

IMPLANTABLE COLLAMER LENS: STEP AHEAD IN REFRACTIVE SURGERY?

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Abstract. *Implantable Collamer Lenses (ICL) represent a significant advancement in ophthalmic refractive surgery, particularly for individuals with high myopia and hyperopia who are ineligible for LASIK or SMILE procedures. First introduced by STAAR Surgical in 1993, ICLs are composed of biocompatible collamer, offering superior visual correction. This article provides a comprehensive review of ICL usage, lens sizing, and postoperative outcomes.*

This review utilized various databases, including PubMed, Google Scholar, Scopus, and others, covering publications until October 2024.

ICL implantation is indicated for patients with high myopia (-8 diopters or greater) and hyperopia. Key eligibility criteria include stable refraction, anterior chamber depth, and a central endothelial cell count exceeding $2,200$ cells/mm². Postoperative results revealed high patient satisfaction, with 86% achieving uncorrected visual acuity (UDVA) of $20/20$ or better.

ICL sizing is crucial, with complications such as pigment dispersion syndrome or cataract formation occurring due to incorrect lens size. Postoperative results demonstrate predictable refractive outcomes and minimal adverse effects when proper sizing and implantation techniques are followed.

ICL offers a safe and effective solution for treating high myopia, providing stable and predictable visual improvements. Long-term studies are needed to address potential complications and optimize lens sizing techniques.

Keywords: *ICL, phakic intraocular lens, myopia, hyperopia, lens sizing, postoperative outcomes.*

Introduction. This article gives more information about what is ICL, why it is used for, who needs phakic Intraocular Lenses, lens sizing and the postoperative results. To begin with, despite the fact that Implantable Collamer Lens(ICL) has been invented in recent history, just in 1993, STAAR Surgical, based in Monrovia, CA, USA, introduced their posterior chamber phakic intraocular lens (pIOL), ICL manufacturing took its own place in refraction of surgical part of ophthalmology and was started production in series. STAAR Surgical developed a biocompatible substance known as collamer, which combines polymer and collagen to create a lens that is lighter, hydrophilic, and facilitates improved gas and nutrient exchange. This patented material consists of 60% poly-hydroxymethylmethacrylate (HEMA), 36% water, 3.8% benzophenone, and 0.2% porcine collagen¹. Generally, ICL is used for patients with low visual acuity, particularly for ametropic humans. Such kind of people have problems with vision and could be diagnosed like Myopia, Hyperopia, etc. Particularly, Myopic and Hyperopic patients with low levels of that diseases could be treated by prescribing them convex or concave glasses, LASIK(laser-assisted in-situ keratomileusis) or SMILE(Small incision lenticule extraction). Unfortunately, with the help of LASIK and SMILE myopia could be treated only in exact diapasons. Laser-in-situ keratomileusis (LASIK) is effective for treating myopia between -1 and -29 diopters. However, the best results are typically achieved for myopia up to -12.00 diopters. Correcting myopia greater

than -12 diopters can lead to excessive stromal ablation, which increases the risk of developing corneal ectasia, depending on the thickness of the cornea². It leads doctors to find out new solutions for myopic and hyperopic patient with high diopters that are behind the diaposons given above suitable for LASIK. So, another option for that kind patients could be using ICL implantations. However, it has also its own indications and contraindications. One of phakic ICL implant indications could be for individuals with high myopia of -8 diopters or greater, phakic intraocular lenses (pIOLs) may offer superior visual results compared to keratorefractive surgeries and enhanced safety compared to refractive lens exchange³.

Materials and methods. This review was conducted in accordance with databases such as PubMed, Google Scholar, Scopus, Embase, Cochrane Library, Clinical Trial, China Biomedical Literature Database (CBM), China National Knowledge Infrastructure (CNKI), and China Science Periodical Database (CSPD) which were explored using keywords like phakic ICL, Implantable Collamer Lens, ICL, Hole, Myopia, Myopias, and Nearsightedness and others. Both free text and subject-specific terms were utilized in the search. This search encompassed publications from the establishment of the library up until October 2024.

Results and discussion. To be eligible for ICL implantation, candidates must have a stable refraction documented for at least one year, adequate anterior chamber depth, a central endothelial cell count exceeding $2,200$ cells/mm², suitable pupil size, and an open anterior chamber angle. For low to moderately high myopes (12.00 D and below), manifest refraction is typically sufficient, but for those with extreme myopia, contact lens over-refraction is recommended. In hyperopic patients, especially younger ones, cycloplegic refraction is suggested. Additionally, it is important to record the vertex distance of the refraction for ICL power calculations, as a 1.00 mm error in vertex distance can lead to a 1% miscalculation in ICL power⁴. When it comes to say about lens sizing, several factors must be considered for lens sizing, including pre-operative measurements like White to White (WTW), Anterior Chamber Depth (ACD), and Sulcus to Sulcus (STS). The complications can arise from the differences in lens sizing, stemming from the uncertainty about which parameter is most appropriate for determining the lens size⁵. Additionally, the sizing of PIOLs is constrained by the standard sizes that are currently available. Incorrect sizing can result in unexpected outcomes regarding the PIOL vault after surgery. If a larger PIOL is used, it may become compressed between the sulcus points, resulting in a high vault and anterior bulging of the PIOL. This can cause issues such as pigment dispersion syndrome, damage to endothelial cells, or increased intraocular pressure, potentially leading to an angle closure attack. Conversely, a smaller PIOL may result in a low vault, causing the lens to touch the anterior segment, which can lead to cataract formation or postoperative rotation of the PIOL, particularly affecting toric PIOLs and resulting in refractive errors⁶. Saying about the postoperative results, they make people being in shock. For instance, due to the facts conducted by Hideyi Hakay and etc., group of scientists made review included 770 eyes from 403 consecutive patients who underwent ICL extraction. We assessed the prevalence, causes, uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), predictability, and patient satisfaction. ICL extraction was necessary for 8 out of 770 eyes (1.0%). The primary reason for extraction was the progression of pre-existing cataract formation in 5 eyes (63%), followed by residual refractive errors in 3 eyes (38%). Among the 7 eyes aimed for emmetropia, 100% achieved UDVAs of $20/40$ or better, and 86% reached $20/20$ or better. In terms of CDVA, 3 eyes (38%) showed no change, 3 eyes (38%) improved by 1 line, and 2 eyes (25%) improved by 3 or more lines. Additionally, 88% and 100% of the eyes were

within ± 0.5 and ± 1.0 diopter (D) of the intended correction, respectively⁷. According to the conclusion of another research results conducted by group of doctors Cakir and etc, the implantation of posterior chamber of spherical pIOLs is a safe and effective refractive surgical technique for correcting high myopia, demonstrating predictable and stable refractive outcomes over a 5-year period. However, further long-term studies are necessary to investigate potential complications, including decreased endothelial cell density (ECD), retinal issues, and lens opacity⁸. Besides that, Thomas Kohnen and his team also made conclusion due to the results of their research, comparing LASIK and Visian ICL implantation, the ICL showed superior outcomes in terms of safety, efficacy, predictability, and stability. Some case reports also demonstrated positive results with the toric posterior chamber pIOL. Schallhorn et al. found better outcomes with the toric ICL compared to conventional photorefractive keratectomy in a randomized prospective study⁹. Furthermore, another group of researchers, counted a range of advantages of implanting pIOL, a supplementary intraocular lens (phakic IOL) placed between the cornea and the lens, fixed in the angle or attached to the iris, can lead to a condition known as duophakia or artiphakia. This approach offers several benefits:

1) It allows the natural lens to maintain its function, potentially safeguarding against vitreo-retinal complications of clear lens extraction (CLE).

2) Due to the high quality of the lens implant surfaces surpassing the eye's optical limits, the nodal points are closer to the pupil. This can enhance the eye's natural optical system, potentially improving retinal image quality and providing excellent vision even in low light conditions. Post-LASIK eyes may exhibit more spherical aberration and coma compared to eyes implanted with a posterior chamber collamer phakic IOL (ICL).

3) The lens is removable and replaceable, offering the possibility of reverting to the preoperative state.

4) The outcomes are predictable, easily adjustable with additional corneal surgeries, and immediately stable, as the refractive results are less dependent on healing processes¹⁰.

Conclusion. The benefits of treating high-level myopia with phakic IOLs include safe, predictable, and effective reduction or elimination of high ametropia and astigmatism with one procedure. These implants have shown stable refractive effects at 6 months post-surgery, with gains in spectacle-corrected visual acuity and good refractive stability. However, caution is advised in implanting these IOLs in young patients or those with compromised endothelial cell counts due to ongoing endothelial loss. Further improvements in IOL power calculation formulas are needed to enhance predictability of refractive outcomes.

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