waters of the myopic eye.

These latter day Sirens first serenaded Spanish ophthalmologists in the 1950s. "Come. Sail into the anterior chamber with your rough hewn Plexiglas boards. It is so deep. So inviting. There is a beautiful, safe harbor here." Those brave surgeons heard the call and sailed forth. The Sirens laughed as the coarse, Plexiglas boats beat upon the endothelium and trabecular meshwork in the shallow passages leading to the "safe" harbor of the scleral spur; the Sirens laughed louder when the boats were dragged from the resulting turbulent waters.

The Sirens sang sweetly again in the 1970s. "Come sail into the placid waters of the anterior chambers of aphakic eyes." And again they came—from England, from Russia, from America. Some used the same old boats. They polished them a little better, thinking that without rough edges, their boats could slip by undamaged, and undamaging. But once again, a gray cloud hung over the blood red turbulent waters, and the Sirens convulsed with laughter as the boats were dragged out.

Although a few eye surgeons carefully studied the submerged topography, diligently compared the measure of their ships against the size of the dangerous obstacles, and meticulously modified their ships so they could be flexible enough to nestle in the harbor without rubbing against the meshwork and endothelial shores, the outcry against the crashes of the poorly designed boats was so great, that ALL ships were deemed unsafe in the waters of the anterior chambers of aphakic eyes.

It is now the late 1990s, and the Sirens are singing again. "Come try the waters again. You may even venture deeper into the harbor, into the posterior chamber." Only now, we believe we know how to design a safer craft. At least some of us know. And we sail again, hopefully more cautiously, and only a few boats at a time, as did the authors of papers published in this issue of the Journal of Refractive Surgery.

But there are some who will not learn from the lessons of the past, who have forgotten or who never learned the important essentials of design.

On the exhibit floor at the 1997 American Academy of Ophthalmology meeting, my heart sank when I saw an anterior lens for myopia, ready for sale outside the United States. It is a lens that violates many of the essential principles of lens design, which we have learned over the past four decades. Some of these are: 1) the haptics must not create intermittent touch in angle, 2) the haptics must not create touch, intermittent or constant, against the peripheral endothelium, and 3) the lens must not be in contact with any portion of the iris that moves during dilation or constriction, 4) the lens must be flexible enough to accommodate an internal diameter slightly smaller than the diameter of the lens, without undue pressure in the angle, 5) the lens must be placed in the largest diameter of the eye so it cannot rotate, and 6) the edges of the lens must be perfectly smooth, when examined under the electron microscope.

I believe there is a need for a phakic IOL for myopia, but it must be one that will be tolerated by the patient's eye for decades, for life. I am concerned not only that ill-conceived designs will create severe problems in eyes in which they are placed, but that they will, once again, so tarnish the reputation of all phakic IOLs that a fair evaluation of well designed lenses will then be impossible.

I implore any company intending to market a lens for myopia to do their homework. There have been many articles written about proper lens design for the anterior chamber. (few for posterior chamber placement!) Ignoring the mistakes of the past will have serious consequences for the future of eyes harboring poorly designed lenses. Since the initial results, even with ill-designed lenses, are almost always good, patients will end up bilaterally implanted and ultimately bilaterally visually compromised. Damn those Sirens, anyway!

**Will Some See the Future Through Phakic Intraocular Lenses?**

Herbert E. Kaufman, MD

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Photorefractive keratectomy (PRK) demands an excimer laser that costs about $500,000, and laser in situ keratomileusis (LASIK) adds to this expense the cost of a microkeratome. Although the exact complication rates for these procedures are debated, especially for LASIK—which depends to some extent on the experience and the background of the surgeon, significant complications are associated with both procedures when they are used for the correction of high myopia and hyperopia. Altering the parabolic shape of the cornea alters the quality of vision in ways that are difficult to quantify. Certainly, both LASIK and PRK result in abnormal corneal curvatures that differ from natural curvatures, and a number of theoretical papers have been written on the undesirable optical aberrations.
induced by such alterations.

Wouldn’t it be wonderful if a phakic intraocular lens could be safely placed inside the eye by any competent cataract surgeon using techniques that are already familiar? With such a procedure, more normal vision might return virtually immediately, there would be little or no postoperative discomfort, and the quality of vision might be far superior to that obtainable by corneal alteration. Just as spectacles, contact lenses, and refractive surgery all coexist as potential modalities that are acceptable for the correction of vision, it is likely that the refractive surgical correction of myopia may encompass multiple modalities, including phakic IOLs and various laser procedures; each may have its niche.

The criteria for success for patients with major refractive errors, such as myopia over -15 D, cannot be the same as the criteria for patients with -3 or -4 D of myopia. A 3-diopter myope with -1 D of residual myopia and 20/40 visual acuity may be unhappy, but a 15-diopter myope with 20/40 uncorrected visual acuity and -1 D of residual myopia is a refractive triumph. It might be more realistic to say that correcting 90% or more of the refractive error is an achievable goal. Remember, too, that a high myope who wears a high spectacle refractive correction is significantly disabled. Viewed objects are minified and peripheral fields are severely distorted by the spectacles. Additionally, if the spectacles are dropped or misplaced, it may be almost impossible for the patient to find them. We remember one of our patients in whom we placed a phakic anterior chamber lens telling us “Doctor, for years I have been afraid that at night there might be a fire or some other emergency and I couldn’t find my glasses and couldn’t save my baby.” It is not just the terribly ugly appearance of very thick glasses but also the visual and functional disability that make the elimination of high refractive errors desirable. Correction of high refractive errors with contact lenses is also a problem. The very thick edges make contact lenses for high myopia—more than -10 or -12 D—very difficult to tolerate, and the success rate for fitting these lenses is reduced.

In this issue of the Journal of Refractive Surgery, Baikoff and colleagues (pp 282-293) report the results of up to 52 months of follow-up on 134 eyes implanted with the ZB5M phakic anterior chamber intraocular lens, his second generation modification of the Kelman multiflex lens. The ZB5M lens has four points of support. The optic is small, with an effective diameter of 4 mm of true optical correction. The lens is available only in 1-diopter increments from -7 to -20 D. The length of the lens required is approximately by measuring the white-to-white diameter and adding 0.5 to 1 mm.

The great importance of the paper is that it supports the safety of these lenses. The results show that, although there was some variability, endothelial cell loss was low and occurred primarily during surgery. There was neither a high average rate of endothelial cell loss nor a subpopulation in which endothelial cell loss was excessive. There was no chronic iritis, and there was no significant glaucoma from these angle-supported lenses. Iridectomies were not necessary, cataracts did not develop, and the lenses were exceedingly well tolerated although they were functionally suboptimal. Significant problems were confined to complaints of glare and halos, especially at night, voiced by approximately 25% of the patients, and the development of oval pupils in more than 20% of eyes. Insertion of this lens requires a temporal incision of about 6 mm, which, however, appears to induce only minimal astigmatism and was not a hindrance to a favorable refractive outcome.

At the LSU Eye Center, we have implanted the ZB5M lens in 10 eyes and followed them for 6 years with systematic questioning and glare testing; we found a much higher incidence of glare with these lenses, as well as a slightly higher incidence of pupillary ovalling. Our experience with this lens supports the results of Baikoff’s study: safety is adequate and the lens is well tolerated, but must be redesigned to eliminate glare and pupillary ovalling, as described at the end of that paper.

Based on gonioscopy of patients with these lenses, we believe that pupillary ovalving occurs because pressure on the small load-bearing area of the haptic in the angle slowly pushes the iris posteriorly as the “spring-loaded” peripheral force of the haptic is redirected toward the equator of the globe and the haptic slides down the scleral rim. We saw no iritis and no membranes on the iris surface. We suggested to the Chiron Company that pupillary ovalling could probably be eliminated by increasing the area of contact between the haptic and the angle where the pressure of the lens is brought to bear, and by making the haptic more flexible so that less pressure is applied to the foot plates. Glare can be reduced by special treatment of the edges and the optic rim, and a slightly larger optic may provide more satisfactory vision with less glare and fewer halos. In fact, most pupils are not central, but are displaced slightly superonasally; rather than redesigning the lens, simply enlarging the effective
optical area and reducing glare may be adequate to compensate for this problem. In addition, in the future, lenses that are more biocompatible and avoid endothelial damage, even if touch occurs, may be desirable, and foldable anterior chamber lenses may be possible.

Also in this issue of the Journal of Refractive Surgery, Zaldivar and colleagues (pp 294-305) describe experience with a posterior chamber plate phakic IOL (dubbed an intraocular contact lens, or ICL) for myopic and highly hyperopic patients, manufactured by Staar. This IOL can be injected through a small incision that does not require sutures, but it does require at least two iridectomies—first, with treatment of the iris with an argon laser, followed by a YAG laser iridectomy. These iridectomies must be done a few days before implanting the IOL to minimize pigment deposits on the lens surface; they are intended to reduce the incidence of pupillary block glaucoma. The posterior chamber phakic IOL is based on the original Fyodorov sulcus support principle, but rather than being made of relatively bioincompatible silicone, is made of a HEMA-porcine collagen copolymer which appears to be significantly more biocompatible. Determination of the optimal lens diameter for a given eye is based on measurement of corneal diameter and is inexact.

The study of 124 highly myopic eyes of 85 patients had a mean follow-up of only 11 months, with some patients followed for too short a time to be meaningful, and only three followed for as much as 3 years. Although only 65% of the myopic eyes in this study had 12 months of follow-up and only 50% had 18 to 24 months of follow-up, the lenses seem to be well tolerated. Three patients had opacities of the crystalline lens, two of which were present preoperatively, and none of which were considered visually significant. There is a real possibility that this lens may rest on the crystalline lens, as suggested by ultrasound biomicroscopy. Certainly, longer follow-up is required to determine its effect, if any, on the crystalline lens. More than 10% of the eyes had at least transient ocular hypertension. Although the series presents the results of only one experienced surgeon, the findings suggest that this approach is likely to be a safe and viable approach to the correction of high myopia and hyperopia. However, endothelial cell counts, which would seem to be especially important for this type of lens that unfolds in a phakic anterior chamber, were not reported. Not all of the lenses used over the course of this study were identical due to a series of design improvements, indicating that both posterior chamber and anterior chamber phakic IOLs are evolving to optimize safety and efficacy.

The purpose of this editorial is not to suggest that excimer lasers are obsolete, or that one phakic IOL procedure is superior to another. It seems very likely to us that, in the future, phakic IOLs will offer a viable alternative to excimer laser surgery that may be less expensive, more stable and predictable, and perhaps even safer than tissue-subtractive procedures. The patients enrolled in these studies had very significant visual disabilities and much to gain from this surgery. As newer designs of these lenses become available and the insertion of such lenses becomes easier and of greater demonstrated safety, it is likely that they will be used for smaller refractive errors and will be able to be used by experienced cataract surgeons all over the world, without the need for complex technology.

**Into Thin Air with Phakic Intraocular Lenses?**

Scott MacRae, MD

It has always been a mystery why intelligent, fit individuals insist on taking risks mountain climbing—surely their motive is not just to see an enhanced view of the world. Sometimes the leaders of such expeditions may have clouded judgment, which was the case when five people died on their hypoxic descent after climbing Mt. Everest in May 1996.¹ There are some parallels between treating high myopia with refractive surgery and high altitude mountain climbing. In both, the stakes are high, each needs to be planned carefully—knowing where potential dangers are and how to avoid them.

The articles on phakic intraocular lens correction of myopia by Zaldivar et al (pp 294-305) and Baikooff et al (pp 282-293) in this issue of the Journal of Refractive Surgery emphasize the need for an approach tempered with experience and caution. In the provocative articles by Zaldivar and colleagues, one can explore the new frontier of posterior chamber IOL implantation in phakic eyes. In the first article, they treated 124 eyes with extreme myopia with a mean baseline spherical equivalent refraction of -13.38 D and achieved a 69% rate of eyes having a spherical equivalent refraction within ±1.00 D of emmetropia. The surgery had some complications, such as implant removal (4%), cataract extraction (1.6%), pupillary block glaucoma (4.8%), transient ocular hypertension (11.2%), and one