

Iris-fixated phakic intraocular lens

Most surgeons induce pupillary miosis before they initiate iris-fixated PIOL implantation, both to protect the crystalline lens and to make the iris easier to manipulate. The lens is generally inserted through a superior limbal incision but can be implanted with the wound placed at the steep meridian to minimize postoperative astigmatism. The long axis of the PIOL is ultimately oriented perpendicular to the axis of the incision. A side port incision is made approximately 2–3 clock-hours on either side of the center of the incision; thus, a 12 o'clock incision requires side port incisions near the 10 and 2 o'clock meridians. The “claw” haptics are fixated to the iris in a process called *enclavation*.

After the PIOL has been carefully centered over the pupil, it is stabilized with forceps while a specially designed enclavation needle is introduced through 1 of the side port incisions, and a small amount of iris is brought up into the claw haptic. This procedure is repeated on the other side. If adjustment of the PIOL position becomes necessary after fixation, the iris must be released before the PIOL is moved. Careful wound closure helps minimize surgically induced astigmatism. PMMA PIOLs require a 6-mm wound and thus generally require sutures for proper closure, whereas iris-fixated PIOLs made of flexible materials can be inserted through a small, self-sealing wound of approximately 3 mm. Video 9-1 demonstrates implantation of an iris-fixated PIOL.

**VIDEO 9-1** Implantation of an iris-fixated phakic IOL.

Courtesy of David R. Hardten, MD.



Sizing the iris-fixated phakic intraocular lens Because this type of PIOL is fixated to the midperipheral iris, not to the angle or sulcus, it has the advantage of having a “one-size-fits-all” length. The PIOL is 8.5 mm long in total, including the 5.0- or 6.0-mm-long PMMA optic (Fig 9-1).

Posterior chamber phakic intraocular lens

Posterior chamber PIOLs require pupillary dilation before implantation. These PIOLs are made of a flexible collamer material and are implanted through a small wound approximately 3 mm long (Fig 9-2). The optic of the PIOL is vaulted to avoid contact with the crystalline lens and to allow aqueous to flow over the crystalline lens. This vaulting can be viewed at the slit lamp as well as with ultrasound biomicroscopy or Scheimpflug imaging (Fig 9-3). The lens manufacturers suggest that an acceptable amount of vaulting of the lens optic over the crystalline lens is 1.0 ± 0.5 corneal thicknesses. Using the appropriate vault is crucial for reducing complications (discussed later in the chapter).

For lens implantation, following pupil dilation, a 3.0- to 3.2-mm temporal clear corneal incision is made, and 1–2 additional paracentesis incisions are created, usually superiorly and inferiorly, to facilitate lens positioning. The lens is inserted using a cohesive viscoelastic material; after the lens unfolds, the footplates are positioned under the iris (Fig 9-4). The leading footplate is marked for identification to allow confirmation of correct orientation of the lens as it is injected. The surgeon should avoid contact with the central 6.0 mm of the lens, as any contact might damage the thin lens optic. Care should also be taken to avoid touching the crystalline lens with the PIOL to minimize the risk



Figure 9-1 An iris-fixated phakic intraocular lens (PIOL) for myopic correction. The iris clip portion of the lens is visible on the right side of the image. (Courtesy of Sherman W. Reeves, MD, MPH.)

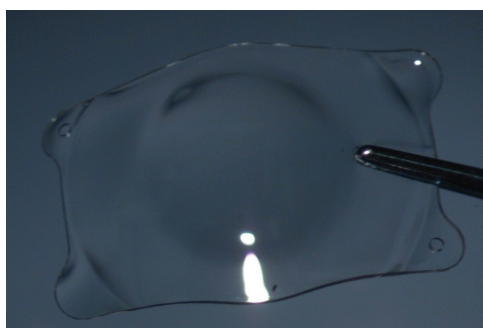


Figure 9-2 An implantable collamer posterior chamber PIOL. (Courtesy of John B. Cason, MD.)

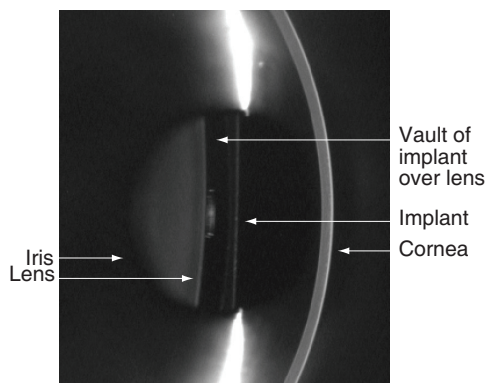


Figure 9-3 Scheimpflug image of a posterior chamber PIOL in place within the ciliary sulcus. The clear space between the implant and the native lens of the eye is termed the *vault* of the implant. (Courtesy of Sherman W. Reeves, MD, MPH.)

of cataract formation. Positioning instruments should be inserted through the paracenteses and kept peripheral to this central area. The pupil is then constricted. It is crucial to remove all viscoelastic material at the conclusion of the procedure to reduce the risk of a postoperative spike in IOP. Video 9-2 shows implantation of a posterior chamber PIOL.



VIDEO 9-2 Implantation of a posterior chamber phakic IOL.
 Courtesy of George O. Waring IV, MD.



Accommodative mechanisms

Accommodating IOLs in use or development primarily employ 3 strategies to accomplish the necessary power change for near vision: a change in optic position, a change in the anterior curvature of the lens, or a change in refractive index.

As discussed earlier in the Accommodating Intraocular Lenses section, one approach is a single-optic IOL that makes use of anterior axial movement of the optic position to increase refractive power. The *Crystalens* (Bausch + Lomb; the only currently FDA-approved accommodating IOL) and *TetraflexHD* (Lenstec) employ this strategy.

Some IOLs in clinical trials or in development rely on a change in anterior curvature of the implanted lens; these lenses include *FluidVision* (Alcon) and *Juvene* (LensGen). The *FluidVision* IOL is completely hollow and filled with fluid. During accommodative effort, the capsular bag compresses and squeezes the lens. Fluid moves from the annular haptics into the body of the optic, increasing the anterior curvature and power of the lens. When the ciliary body relaxes again, the fluid moves from the optic back into the haptics, flattening the lens.

The *Juvene* IOL is a 2-piece device consisting of a larger base lens within a flexible outer silicone ring that is inserted into the capsular bag, followed by a smaller fluid-filled lens placed into the ring. Accommodative effort squeezes the silicone ring, which in turn compresses the fluid-filled lens, changing the anterior curvature of the lens and increasing its near power (Video 10-3).



VIDEO 10-3 Insertion of a Juvene intraocular lens.
Courtesy of Sumit (Sam) Garg, MD.



The *NuLens* (NuLens Ltd) relies on ciliary body contraction and relaxation to change power. The IOL consists of an anterior polymethyl methacrylate (PMMA) reference lens, a silicone gel-filled chamber, and a posterior piston. During accommodative effort, haptics placed in the sulcus generate a force that drives the piston forward; this in turn compresses the gel and pushes it through a small central aperture in the anterior PMMA portion of the lens. This changes the anterior curvature of the lens and provides near power.

The *Opira* (ForSight Vision6) and *Atia* (Atia Vision) IOLs are 2-piece modular systems that make use of ciliary body contraction to initiate power changes. The *Opira* is unique in that the anterior dynamic portion has haptics that straddle the edge of the capsulorrhexis (bag-in-the-lens concept), while the posterior portion provides optical power.

Other approaches

The *Sapphire* IOL (Elenza) uses an electric current to physically change the lens optics. A sensor built into the lens can detect pupil constriction as part of the accommodative reflex. An electric current is passed through the lens, altering the molecular configuration of the lens material and changing the power of the lens from distance to near. A small, wireless rechargeable battery powers the lens.

The *Harmoni* IOL (Alcon) is a modular system in which the central optic is detachable from the haptic base (Fig 10-8). Theoretically, this would allow for different types of



Figure 10-8 Example of a 2-piece modular lens (Harmoni). The central optic is detachable from the haptic base for ease of IOL exchange. (Courtesy of Malik Kahook, MD.)

optics to be used, including monofocal, multifocal, and toric lenses. The main advantage of this type of implant would be ease of exchange if a patient cannot tolerate a multifocal lens or if there is significant postoperative ametropia (ie, the refractive target was missed) in a monofocal lens.

Another type of lens, the *Smart IOL* (Medennium) is made from a thermoplastic acrylic gel. On insertion into the eye, the gel responds to body temperature and deforms to take the shape of the capsular bag. Theoretically, compression of this pliable lens by the capsular bag allows adjustment of its effective power in a manner analogous to the way the crystalline lens adjusts. Potential problems with this approach include difficulty in predicting the lens power that results from filling the capsular bag and uncertainty about management of posterior capsule opacification.

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- Saraiva J, Neatroun K, Waring GO IV. Emerging technology in refractive cataract surgery. *J Ophthalmol.* 2016;2016:7309283.