In the decades since their introduction in the 1950s, phakic IOLs have become a compelling option for the correction of refractive error. There are, however, potential problems that can result from electing a phakic IOL as part of a refractive solution. Consequently, various safety parameters have been devised to minimize risks. But before complications can be properly addressed, it is important to distinguish among the available phakic IOLs and differentiate those problems associated with each lens design.

**TYPES OF PHAKIC IOL**

Initial phakic IOL designs were angle-fixated lenses intended for implantation in the anterior chamber.\(^1\) Unfortunately, the first 5-year follow-up study demonstrated a high rate of angle recession, glaucoma, hyphema, endothelial cell loss, and decentration, leading to removal in up to 60% of cases.\(^2\) Subsequent lens designs improved, and today, in addition to anterior chamber phakic IOLs, posterior chamber phakic IOLs are also available.

**Anterior chamber phakic IOLs.** Phakic IOLs designed for the anterior chamber are either angle-supported or iris-supported. Angle-supported lens models include the AcrySof Cachet one-piece foldable lens (Alcon Laboratories, Inc.) and the two-piece Kelman Duet Implant (Tekia).\(^3\) Several rigid PMMA angle-supported lenses are still used in Europe, notably the ZSAL-4 (Morcher GmbH). With its flexible haptics, this lens is designed to disperse compressive forces, reduce movement, and thus, decrease endothelial damage.\(^4\)

Iris-supported lenses were developed to avoid the complications seen with angle-supported lenses in their early years. The longest-serving example is the Artisan lens (Ophtec GmbH; Figure 1), a one-piece PMMA lens that fixes onto the anterior surface of the iris. A foldable version of this lens, the Artiflex, is also available. Studies have shown that endothelial loss rates with this lens are no higher than natural atrophy.\(^5\)

**Posterior chamber phakic IOLs.** The move to the posterior chamber began in the 1980s, when surgeons began fixating iris-supported lenses on the posterior rather than the anterior face of the iris but continued to place the optic in the anterior chamber.\(^6\) These so-called anterior-posterior lenses were associated with pupil block and daytime photophobia in bright light, as the pupil could not constrict beyond a certain size due to the protruding optic.\(^6\) The only such lens in use today is a one-piece meniscus PMMA lens, the Nikai IOL (Soleko).

After this experience, lenses placed entirely in the posterior chamber were developed in the early 1990s. The first lens of this design was what is now called the Implantable Collamer Lens (ICL; STAAR Surgical);\(^7\) others followed, including the Sticklens (IOLTech Laboratories).

**POTENTIAL PROBLEMS AND SAFETY CONSIDERATIONS**

**Endothelial cell count.** Arguably the two most important parameters for contraindication of phakic IOL implantation are anterior chamber depth (ACD) less than 2.8 mm and endothelial cell count (ECC) lower than 2,500 cells/mm\(^2\) at 20 years of age or 2,000 cells/mm\(^2\) at 40 years of age.\(^3\) However, these parameters are
no longer absolute and should be considered on a case-by-case basis. A calculation based on the ECC, the age of the patient, and the natural endothelial cell death rate (14 cells/mm²/year) can be used to determine safety.⁸

All intraocular procedures entail some degree of endothelial cell loss, and insertion of a phakic IOL induces between 2.1% and 7.6%.³ Postoperative endothelial loss is also an important issue. In one study, the Artisan lens was associated with endothelial cell loss of 1.06% at 1 year, with an average yearly endothelial cell density change of -1.7% over the course of 3 years⁹ compared with the natural average change of -0.6%.¹⁰ Another study showed 1-year endothelial loss rates of 3.5%; however, the loss rate stabilized over 5 years and the percentage of hexagonal cells increased, indicating stability.¹¹ For the ICL, the 1-year endothelial cell loss rate was 5.17% in one study,¹² and, in another, a cumulative decrease of 7.7% was seen in endothelial cell density over 5 years.¹³ The reason for the discrepancy is possibly due to chronic low-grade inflammation.¹⁴

Postoperative checks are vital to detect higher-than-expected rates of endothelial cell loss, and the lens should be removed if the loss rate is too high.³ There is debate as to how high the cell loss rates must be before one contemplates removal, with the options based on an absolute ECC or on cumulative loss compared with preoperative values.

**Endothelial morphology.** A high rate of hexagonal cells indicates endothelial stability. During pre- and postoperative evaluation of the endothelium, check for signs of polymegathism and pleomorphism, which are variations in the size and shape of the cells, respectively (Figure 2). Corneas with high rates of polymegathism and pleomorphism do not tend to do well after intraocular surgery, and the presence of less than 50% hexagonal cells is considered high risk for decompensation.¹⁵ The usual rule is that these indices stabilize after initial postoperative decompensation as rates of hexagonal cells increase.¹¹ Reversal of this trend may be an indication for explantation.

**Angle considerations.** A stable refraction and good ocular health are also important criteria. For posterior chamber phakic IOLs, an open angle is the most important factor; Shaffer grades 3 and 4 are the least problematic angles.¹⁶

**Age.** Declining endothelial cell counts and increasing crystalline lens thickness, which both occur with aging, reduce ACD. Current thinking suggests 50 years of age is the upper-age limit for phakic IOL implantation.³ One must also bear in mind that phakic IOL implantation preserves the crystalline lens, and therefore, in a younger patient, preserves accommodation. In patients of presbyopic age, this advantage is void, and the surgeon must consider whether these patients would not be better served by clear lens extraction and placement of a pseudophakic lens such as a multifocal.¹⁷

**Crystalline lens rise.** Another recently recognized safety criterion proposed for anterior chamber phakic IOLs is crystalline lens rise,¹⁸ defined as the distance between the anterior pole of the crystalline lens and the horizontal plane joining the opposite iridocorneal recesses. Among 87 eyes implanted with an Artisan IOL, little risk of pigment dispersion was found when the crystalline lens rise was less that 600 µm. Beyond this level, the incidence jumped to 67%.

Additionally, due to natural thickening, the anterior pole of the crystalline lens moves forward by 20 µm each year, and for every 1.00 D of accommodation the anterior pole moves forward by 30 µm.¹⁹ Anterior segment optical coherence tomography (OCT) can be used to calculate whether a phakic IOL—and which model—is safe to implant.²⁰

**Cataract formation.** The incidence of nuclear cataract 4 years after angle-supported phakic IOL implantation has been reported as 3.42%.²¹ In one series of posterior chamber IOLs,²² 8.2% of 170 patients developed some degree of anterior subcapsular opacity, which was symptomatic in five patients (2.3%) and required phacoemulsification in two patients (1.2%). As 86% of these anterior subcapsular elements presented within 7 months of the
operation and tended to be within the first group of patients operated upon by individual surgeons, the study authors posited that surgical technique and adequate sizing were more relevant to cataract formation than the presence of the lens in the posterior chamber. Cataract formation does not always occur; one of the first patients who underwent posterior chamber phakic IOL implantation showed no sign of cataract at 18-year follow-up.\textsuperscript{14}

**Intraocular pressure (IOP) and uveitis.** The level of initial surgical trauma due to phakic IOL insertion determines postoperative rates of uveitis and pigmentary dispersion glaucoma.\textsuperscript{2} Newer phakic IOL designs and the performance of prophylactic peripheral iridotomies have been introduced to prevent pupil block. Therefore, transient rise in postoperative IOP is now thought to be related more to steroid use than to the operation itself.\textsuperscript{23,24} There have, however, still been reports of intractable increases in IOP requiring trabeculectomy\textsuperscript{25} as well as pupil block despite a patent peripheral iridotomy.\textsuperscript{26}

Similarly, postoperative uveitis is no longer a significant long-term problem with modern lens designs.\textsuperscript{23} However, one group of researchers found evidence of low-grade anterior chamber inflammation up to 2 years postoperatively.\textsuperscript{27}

**OTHER CONSIDERATIONS**

Patients who are best served by a less-invasive refractive solution, such as spectacles, contact lenses, or LASIK, is it common, as reoperation rates are below 8% in the majority of studies and less than 4% in others.\textsuperscript{23} The vast majority of explantations in these series were performed due to one of the complications described above, but refractive errors still occur, and one of the most vital preoperative considerations is accurate calculation of the power of phakic lens needed.\textsuperscript{28}

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**TAKE-HOME MESSAGE**

- Insertion of a phakic IOL induces between 2.1% and 7.6% endothelial cell loss.
- During pre- and postoperative assessment of the endothelium, check for polymegathism and pleomorphism.
- Anterior segment OCT can indicate whether a phakic IOL is safe to implant, and which one.
- The most vital preoperative consideration is accurate calculation of the power of the phakic IOL power.