The Appeal of Phakic Implants

Both cataract and refractive surgeons can appreciate these lenses.

BY DIMITRII DEMENTIEV, MD

Even with the continual evolution of refractive surgery techniques, LASIK remains one of the most common refractive procedures worldwide. However, having learned in the past 20 years that there is a limit to the effectiveness of corneal ablation—especially in patients with thin corneas, high myopia, and hyperopia—clinicians are more frequently relying on lenticular solutions for refractive correction. Likewise, as the quest for excellent visual quality after IOL implantation continues, cataract surgeons have become more interested in the refractive side of ophthalmic procedures. Phakic IOLs offer an option that appeals to both subspecialities.

The goal of cataract surgery in the 1990s was to restore diminished vision, exchanging a cloudy crystalline lens for an IOL. But in the past decade, cataract surgery has been slowly converted into a refractive surgery hybrid. Today, the goal of cataract surgery is achieving not only restoration of vision but also a precise refractive outcome. Every cataract surgeon wants to make the patient less reliant on glasses or contact lenses, even after routine phaco. That is why surgeons spend so much time educating and advising patients regarding the choice of an appropriate IOL.

Phakic lenses are a logical evolution from cataract replacement IOL technologies. These implantable lenses fill the gap between existing and emerging treatment modalities for spherical visual acuity defects. They are indicated for any level of myopia or hyperopia, including correction greater than 3.00 D. In 1990, several companies began to manufacture phakic IOLs, with associated instruments and devices following behind.[1-3] More than 20 years later, follow-up shows excellent refractive results and vast benefits for the most difficult group of refractive patients—those with high levels of ametropia.[4]

TAKE-HOME MESSAGE

- Phakic IOLs are indicated for the correction of myopia or hyperopia in eyes with suitable dimensions.
- The ideal placement of the implant, in the anterior or posterior chamber, is still under debate.

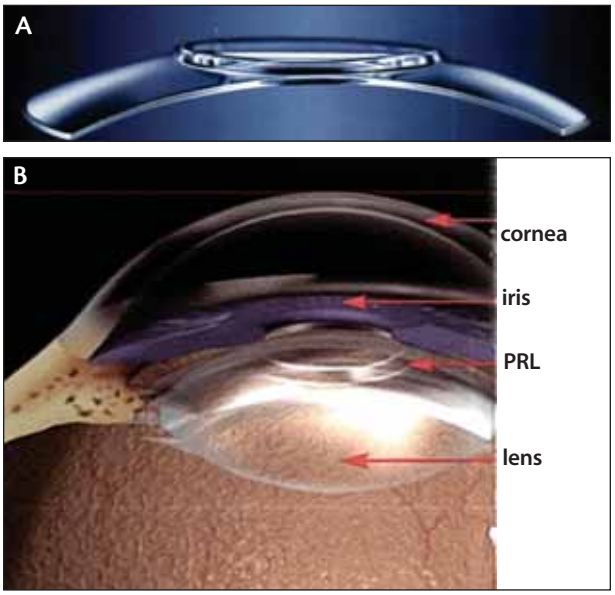

Figure 1. (A) Myopic PRL. (B) The position of the PRL within the posterior chamber.

PHAKIC LENS DESIGNS

There are two main differences in available phakic IOL models: placement of the implant within the eye and the materials used for manufacturing.[5]

Placement. Phakic lenses are designed to be implanted either in the anterior chamber or the posterior chamber.[6] Anterior chamber phakic IOLs have either angle-fixated or iris-fixated designs. Posterior chamber lenses come in three designs; they can be fixated in the sulcus or on the zonular fibers or can be left free to float over the clear crystalline lens.[7-11]

Figure 2. Visante (Carl Zeiss Meditec, Jena, Germany) anterior chamber optical coherence tomography 20 minutes after PRL implantation.

The ideal position for phakic IOLs is still under debate, and we are still unsure which is safest. We do know that complications can occur when any of these IOLs is placed in the wrong position. For instance, angle-fixated phakic IOLs may cause endothelial cell loss and corneal decompensation when there is little space between the body of the implant and the corneal endothelium. Iris-fixated IOLs, especially earlier models, were associated with pupil ovalization. Posterior chamber phakic IOLs have been associated with a high rate of cataract formation due to contact between the implant and the anterior capsule of the natural lens.[12,13]

Material. Lens material plays an important role in the safety of these implants. Polymethyl methacrylate (PMMA) has been used for a number of anterior chamber phakic IOL models, including the Baikoff ZB5MF (Morcher GmbH, Stuttgart, Germany), the Phakic 6 Model 130 (Ophthalmic Innovations International Inc.; now Aaren Scientific Inc., Ontario, California), the NuVita Baikoff MA 20 (Bausch + Lomb, Rochester, New York), and the iris-fixated Artisan (Ophtec GmbH, Groningen, Netherlands). When these rigid lenses are implanted in the anterior chamber, they require large incision sizes (over 6.0 mm) and suture closing, which can lead to induced astigmatism.

Foldable materials have been used for some anterior chamber phakic IOLs, including hydrophobic acrylic for the AcrySof Cachet angle-supported lens (Alcon Laboratories Inc., Fort Worth, Texas) and silicone for the iris-supported Artiflex (Ophtec GmbH). Foldable materials are also used in all posterior chamber phakic IOLs, including Collamer in the Visian ICL (STAAR Surgical, Monrovia, California) and silicone in the PRL (IOLTech/Carl Zeiss Meditec, Jena, Germany; Figure 1). These materials allow the lens to be implanted through smaller incisions (2.5-3.0 mm) and avoid the need for suturing.[14-16]

Biocompatibility is also important for phakic IOL materials. These lenses must not cause chronic inflammation, cataract formation, or progressive endothelial cell loss—side effects that were seen with earlier phakic IOL models. Additionally, materials with a higher refractive index are preferable because they produce thinner implants. Thin posterior chamber phakic IOLs have many advantages compared with thicker implants, including an easier implantation procedure and fewer complications.[17,18]

PERSONAL EXPERIENCE

Below I share 15 years of personal experience with phakic IOLs, most specifically the PRL.

Lens design. What I like about this lens is that it makes no contact with the anterior capsule. The PRL is made from a hydrophobic material and has a curvature duplicating that of the crystalline lens. With the edges of the implant resting on the zonular fibers, the implant essentially floats in the posterior chamber (Figure 1B). In addition to maintaining a distance from the anterior capsule, this position allows aqueous to pass under the

TABLE 1. STRUCTURAL CHARACTERISTICS OF THE PRL

Model	Optic diameter (mm)	Overall diameter (mm)	Overall width (mm)	Dioptric Range (D)	Increments (D)
PRL 100 (myopia)	4.5 to 5.0	10.8	6.0	3.00 to -20.00	0.50
PRL 101 (myopia)	4.5 to 5.0	11.3	6.0	3.00 to -20.00	0.50
PRL 200 (hyperopia)	4.5	10.6	6.0	3.00 to 15.00	0.50

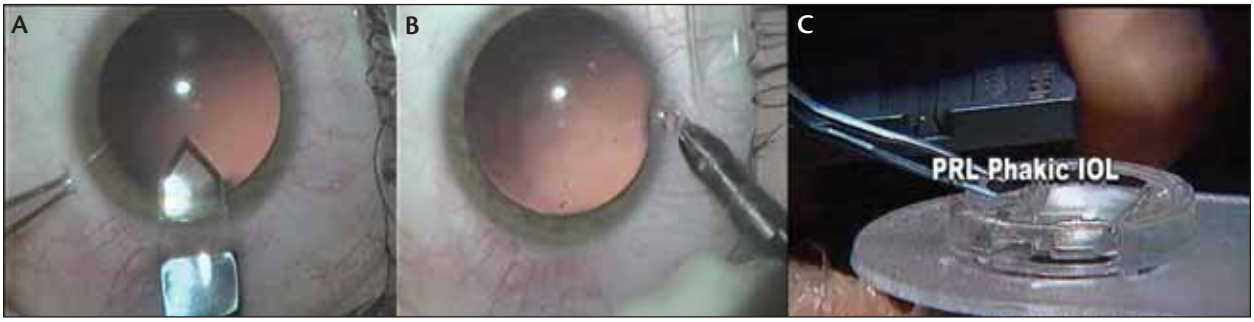

Figure 3. (A) 3-mm clear corneal incision; (B) paracentesis at 12 o'clock; (C) PRL being loaded into forceps.

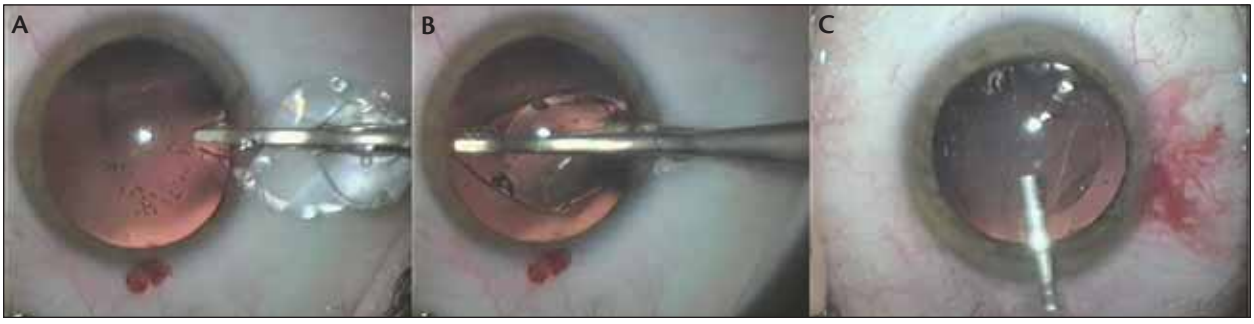

Figure 4. (A) PRL insertion (self folded); (B) PRL opening in the anterior chamber; (C) placement of the IOL behind the iris.

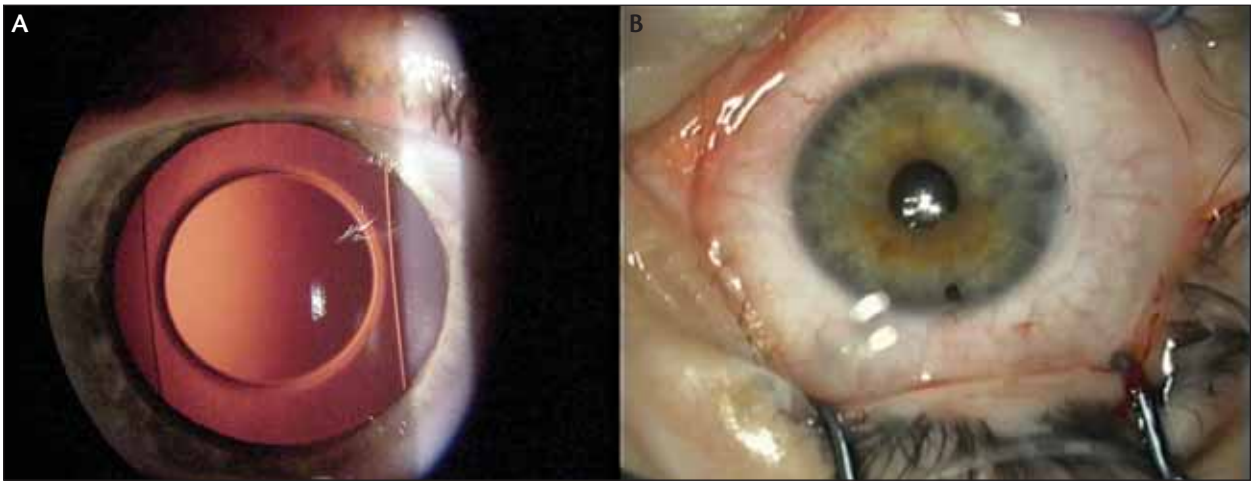

Figure 5. (A) PRL is loaded behind the iris; (B) the pupil is constricted, and peripheral iridectomy is performed at the 12 o'clock position.

PRL, keeping the crystalline lens metabolism unchanged. No synechiae between the PRL and the crystalline lens or between the PRL and the iris have been seen in long-term follow-up at 15 years (Figure 2).

Patient selection. I use the PRL to correct myopia of -3.00 to -30.00 D and hyperopia of 3.00 to 15.00 D. Because the anterior chamber is usually shallow in patients with hyperopia, it is safer to limit the hyperopic correction to a maximum of 11.00 D. I will consider extending the limit if the patient has a deep anterior chamber.

The PRL can be implanted in patients with keratoconus for correction of the myopic component of their refractive error after corneal stabilization with collagen crosslinking or intrastromal corneal ring segment (Intacs; Addition Technology, Inc., Des Plaines, Illinois) implantation. Additionally, I use the PRL as a secondary procedure in patients who require enhancements after radial keratotomy, LASIK, or PRK.

Patients with cloudy or opaque corneas, cataract, lens subluxation, glaucoma or ocular hypertension, shallow anterior chamber (less then 2.5 mm), or vitreoretinal problems that preclude good vision or require posterior

segment intervention should not receive the PRL.

Surgical technique. Surgery, done under topical anaesthesia (lidocaine 4%), takes approximately 7 to 10 minutes. After a clear corneal incision (2.75 mm) is created, an ophthalmic viscosurgical device (OVD) is added to the anterior chamber, and a paracentesis (0.5 mm) is made at the 12 o'clock position (Figures 3 and 4). The PRL is removed from its plastic sterile container with the anterior surface of the lens facing up and the posterior surface facing down. The implant must not come in contact with the patient's skin, conjunctiva, lids, lashes, or corneal epithelium because microelements can be attracted to and become deposited on the lens surface. The PRL is then placed on the PRL loading block and grasped lengthwise with forceps (Figures 3 through 5). The edge of the implant must line up with the end of the forceps.

After the implant has been grasped and oriented in the forceps, the PRL is prepared and then inserted (Figure 4). Once the PRL has unfolded under the iris, the OVD is removed by washing the chamber with balanced saline solution. Pupil constriction is achieved with acetylcholine chloride (Miochol-e; Bausch + Lomb), and a peripheral iridectomy is performed through the paracentesis. Neither stitches nor an eye patch is needed.

Results. The PRL is predictable, efficient, and safe in long-term follow-up, and patients have experienced good visual acuity and a low complication rate after implantation.[17-21]

CONCLUSION

In a prospective study comparing matched populations who underwent LASIK surgery or PRL implantation, the PRL performed better than LASIK in almost all measures of safety, efficacy, predictability, and stability. Additionally, the PRL has demonstrated reversibility and excellent optical quality, and it potentially provides a gain in visual acuity in myopic patients due to retinal magnification. Correction is not limited by corneal thickness or topography. With proper anatomic conditions, especially sufficient anterior chamber depth, the PRL also shows good refractive and clinical results in hyperopic patients.

In general, all phakic IOLs preserve the architecture and asphericity of the cornea and the accommodative ability of the crystalline lens. These implants achieve immediate and stable refractive effect and improve UCVA and BCVA. Implantation is relatively safe and easy to perform for any skilled cataract surgeon. Phakic IOL implantation is not without complications; however, the complications have been minor and treatable. The three main issues that require follow-up after phakic IOL implantation are subcapsular lens opacity, implant decentration, and pigment dispersion that may lead to glaucoma. Our study shows that there is no pigment dispersion in negative-powered silicone PRLs but some slow dispersion in positive-powered PRLs. Ultrasound biomicroscopy has shown that the PRL does not touch the anterior capsule.

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With 15 years' follow-up and constant development of surgical and diagnostic equipment, we have witnessed the power of phakic IOL implants to become one of the most exciting areas of refractive surgery. ■

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