IOL Basics

Materials, designs, and when to implant which type of lens.

BY SUMITRA S. KHANDELWAL, MD

What is the best IOL to choose for a particular patient? This is a question that surgeons must consider when planning for cataract surgery. In this edition of "Residents and Fellows," the basics of IOL characteristics are reviewed. I hope you enjoy this installment of the column, and I extend an invitation to readers to submit topics for publication.
—Sumit "Sam" Garg, MD, section editor

I asked a friend the other day why he uses a particular IOL. He answered, "I don't know. It's the only one I've used since training." Most residents have few IOL choices during training, however, an awareness of the various IOL materials, designs, and in which clinical scenarios to use each lens is very important. Although there are many lenses to choose from, this article describes the most commonly used ones (Table).

MATERIAL

It is easy to take for granted the inert material of a lens. Understanding the history of lens materials and subsequent modifications is helpful when deciding which lens to use.

Polymethyl Methacrylate

The original IOLs were made of the rid material polymethyl methacrylate or PMMA, and required an incision larger than the optic (6-7 mm) for implantation. PMMA IOLs work well in large-incision cataract surgery such as extracapsular extraction or for scleral-sutured lenses. An example of this type of IOL is the CZ70BD (Alcon), which has eyelets through which to pass sutures, allowing fixation to the scleral wall.

Acrylic

The ability to fold lenses revolutionized cataract surgery. The most common lenses in this category are hydrophobic acrylic lenses made of a blend of polymers, resulting in a high index of refraction and therefore a thinner profile. Popular designs include the one-piece AcrySof IOL (Alcon), the one- and three-piece Tecnis IOLs (Abbott Medical Optics), and the one-piece enVista (Bausch + Lomb). Although glistenings and dysphotopsias can occur with these lenses, they traditionally have the lowest rate of posterior capsular opacification (PCO) and anterior capsular contraction. Hydrophilic acrylic IOLs can cause high rates of PCO and calcification of the optic's surface.

Silicone

Silicone IOLs such as the Tecnis ZA9002, the SoftPort AO (Bausch + Lomb), and the AQ5010V (STAAR Surgical) have a low refractive index, which results in fewer dysphotopsias than acrylic lenses. These IOLs unfold quickly, which experienced surgeons typically appreciate. If a patient should require silicone oil as a result of retinal issues, these lenses must be explanted due to irreversible binding of the oil to the lens.

DESIGN

IOLs are often categorized according to their haptic design. Anterior chamber IOLs are fixated in front of the iris, whereas posterior chamber IOLs (PCIOLs) are generally fixated in the capsular bag. Depending on their haptic design, lenses are one or three pieces. Most residents are familiar with both types, but they should also know how the differences in design relate to the fixation method.

One-Piece PCIOLs

These lenses have thick but semi-rigid acrylic haptics molded to the optic. One-piece PCIOLs are easily injected through a small incision. Due to the risk of iris chafing by the bendable, thick haptics, however, these IOLs cannot be placed in the sulcus.

Three-Piece PCIOLs

The optic of these lenses can be made of any material. Three-piece PCIOLs have thin haptics that are often made of PMMA or polypropylene. They can be placed in

IOL DESIGN PEARLS

- A one-piece IOL requires a small incision, is easy to load and insert, unfolds gently, and cannot be placed in the sulcus.
- A three-piece IOL can be placed in the bag, sulcus, or fixated to the iris or sclera. It can be injected or folded and the wound may need to be enlarged.
- A silicone lens should not be placed or kept in an eye requiring silicone oil.
- Use aspheric and negative spherical lenses for patients with positive spherical aberrations such as after myopic LASIK, in eyes with keratoconus, or for most other patients who have not had previous surgery.
- Use positive spherical lenses for posthyperopic LASIK patients.

TABLE. POPULAR IOL CHOICES AND CHARACTERISTICS

Lens Material	Lens Design	Example	Characteristics
Hydrophobic acrylic	1 piece	Tecnis ZCBOO AcrySof SN60WF enVista AcrySof SN60AT	Aspheric, negative SA, clear Aspheric, negative SA, yellow Aspheric, junction eyelets, zero SA, clear Positive SA, clear
	3 pieces	Sensar Ar40e Tecnis ZA9003 AcrySof MA60AC/MN60AC	Positive SA, clear Aspheric, negative SA, clear Positive SA
Silicone	3 pieces	Tecnis ZA9002 AQ5010V	Aspheric, clear Useful as a piggyback IOL
PMMA	1 piece	CZ70BD	Eyelets for suturing

Abbreviation: SA, spherical aberration; PMMA, polymethyl methacrylate
Product (Company): Tecnis ZCBOO (Abbot Medical Optics); AcrySof SN60WF (Alcon); enVista (Bausch + Lomb); AcrySof SN60AT (Alcon); Sensar Ar40e (Abbott Medical Optics); Tecnis ZA9003 (Abbott Medical Optics); AcrySof MA60AC/MN60AC (Alcon); Tecnis ZA9002 (Abbott Medical Optics); AQ5010V (STAAR Surgical); CZ70BD (Alcon).

the capsular bag as well as in the sulcus, sutured to the iris, and sutured or glued to the sclera. They are loaded into the cartridge differently than one-piece lenses, so it is important for residents to learn the steps. The surgical staff may not have experience loading these IOLs, which means the surgeon may have to fold or load the IOLs. Three-piece PCIOLs are also inserted differently (involving more pronation) than the one-piece lenses. The haptics are susceptible to plunger damage, so practicing insertion in the wet lab is helpful. I recommend enlarging the wound and using a folding forceps to place three-piece IOLs, because this approach offers more control, especially if it is a resident's first time using this type of lens.

The Optic's Edge

The optic of traditional IOLs has a round edge, whereas newer designs have a square edge. The sharp barrier of the square edge is thought to prevent lens epithelial cell migration and therefore decrease PCO formation. Square-edged IOLs often have more dysphotopsias, however, so further modifications to the optic's diameter, its anterior edge, and even clouding of its edge have been developed.

SPHERICAL ABERRATIONS

A cornea that has not undergone refractive surgery has positive spherical aberration. A young crystalline lens has negative aberration but becomes more positive with age. Spherical aberration can be evaluated when choosing an IOL. Depending on the patient's spherical aberration, the IOL choice can be modified accordingly to improve contrast sensitivity and night vision.

Positive Spherical IOLs

These standard lenses add to the positive spherical aberrations in the cornea. They work very well for patients who have undergone hyperopic refractive surgery, because these patients have a cornea with negative spherical aberrations.

Negative and Aspheric IOLs

Negative and aspheric IOLs can compensate for positive spherical aberrations in the cornea. These lenses are especially important for patients who have undergone myopic LASIK or PRK. Aspheric lenses are more forgiving of centration errors and reduce spherical aberrations in most patients.

CONCLUSION

The placement of an IOL during cataract surgery helps to ensure patients' satisfaction and provide quality postoperative vision. Although consistency is important during training to learn the surgical steps, it is equally important to consider how IOLs' characteristics will affect patients and their vision for years to come. ■

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