Several different factors come into play when it comes to choosing an intraocular lens (IOL) for cataract surgery. On the one hand, materials and design should result in a low degree of postoperative inflammation by being as inert as possible and have a good track record concerning long-term complications such as posterior capsule opacification (PCO), and on the other hand, also be easy to handle concerning folding and implantation. Also, the production process for the manufacturer should be relatively simple to make it affordable. In special cases, such as those with incomplete capsule support, high myopia, or with a history of uveitis, the IOL choice may differ from the usual one. Additionally, in eyes with a cornea that either has astigmatism and/or spherical aberrations (SA), special IOLs may be indicated. Last but not least, patients who want to be less dependent on spectacles for near work or intermediate distance vision after surgery may be candidates for multifocal IOL designs.

This chapter will first focus on the different materials and designs available, then on the clinical outcomes relevant to IOLs, such as postoperative inflammation and PCO, and some of the criteria important for choosing an IOL for the individual patient.

**INTRAOCULAR LENS MATERIALS**

The earliest IOLs were made of polymethylmethacrylate (PMMA), the plastic that IOL inventor Harold Ridley had noticed to be inert in eyes of World War II aviators struck by flying plastic during combat. With the introduction of phacoemulsification and the possibility to remove the cataract through smaller incisions, foldable materials were developed for IOLs such as hydrophobic acrylic, hydrophilic acrylic (or hydrogel), and hydrophobic silicone, the three main material groups in use today (Figure 12-1).

**Hydrophobic Acrylic**

Polymethylmethacrylate

Even though the use of nonfoldable PMMA for cataract surgery today plays little role in the United States and Europe mainly because of large wound size, it still plays an important role in countries where extracapsular cataract extraction (ECCE) with manual expression of the nucleus is the technique of choice. PMMA IOLs with a sharp optic edge have been shown to result in relatively low PCO rates, and heparin-surface modified PMMA IOLs have been used in uveitis patients with good results. Currently, PMMA is still used for sulcus-placed IOLs due to their overall rigidity, which
results in good centration and resistance to tilt, as well as in sulcus-sutured IOLs for the same reasons. Anterior chamber IOLs as well as iris-fixated IOLs are also made of PMMA and known to be very inert concerning the uveal inflammatory reaction.

**Foldable Hydrophobic Acrylic**

Currently the most commonly used material group, these polymers of acrylate are foldable under room temperature. The materials have very low water content, a high refractive index, and usually a high memory, which also makes the material suitable for the haptics of a monobloc open-loop IOL. This group of material unfolds in a controlled fashion and has been shown to have a good uveal and excellent capsular biocompatibility (see more below). The two main representatives of this group are AMO Acrylic (Santa Ana, CA) and Acrysof (Alcon, Fort Worth, TX).

One of the drawbacks of this material group has been intralenticular changes. Small water inclusions in the optic material called glistenings can occur in hydrophobic materials, predominantly seen with the Acrysof material. Over time, the glistenings can increase, but evidence to this date does not indicate any effect on visual function.

The other drawback has been dysphotopsias reported with this high refractive index material. The most common positive dysphotopsia was edge glare, which was due to internal reflections at the rectangular edge of the Acrysof IOL under mesopic conditions with a large pupil, typically induced by a light source from the side and reported as a peripheral arc of light by patients. As a result of changes in optic geometry, these dysphotopsias have been reduced significantly with newer hydrophobic acrylic models. A smaller proportion of patients report negative dysphotopsias, which are perceived as a scotoma in the temporal peripheral visual field and are also found more frequently with materials of high refractive index.

**Hydrophilic Acrylic**

Hydrophilic acrylic is a quite heterogeneous material group and has a high water content. These lenses are cut in the dehydrated state and then hydrated and stored in solution. The water content between IOLs varies widely and can be as high as 38%. A recent meta-analysis on PCO showed that the hydrophilic acrylic lenses are more prone to develop PCO than hydrophobic acrylic lenses or silicone lenses. This may be due to the high water content being more “inviting” to lens epithelial cells (LEC) ingrowth or the fact that the optic edge of IOLs in this group is never as sharp as with the hydrophobic materials, therefore inducing a less sharp bend of the capsule at the edge and being a less effective barrier to regenerating LECs.

One major problem with some hydrophilic acrylic lenses of different companies was opacification of the optic material due to calcification. These cases needed subsequent explanation due to the poor optical quality. It must be said, however, that the majority of hydrophilic lenses of other companies have never shown such problems in the past.

**Silicone**

Silicone was the first material available for foldable IOLs. In the past decade, we have been seeing a continuous decline in the use of silicone IOLs. While silicone is a very good IOL material, especially concerning its PCO blocking effect, it cannot be used for a monobloc open-loop lens. This lens design is the preferred choice for use with preloaded injectors that allow implantation through incisions smaller than 2.8 mm, which appears to be the current trend. When using an injector for small incisions, there is a risk of tearing of the optic at the optic-haptic junction or kinking of the haptics during injection with multipiece open-loop IOLs.

**Light Filtering**

All IOL materials used today include ultraviolet (UV) light-blocking chromophores to filter the UV light. From in vitro and animal experiments, blue light was considered harmful due to short wavelength high
energy light causing retinal damage by inducing more oxidative stress at the retinal level. Even though this has not been shown or proven in humans, some manufacturers have introduced yellow-tinted IOLs to filter the short wavelength light. A yellow lens has two potential drawbacks: one is a reduction in color contrast sensitivity, especially under mesopic conditions, and another is that the melatonin production in the brain may be altered, causing a change in the circadian rhythms that are steered by blue light levels in the eye.12

Although to date no study has shown that a yellow lens causes a significant loss in color contrast sensitivity, this may also be due to the lack of sensitivity of the psychophysical tests used. From my own experience, I have two patients who could clearly identify the eye with the yellow lens from the eye that had a standard fully transparent non-yellow lens. They described the vision with the yellow lens eye as a little “dirtier” than the other. Clinically, yellow lenses have not been shown to be protective, and the possible drawbacks may contribute to surgeons being somewhat hesitant to implant yellow lenses on a routine basis in patients with no increased risk to develop macula problems.

**INTRAOCULAR LENS DESIGN**

Design options for IOLs currently are manifold: multipiece or monobloc; plate or open-loop style; angulated or planar haptics; special haptics for certain indications such as sulcus, anterior chamber angle, or iris fixation; optic shape and edge design; and optic geometry for certain indications such as toric, aspheric, or multifocal IOLs (Figure 12-2).

**Plate Haptic**

One of the first foldable IOLs was a silicone plate haptic IOL (see Figure 12-2). Today, several manufacturers of hydrophilic IOLs still use a plate-style design, usually combined with small loop-like haptics at the four corners to allow better adaptation to capsule bag size. One major drawback of the plate-style design is the incomplete fusion of the anterior and posterior capsule leaves along the plate haptic axis and, therefore, the lack of capsule bending at the optic edge. This allows LECs to migrate centrally onto the posterior capsule and cause the most common long-term problem after cataract surgery—PCO.

Some manufacturers have designed a cross-over between plate haptic and open-loop haptic design (see Figure 12-2). This allows better adaptability to capsule bag size variations and also reduces the zone of missing capsule bend.

**Open-Loop**

**Multipiece**

Open-loop IOLs are held in place in the capsule bag by exerting a centripetal pressure on the capsule bag fornix and sometimes also the ciliary body, or in case of sulcus placement the ciliary sulcus. The haptics of an IOL should maintain their original configuration during the implantation procedure. The haptic rigidity, which is the resistance of the haptic to forces that bend the loops centrally, and the haptic memory, which is the ability of the haptic to go back to its original configuration after having been bent, are the two factors that determine whether an IOL will center well in an eye after implantation. Additionally, the contractile forces of the shrinking capsule bag due to fibrosis, especially in cases with zonule weakness or asymmetric shrinking, will need counteracting pressure from the haptics to ensure good centration.

Haptic materials are most commonly PMMA, and then polyvinylidene fluoride (PVDF), polyimide (elastimide), and polypropylene (prolene) (Figure 12-3). The prolene haptic material, however, has a lower memory than the other three materials13 and is used less frequently due to recurrent problems of decentration.

Concerning haptic shape, the j-loop design results in pinpointed contact with the capsule bag equator. This may lead to stress folds of the posterior capsule, which usually disappear within the first months after surgery concomitant with the decrease in memory of the haptic material. This type of loop is the preferred type for IOLs dedicated for sulcus placement.

**Single-Piece**

New manufacturing methods led to the introduction of single-piece open-loop IOLs some years ago. Unlike three-piece IOLs, which usually consist of two different materials (optic and haptics) and need to be assembled by hand, these IOLs are produced in a single step from one material. Single-piece IOLs tend to be more resistant to damage when used with injectors and the production process is cheaper since less staff intensive. However, most single-piece designs feature broad haptic shoulders at the transition to the IOL optic for stability reasons (see Figure 12-3). This raises the question whether these lenses may have less of a PCO-inhibiting effect because of the incomplete sharp posterior optic rim. Nevertheless, clinical trials (some of them still ongoing) did not show significant differences in PCO rates between single-piece and multipiece IOLs (Figure 12-4).14,15 However, the
interrupted sharp optic rim might lead to problems in new ultrathin single-piece IOLs developed for microincisional surgery. Next-generation one-piece IOLs, such as the Tecnis 1-Piece IOL, incorporate a 360-degree square-edge design.

**Haptic Angulation**

The PCO preventative effect of sharp-edge optics suggests that it might be useful to maximize the barrier effect to migrating LECs at the posterior optic edge by pushing the IOL backward against the posterior capsule. This can be achieved with angulated
haptic designs (see Figure 12-2). They were originally introduced because an angulation reduced iris shave in cases where the lens was placed in the sulcus. Consequently, such posterior vaulting characteristics can be found in many modern three-piece IOLs, with angulation of 5 to 10 degrees. However, studies showed that these designs do not lead to a smaller IOL to posterior capsule distance\(^{16}\) and do not seem to have a better PCO-inhibiting effect than IOLs with little or no haptic angulation.

**Intraocular Lens Overall Length**

Even though the average capsule bag only has a diameter of about 10.4 mm,\(^{17}\) the variability is quite large with size ranging from 9.8 to 10.9 mm. For this reason and the fact that the bag ovalizes after lens implantation, especially in the case of weak zonules, most IOLs are oversized for the bag. This is especially true for the multipiece IOLs from the major manufacturers, which usually have an overall length of 13 mm. It appears that the main reason for such oversizing is the need for the IOL to also be suitable for sulcus placement, even though a larger diameter would be preferable for this occasion.

**Intraocular Lenses for Insufficient Capsule Support**

In the case of capsule complications where a bag placement of an IOL is no longer possible, but the anterior capsule is intact, the IOL can be placed with the haptics in the sulcus. However, in order to ensure centration and axial stability of the IOL, an overall length (haptic to haptic) of at least 13 mm should be chosen. Optimally, especially in eyes with a larger sulcus diameter such as myopic eyes, 13.5 or 14 mm would be more appropriate. There are some dedicated sulcus IOLs with such overall length often combined with a larger optic diameter of 6.5 or even 7 mm, both available as nonfoldable PMMA or foldable IOLs (see Figure 12-2). Foldable single-piece IOLs should be avoided for these situations as their relatively thick haptics can cause rubbing on the posterior aspect of the iris with pigment dispersion.

In cases where the rhexis is still fully intact, a positioning of the optic through the rhexis and behind the anterior capsule (posterior buttonholing) ensures a good centration of the IOL and results in an axial position of the optic close to that of bag placement, therefore, only requiring a small to no adjustment.
of IOL power. Should buttonholing not be possible, about 0.5 diopters should be deducted from the calculated power since the IOL will be more anteriorly placed in the eye.

In cases where no capsule support is given, apart from the classical angle-supported anterior chamber IOL, iris-supported IOLs and scleral-sutured IOLs are the most popular options (see Figure 12-2). In the case of the iris-supported IOL with lobster-claw haptics that are “clipped” onto iris stroma, they can be clipped onto the iris from the anterior side or from the posterior side—so-called retropupillary fixation. This IOL style has a long track record in aphakic eyes and appears to have a low rate of endothelial cell loss, but do require a 6-mm incision since the aphakic style is currently only available in PMMA.

In the case of scleral suturing of a posterior chamber IOL, both foldable and rigid IOLs can be used. However, there have been several reports of long-term knot erosion resulting in decentraltion or even subluxation of these IOLs as well as late endophthalmitis. Apart from lacking evidence of their function, these IOL designs have had significant amounts of PCO with most patients needing Nd:YAG capsulotomies within the first 2 years after surgery (Figure 12-5).

**INTRAOCULAR LENS OPTIC DESIGN**

**Edge Design**

During the past decade it has become clear that optic edge design plays an important role in the prevention of PCO. When the Acrysof lens (Alcon) was introduced in the early 1990s, several studies showed that PCO development was significantly less than with other IOLs. This first was attributed to the acrylic material and to the surface properties of the IOL. Later it could be shown that the sharp-edge design of the lens seemed to be the key factor for this effect. The sharp IOL edge was a result of the manufacturing process, and its blocking effect on LEC migration, therefore, rather coincidental. Further studies confirmed that the rectangular shape of the IOL rim with its sharp edges, in combination with the acrylic material, was in fact the main reason for the reduced
formation of PCO. Studies by Nishi revealed that the discontinuous capsular bend seems to be a key factor for the preventative effect of a sharp-edge optic. The capsular bend at the posterior optic edge causes mechanical pressure and/or contact inhibition of LEC growth on the posterior capsule (Figure 12-6).

As a result of these findings, several new IOLs with a sharp optic edge design were introduced in the past years and compared in clinical trials. In a meta-analysis of the randomized controlled trials comparing round and sharp-edge IOLs, there was a clear beneficial effect of sharp-edge IOLs concerning inhibition of PCO. This also confirmed that the sole modification of the posterior optic edge from a round edge to a sharp edge leads to a significant reduction of PCO by inducing a discontinuous bend at the posterior capsule (Figure 12-7).

Unfortunately, sharp optic edges of IOLs may also have disadvantages. As described previously, in some cases with implantation of lenses with a rectangular edge shape combined with a high refractive index, such as found with the Acrysof lens, an increased incidence of persistent edge-glare phenomena was reported. Sharp-edge IOL designs cause the light rays that are refracted through the peripheral IOL to be more intense on the peripheral retina. Round-edge IOL designs disperse the rays of light over a larger surface area of the retina, leading to less glare. However, the half-rounded edge profile of some newly developed IOLs with a round anterior and sharp posterior optic edge seems to avoid this disturbing side effect.

Optic Geometry

Biconvexity

Most IOLs on the market have a symmetrically biconvex optic, meaning that the radius of curvature of the front and back surface are identical. Some manufacturers have an asymmetric biconvex optic, where the back surface curvature is relatively flat and constant throughout most of the power range and the anterior curvature is varied for IOL power. This causes a slight shift of the principal optical plane of the IOL and also implies that the lens should not be implanted front to back in the eye, apart from the angulation of the haptics being backward as well. In a symmetrically biconvex lens with no angulation, the IOL could be implanted front to back without a change in optical power.

Optical Zone

Most IOLs have a full-size effective optical zone of 6 mm in the main range of IOL powers. Therefore, the higher powered IOLs will have a thicker optic than the lower powers. This has the advantage of a full optic zone, but can make folding of the IOL or injecting with a shooter variable depending on IOL power. Some IOLs keep a constant center thickness of the optic and vary the effective optical zone, thereby varying the curvature of the optic and, therefore, optic power. To my knowledge, there was only one manufacturer (Dr. Schmidt) that actually varied refractive index of the silicone material used for different powers, thereby keeping a constant effective optical zone and center thickness.

Special Optics

Aspherical Intraocular Lenses

This topic is covered extensively in Chapter 13. In short, these IOLs are either neutral concerning SA, therefore not adding SA to the eye, or like most models currently on the market have a prolate surface inducing negative SA, which should neutralize
the positive SA of the average cornea. The aim is to increase contrast sensitivity under mesopic conditions where the pupil is dilated. The IOLs have little to no effect when the pupil is small.

**Toric Intraocular Lenses**

With cataract surgery we can attempt to reduce preexisting corneal astigmatism using incisional techniques, such as placing the corneal incision on the steep axis, adding an opposite clear cornea incision (OCCI) on the same axis, or making limbal relaxing incisions (LRIs) on the steep axis. Most surgeons will use a 600-micron knife to perform LRIs. LRIs are able to reduce corneal astigmatism by as much as 3 diopters. This topic is covered at length in Chapter 16. The variability of the outcome is mainly due to interpatient differences in scarring of the corneal tissue, corneal rigidity, and corneal thickness.

**Figure 12-7.** PCO 1 year (upper) and 3 years (lower) after surgery for round (left) and sharp (right) edge optic design for a hydrophobic acrylic IOL.
An effective and quite predictable method of neutralizing corneal astigmatism is the use of toric IOLs. The steep axis of the eye needs to be marked in the sitting position before surgery since the eye will undergo some cyclotorsion in the supine position. The mean cyclotorsion was reported to be 2 degrees, however, can vary between patients and be up to 10 degrees in individual cases. Accurate axis placement of the toric IOL is critical to the outcome since 3% of the toric correction is lost for every degree off axis. Toric IOLs have marks on the IOL optic for alignment (Figure 12-8). Being 10 degrees off the desired axis results in about one-third of the toric correction lost. Being 30 degrees off results in no toric correction and a shift of the axis, and errors beyond that result in an increase in astigmatism of the eye, being more than preoperatively and at a completely different axis (axis-flip). Since it is crucial that the IOL does not rotate inside the capsule bag during capsule shrinkage, there are several different special haptic designs that should ensure stability. Clinical outcomes with modern toric IOLs have been very promising and rotational stability appears to be within 2 degrees. Good planning and precision during surgery seem to be key to the success with these IOLs.

Multifocal Intraocular Lenses

Multifocal IOLs (mIOLs) are designed to overcome the postoperative lack of accommodation by dividing the incoming light onto two or more focal points. One of these is used for distance vision, the other for near or intermediate vision. These IOLs have shown to reduce the need for spectacle correction in daily life. However, good refractive outcome and low residual astigmatism after surgery are key to success. Therefore, meticulous biometry and power calculation are needed. Additionally, since the light is divided and also some light (about 20%) is lost to higher orders of diffraction, patients have reduced contrast sensitivity. Small amounts of PCO may cause substantial loss in visual functions and Nd:YAG capsulotomy may need to be performed earlier than usual. Additionally, the blurred nonfocused image will overlay the focused image and can cause the photic phenomenon of halos seen around light sources especially at night with a larger pupil. These can be disturbing to patients and are the main reason for explantation of mIOLs.

There are two types of mIOLs: diffractive and refractive. Diffractive mIOLs (Figure 12-9) use the entire optical zone for the creation of two foci and are, therefore, bifocal mIOLs. The focal points are created using constructive and destructive interference of light rays. These phase differences are induced by small steps that are about one-half of the incident light wavelength. In refractive mIOLs, several foci are created by zones of different surface curvatures of the lens. These IOL models will differ according to the distribution of the zones on the optic surface, and the light distribution onto the different foci is pupil size dependent.

In general, diffractive mIOLs usually have very good near vision outcomes, however, intermediate vision is poor. In contrast, refractive mIOLs usually have good intermediate vision but relatively poor near vision. In an attempt to get the best of both worlds, a strategy called “mix-and-match” with implantation of a refractive mIOL into one eye and a diffractive mIOL into the contralateral eye has been developed. To date there are little published data available, but this strategy appears promising in some patients.

Another strategy to avoid mIOLs and their potential drawbacks as mentioned above is monovision where both eyes receive standard monofocal IOLs. The dominant eye receives an IOL power to achieve good distance vision and the contralateral eye is made about 1.25 diopters more myopic to allow intermediate vision. With both eyes open, the patients usually have satisfactory near vision, at least under good lighting conditions.

Whether using mIOLs or monovision, patient selection and extensive preoperative counseling are key factors for a good outcome. It appears that patient motivation to achieve spectacle independence may be the critical deciding factor for success.
Clinical Performance of an Intraocular Lens

Biocompatibility

Phacoemulsification and foldable IOL technology have permitted the use of small incisions, which results in less trauma caused by cataract surgery. Immediate postoperative inflammation is mainly attributed to surgical irritation of the anterior uvea, which causes changes in the blood-aqueous barrier. Long-term postoperative inflammation is caused by other factors such as immunological reactions.

The performance of an IOL is determined by several factors such as the surgical technique, the perioperative treatment, the IOL biomaterial and design, and the host reaction to the lens.

The cellular reaction seen on an IOL is an important indicator of the IOL’s biocompatibility. On the one hand, it consists of macrophages in the form of small, round cells and foreign body giant cell on the IOL surface. On the other hand, the cells are LECs after the capsule comes into contact with the foreign body IOL. Accordingly, the biocompatibility of an IOL can be divided into two parts—the uveal and the capsular reaction, as described by Amon.

Uveal biocompatibility is defined as the reaction of the uvea to the IOL. As a result to the surgical trauma and the IOL, monocytes and macrophages migrate through the uvea’s vessel walls into the aqueous and then onto the IOL surface. Monocytes transform into small, round cells and macrophages transform into epithelioid and foreign body giant cells that are responsible for the phagocytosis of debris. These cells constitute the natural immunological process in a foreign body reaction.

Capsular biocompatibility is defined as the reaction of LECs and the capsule to the IOL material and design. This encompasses LEC ongrowth, anterior capsule opacification, and PCO. The LECs residing on the posterior side of the anterior capsule (Figure 12-10), the so-called A-cells, can proliferate onto the IOL optic from the anterior capsular rim (ongrowth) and lay down collagen which results in whitening of the capsule as well as contraction of the capsule, which in turn may cause rhexis contraction or even phimosis, decentration of the IOL, or buttonholing of the IOL (Figure 12-11).

LECs also express cytokines, such as interleukin-1, interleukin-6, and transforming growth factor β, that are responsible for LEC proliferation and transdifferentiation into myofibroblasts and the synthesis of collagen fibers. These cytokines may act in an autocrine and paracrine fashion, influencing the postoperative proliferation of LECs in the capsular bag. Thus, Nishi and coauthors postulated that fibrous proliferation of LECs with anterior capsule fibrosis is often associated with blood-aqueous barrier disruption, clinically visible as flare in the anterior chamber.

Posterior Capsule Opacification

PCO (or after cataract) remains a common problem after cataract surgery with implantation of an IOL. It resulted from the transition from intracapsular cataract extraction (ICCE) to ECCE, where the posterior lens capsule is left intact during surgery. Patients with PCO suffer from decreased visual acuity, impaired contrast sensitivity, and glare disability.

Clinically, two different components of PCO can be differentiated, namely a regeneratory and a fibrotic component (Figure 12-12). Regeneratory PCO is much more common; it is caused by residual LECs from the lens equator region, the so-called E-cells, migrating and proliferating into the space between the posterior capsule and the IOL, forming layers of lens material and Elschnig pearls. Fibrotic PCO is caused by LECs from the anterior capsule that undergo transformation to myofibroblasts and gain access to the posterior capsule, causing whitening and wrinkling of the
capsule. As described above, this can lead to decen-
tration of the IOL and hinder visualization of the
peripheral retina. Both components of PCO lead to a
decrease in visual function when they affect the cen-
tral region around the visual axis.

PCO can easily be treated by Nd:YAG laser capsu-
lotomy, however, this may lead to other complications,
including a short-term increase in intraocular pressure,
ocular inflammation, cystoid macular edema, and reti-

cal detachment. Besides, Nd:YAG laser capsulotomy
does not improve visualization of the peripheral retina,
increases the overall costs for cataract treatment, and
is not available in large parts of the developing world.
Therefore, many efforts are made to prevent the for-
mation of PCO. These efforts include mainly modifi-
cations in lens design and material, as well as modifica-
tions in surgical technique, application of drugs, and
others. While there is currently no commonly used
surgical technique and/or drug that would lead to a
significant reduction in PCO, the development of new
IOL models in order to reduce PCO has made signifi-
cant progress.

There is ongoing research to better understand
the development of PCO and its changes over time
and whether it can be modulated by pharmaceutical
means. This knowledge would have implications for
the ultimate cataract treatment, namely lens refilling
(or phakoersatz), where the lens substance is replaced
with an elastic polymer to allow full accommodation
after surgery. The main hurdle for lens refilling has
been after cataract with loss of bag elasticity due to
fibrosis of the capsule and opacification of the capsule
due to the regenerator PCO. Regenerator PCO has
been shown to be a very dynamic and always chang-
ing process, whereas Elschnig pearls have a life span of
several weeks to a few months only (Figure 12-13).

**Intraocular Lens Material and Posterior Capsule
Opacification**

While the PCO-inhibiting effect of a sharp pos-
terior optic edge has been clearly demonstrated in
several trials, the role of different IOL optic materials
(ie, PMMA, hydrophobic acrylic, hydrophilic acrylic
[hydrogel], silicone) in reducing PCO remains uncer-
tain. Although many studies comparing different IOL
materials have been performed, significantly higher
PCO rates have only been shown for hydrophilic
acrylic in comparison to other materials (ie, acrylic and silicone IOLs). A few studies comparing
hydrophobic acrylic and silicone lenses did not find
significant differences between the two materials.

**Intraocular Lens Material and Biocompatibility**

Concerning uveal and capsular biocompatibility,
hydrophilic acrylic (hydrogel) materials show a good
uveal biocompatibility with less flare and less uveal
cells on the IOL optic surface, but a poorer capsular
biocompatibility than hydrophobic materials. This
is clinically visible as a stronger tendency for LEC
ongrowth onto the IOL optic surface and especially
higher PCO rates. The higher incidence of PCO with
hydrophilic materials may also be due to the fact that
the optic edge with hydrophilic materials is not as
sharp as with hydrophobic materials.

Hydrophobic acrylic IOLs show a low rate of
PCO, but a higher incidence of giant cell reaction on
the surface. Despite the good capsular biocompat-
ibility, the uveal biocompatibility seems worse than
with silicone IOLs. Modern silicone lenses with a
sharp-edge optic have shown both excellent uveal and
capsular biocompatibility.
How to Achieve a Low Posterior Capsule Opacification Rate

Meticulous surgical technique is a prerequisite for low PCO rates. A well-centered capsulorrhexis where the rhexis edge overlaps the IOL optic edge around the entire circumference is necessary to ensure a bending effect on the posterior capsule to act as a barrier to invading LECs. Concerning IOL design, the concept of a sharp posterior optic edge has been proven to be the most effective method to reduce PCO up to now.

As a result, round-edge IOLs have practically disappeared from the market. However, although drastically reduced, the problem of PCO has not been eliminated. The role of IOL optic material remains unclear, while hydrogel lenses have been shown to have a high PCO incidence, there is still an ongoing debate about which of the hydrophobic material—hydrophobic acrylic or silicone—should be preferred with respect to PCO inhibition. Single-piece IOLs with an incomplete sharp optic rim have not shown significantly higher PCO
Intraocular Lens Materials and Design

rates than multipiece IOL designs. However, new ultrathin IOLs that are currently being developed for microincision surgery might perform worse concerning PCO inhibition, due to their thin optic rim and therefore possibly weaker barrier effect at the optic edge.

REFERENCES


Figure 12-13. Examples of the dynamic changes of Elschnig pearls within a month in eyes with PCO; birth and death (upper), questionable fusion of two pearls and then disappearance (lower).