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Editorial

Phakic intraocular lenses

The main objective of refractive surgery is improving the patient's quality of life by decreasing their dependence on spectacles and contact lenses. In the majority of cases, we, refractive surgeons, are dealing with young healthy individuals with excellent quality of vision; they are seeking no less than excellent uncorrected visual acuity with at least the same quality of vision postoperatively. Hence, any complication after refractive surgery has a dramatic impact on the patient's quality of life. With the introduction of excimer lasers in refractive surgery, more than 25 years ago, the predictability and safety of refractive procedures improved to unprecedented levels compared to contemporary procedures such as radial keratotomy and keratomileusis.

Over the last 2 decades, excimer laser keratorefractive procedures have become the standard of care to correct a wide range of refractive errors with generally excellent outcomes. There were a number of developments over time including a better understanding of the effect of ablation and flap creation on corneal biomechanics, and the development aberrometers to measure the induction of high order aberrations after laser vision correction. Limitations of excimer laser ablation and in rare cases, the detrimental effects on corneal stability and/or quality of vision were also evaluated by aberrometry and from studies of corneal biomechanics.[1–3]

In the late eighties and early nineties, the concept of phakic IOL was revisited with new lens materials, contemporary microsurgical techniques, modern viscoelastics and advanced imaging devices. Subsequently, phakic IOLs passed through many stages of development and innovation to achieve the state-of-the art designs that are available today.

Currently, there are 3 available phakic IOL designs, classified according to the position of the lens inside the eye; angle supported, iris-fixated and posterior chamber phakic lenses.

Angle supported phakic IOLs were the first to be introduced by Jose Barraquer,[4] modern designs were introduced and improved by Georges Beikoff,[5] before they were withdrawn from the market due to late endothelial decompensation.

The most recent angle supported lens is the AcrySof Cachet (Alcon Laboratories, Inc., Fort Worth, TX). The AcrySof Cachet is a single piece foldable hydrophobic lens, that can be implanted in the anterior chamber through a 2.6 mm clear corneal incision. It is designed to achieve predictable positioning in the anterior chamber, stable vaulting and low compression forces on the irido-corneal angle.[6]

The iris fixated lenses were first introduced by Jan Worst in 1984, the earlier design was a biconcave PMMA lens, that was improved in the mid-nineties to a convex–concave design with the same claw mechanism at the haptic. The rigid polymethyl methacrylate (PMMA) model (Artisan, Ophtec, Groningen, The Netherlands; Verisyse, AMO, Santa Ana, CA, USA) has received FDA approval in the United States in 2004. The Artiflex/Veriflex phakic IOL is a foldable version of the Artisan/Verisyse with a similar convex–concave design polysulfone optic having two opposed PMMA haptics to enable fixation on the mid-peripheral iris.[4] This foldable phakic IOL has the advantage over PMMA Artisan lens in that it can be inserted/removed through a suture-less, small corneal incision.[7]

Currently, the most commonly used posterior chamber phakic IOL is the Visian Implantable Collamer Lens (ICL, STAAR surgical, Nidau, Switzerland). This ICL was approved by the United States Food and Drug Administration (FDA) in 2005 for myopia between 3.00 and 20.00 diopters (D). The Toric Implantable Collamer Lens (TICL) represents an expansion of the earlier Visian ICL and has been available internationally since 2003.[8] The recently introduced ICL model (VICMO-V4c) has a central hole (aquaFlow) that enables more physiologic aqueous circulation through the pupil to the anterior chamber thus eliminating the need for a peripheral iridectomy.[9]

Phakic IOLs have numerous anatomical selection criteria including an anterior chamber depth of at least 3.0 mm measured from the endothelium, an open angle, a flat or concave iris configuration and healthy endothelium.

Phakic IOLs have a number of advantages compared to laser vision correction the most important is preserving corneal tissue and biomechanics eliminating the risk of ectasia, and maintaining the corneal shape without inducing high order aberrations. A third major advantage of phakic IOLs is the ability to removal and exchange the phakic IOL a criterion that is of prime importance in refractive surgery procedures which is not possible with excimer laser procedures.[10]

Another advantage of phakic IOLs the high predictability,[11,12] which is expected with phakic IOLs as the refractive outcome is not modulated by the individual response of corneal tissue especially with higher refractive errors. Preservation of the tear film and the accommodation are other important advantages of phakic IOLs compared to refractive lens exchange.[13]

Each phakic IOL design has its own advantages over the other designs; angle-supported phakic IOLs are the easiest to implant, iris-fixated phakic IOLs can be manually centered over the pupil, which is an important advantage in eyes with a decentered pupil, they also come in a one size that fits all

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eyes eliminating the possibility of wrong sizing. Posterior chamber phakic IOLs are cosmetically the best, have the largest range of correction including astigmatism, provide the largest functional optical zone (FOZ) because they are closest to the nodal point of the eye, and represent the lowest risk of endothelium and anterior chamber angle complications.

The primary disadvantage of angle-supported lenses is their proximity to the endothelium with the highest risk of late endothelial decompensation which resulted in the withdrawal of all designs of angle supported lenses that were commercially available in 2007. The relatively newly introduced design (Acrysof Cachet, Alcon Fort Worth, TX, USA) was voluntarily recalled earlier this year pending revised selection criteria for implantation of this lens by the investigators.

The main disadvantages of the iris fixated phakic IOL, are the difficulty of implantation, the potential damage to the iris, the need for a large incision with the PMMA lenses, and the relative proximity to the endothelium.

Posterior chamber lenses have the highest risk of inducing lenticular opacities, which are more likely to form when the aqueous flow between the IOL and the crystalline lens is impaired leading to accumulation of metabolites. This is more likely in cases with very shallow vaults (less than 50 microns) or in cases with complete circular peripheral contact leading to aqueous entrapment. The newly introduced posterior chamber lens with a central hole (aquaFlow) should reduce the incidence of cataract than the 0.5% rate reported with the current model.

The most dramatic yet extremely rare complication of phakic IOLs is infection that may lead to endophthamitis.

Phakic IOL calculations are based on nomograms or software developed by the manufacturers that account for refractive error, corneal curvature, and anterior chamber depth. However, sizing remains a challenge for phakic IOL surgeons. While iris-fixated lens come as a ''one size that fits all'', angle fixated and posterior chamber lenses come in variable sizes and over or under sizing issue may lead to postoperative complications.

Angle supported lens sizing is based on the angle-to-angle diameter, best measured with an anterior segment OCT, posterior chamber lens sizing is based on the sulcus-to-sulcus diameter that is best measured with a high frequency ultrasonography. White-to-white can be adequate in the majority of cases however recent studies show that there is poor correlation between white-to-white measurements and the angle-to-angle or sulcus diameters.

An undersized angle supported lens may rotate excessively and damage the angle structure and the endothelium. An undersized posterior chamber lens will have a low vault, increasing the risk of induced cataract, and poor refractive outcome in the case of Toric lenses. An oversized angle fixated lens will lead to angle damage as well as an increased risk to the endothelium. In posterior chamber lenses, oversizing may cause excessive vaulting, angle closure and secondary glaucoma.

The near future holds promise for phakic IOL surgery as all manufacturers are improving the designs, techniques and selection criteria. Hopefully there will be an angle-supported lens with no long-term effect on the endothelial cells. There will definitely be better diagnostic tools for lens sizing. Preloaded ICLs are in the development pipeline and represent a significant improvement in the surgical technique. Long term results after ICL with the centraFlow technology will determine whether the central hole mitigates or eliminates the incidence of induced anterior subcapsular cataract.

Lastly, phakic IOLs and LASIK are complementary, and not competitive, surgical alternatives. Both options are essential modalities in any accomplished refractive surgery service, because they enable treatment of patients with high amounts of errors, thin or suspicious corneas and provide them with the best possible quality of vision.

In this issue of the SJO, Sabaani et al.,[14] assess the safety and efficacy of the implantable phakic IOL to treat myopia in 69 eyes of 46 patients from a single center. They studied these myopic eyes as a non-randomized case series in the range of −3.00 to −25.00 D. During the mean follow up of 12.35 months, over 84% had predictable visual acuity within 1 D. Visual acuity of 20/20 or better was achieved in 64.6% of eyes postoperatively, compared to 31.9% preoperatively. Four phakic IOLs were removed without significant loss of visual acuity, and 2 eyes with clinically significant lens opacities were observed. Four eyes (5.8%) developed a pupillary block on the first day postoperatively. Only one eye (1.4%) developed hypotony and a shallow anterior chamber. Sabaani et al's outcomes concur with other major studies of phakic IOL implantation. They conclude that the implantation of phakic IOLs for the correction of myopia may be a relatively safe procedure with good visual and refractive results over a one-year period that they studied. However, due to the short follow-up, the authors suggest that long-term follow-up may be necessary to confirm the long-term safety of these phakic IOLs.

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