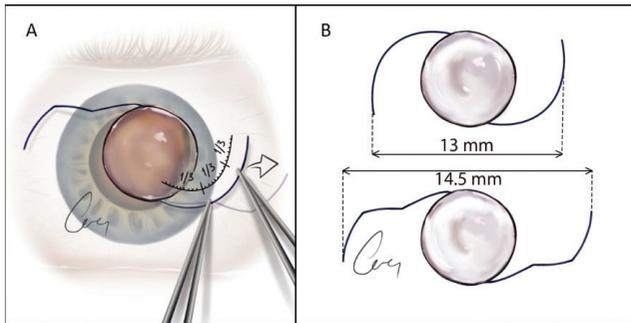
ACD: Anterior chamber depth, UV: Ultraviolet



**Figure 2.** A) The modified intraocular lens (IOL) is inserted into the cartridge. B) The IOL is folded, paying attention to its posterior angulated position. C) The IOL is introduced into the anterior chamber through the main corneal incision at 12 o’clock. D) The leading haptic is placed in the sulcus. E) The trailing haptic is gently pushed under the iris by clockwise rotation using a lens hook. Corneal incisions are closed with hydration after removing the viscoelastic. F) The IOL is seen to be well-stabilized and centered at the end of the surgery



**Figure 3.** A) Ultrasound biomicroscopic image (UBM) demonstrating a well-positioned haptic of a modified three-piece intraocular lens (IOL). The hyperechoic double line (white arrow) indicates the IOL haptic located in the ciliary sulcus. (C: cornea; I: iris). B) A UBM image showing the optic of the same modified three-piece intraocular lens (O: optic; I: iris)



**Figure 4.** A) The haptic is grasped by two pairs of toothless forceps at the one-third and two-thirds lengths of the haptic. While the forceps at the first junction is held tight and fixed, the other forceps, at the second junction, is pulled backward in the direction opposite the haptic's normal curve (in the direction of the arrow). The final form of the haptic is shown with shaded color. B) After applying the same procedure to both haptics, the overall length of the lens increased from 13 mm to 14.5 mm

## Results

Modified and elongated three-piece IOLs were implanted in the ciliary sulcus in 11 eyes of 11 patients with inadequate capsular support. The mean age of the patients was  $53.9 \pm 12.2$  years. Six patients (54.5%) were male. Nine of the 11 eyes were aphakic (due to complicated cataract surgery in 5 eyes and ocular trauma in 4 eyes). In the remaining 2 eyes, ciliary sulcus implantation was required because of previous IOL dislocation.

The mean axial length was  $24.13 \pm 1.93$  mm. The axial length was longer than 24 mm in 4 (36.4%) of 11 eyes. The mean preoperative BCVA was  $0.88 \pm 1.1$  logMAR, while the postoperative BCVA was  $0.28 \pm 0.30$  logMAR. The mean preoperative spherical equivalent (SE) was  $+9.92 \pm 4.43$  diopters (D), and at postoperative 6 months, the mean SE was  $-2.66 \pm 1.44$  D. The mean intraocular pressure was  $16.2 \pm 2.6$  mmHg at postoperative 6 months.

No haptic breakage occurred during IOL modification and implantation. Postoperatively, no pigmentary dispersion, pupillary capture, IOL dislocation, or decentration were observed upon slit lamp examination in any of the patients during 6-month follow-up. However, IOL tilt angles could not be measured in our study due to technical problems.

## Discussion

The safety and efficiency of ciliary sulcus implantation has been well established and accepted in patients with an insufficient lens capsule.<sup>7</sup> However, it is essential to choose the correct IOL, one that is compatible with the sulcus-to-sulcus distance, to decrease the risk of IOL decentration and tilt. The sulcus-to-sulcus distance is estimated to be 11.0 to 12.5 mm based on the measurements taken using endoscopic imaging and UBM. Regarding this, an IOL to be implanted into the sulcus should have an overall length of at least 12.5 mm to generate sufficient outward tension and provide stable haptic fixation.<sup>8,9,10</sup>

A recent study compared the amount of IOL tilt and decentration in lenses implanted in the bag and ciliary sulcus.<sup>6</sup> It was observed that the horizontal and vertical mean tilt were  $2.5^\circ$  and  $2.6^\circ$  for in-the-bag IOLs and  $7.68^\circ$  and  $3.01^\circ$  in sulcus IOLs, respectively. Mean horizontal and vertical decentration were 0.06 mm and 0.02 mm for in-the-bag IOLs and 0.4 mm and 0.31 mm in sulcus IOLs, respectively. Although the IOLs used in that study had an overall length of 13 mm, it was clear that the amount of IOL tilt and decentration was larger in sulcus implantation than in-the-bag implantation.<sup>6</sup>

In a UBM study, the surgeon intended to perform sulcus implantation using IOLs with overall diameters ranging from 12.5 to 14.0 mm in 36 eyes.<sup>11</sup> However, UBM showed that both haptics were in the target position in only 47% of eyes. In the rest of the eyes, one or both haptics were in inadvertent positions, such as in the pars plicata, pars plana, and in-the-bag. In the aforementioned study, the optic of the IOL was found to be tilted in 56% of the patients. However, this was an insignificant tilt ranging from 100 to 200  $\mu\text{m}$ , a degree that could not be detected clinically by slit lamp examination and was only detectable via UBM.<sup>11</sup> In another UBM study, Zhao et al.<sup>7</sup> suggested a greater tendency toward vertical decentration than horizontal decentration in ciliary sulcus fixation in the pediatric age group. They hypothesized that the size disparity between the IOL and ciliary sulcus and gravity may cause IOL decentration. Similarly, Trivedi et al.<sup>12</sup> suggested that longer eyes, associated with wider sulcus-to-sulcus distance, might be prone to IOL decentration.

We describe a novel haptic modification technique intended to decrease the risk of IOL tilt and decentration resulting from the size disparity between the IOL and sulcus. The IOL is modified by elongating its haptics, thereby increasing the overall length from 13 mm to 14.5 mm. We attribute the better IOL centration and stability to the modified, longer haptics, which provide sufficient outward tension to sit tightly in the ciliary sulcus. In addition, the modified IOL could enable sulcus implantation even in eyes with minimal anterior capsular support.

This technique can be used both for primary IOL implantation during cataract surgery complicated by capsular tear and secondary IOL implantation in the management of surgical or traumatic aphakia. Possible complications of the technique include the breakage of the PMMA haptics during the elongation procedure. However, in our small study cohort

(11 eyes), we did not observe any haptic breakage during IOL modification and implantation. In addition, bending the haptic could compromise the structural and mechanical strength of the haptic and lead to breakage in long-term follow-up.

#### Study Limitations

Limitations of the study are the small number of patients, the retrospective nature of the study, the lack of long-term results, and the inability to measure the amount of IOL decentration and tilt due to technical issues.

#### Conclusion

In conclusion, this cost-free, easy-to-learn, and easily applicable technique may be a safe and viable alternative method in sulcus implantation, particularly in longer eyes with inadequate capsular support. However, further prospective studies that measure IOL tilt angle via UBM or anterior segment optical coherence tomography in larger numbers of patients with long-term follow-up are required to determine the safety of our technique.

#### Ethics

**Ethics Committee Approval:** The study adhered to the tenets of the Declaration of Helsinki and approval to review the patient data was obtained from the Institutional Review Board of Uludağ University (11.11.2020, 2020-20/11).

**Informed Consent:** Retrospective study.

**Peer-review:** Externally peer reviewed.

#### Authorship Contributions

Surgical and Medical Practices: M.B., Concept: M.B., G.U.G., A.Ç.E., Design: M.B., G.U.G., A.Ç.E., Data Collection or Processing: G.U.G., A.Ç.E., Analysis or Interpretation: M.B., G.U.G., Literature Search: G.U.G., A.Ç.E., Writing: G.U.G.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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