

Clinical Evaluation of Visual Recovery After Phakic Intraocular Lens Implantation in Patients with High Myopia and Amblyopia

Mirxodjaeva D.A.

NAZAR EYE CLINIC, Private Eye Clinic, Tashkent, Uzbekistan

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Abstract: Anisometropic amblyopia associated with high myopia (usually -6.0 D and higher) significantly reduces visual acuity, and conventional methods (spectacles, contact lenses, occlusion) often fail to provide sufficient effect. Implantation of a phakic intraocular lens (mainly posterior-chamber ICL — Implantable Collamer Lens) is an important alternative for refractive correction and alleviation of amblyopia in such patients.

Literature review shows that postoperative corrected distance visual acuity (CDVA) improves on average by 2–3 lines (in some cases by 3 lines or more), contrast sensitivity increases, and partial recovery of near stereopsis occurs in some patients. Refraction stabilizes, and serious complications are rare (endothelial cell loss is usually within 5–11%). The method is effective both in adults and in children who have not responded to conventional treatment.

Keywords: Phakic intraocular lens, high myopia, amblyopia, implantation, postoperative adaptation.

Introduction: Phakic intraocular lens (PIOL) implantation is widely used as a modern and effective method for correcting high myopia. It also allows optical restoration while preserving ocular structures and is particularly important for patients whose corneal anatomic-topographic features are unsuitable for laser surgery. In addition, visual recovery after surgery in patients with amblyopia opens opportunities to study neurovisual adaptation and to observe this process dynamically and in full profile.

High myopia is a widespread refractive error worldwide, with especially high prevalence among Asian populations. In its anisometropic form, when one eye has high myopia, the risk of amblyopia development is high. Amblyopia is reduced vision that occurs due to lack of adequate visual stimulation during the period of visual system development and cannot be fully restored by optical correction alone.

Conventional treatment methods (spectacles, contact lenses, occlusion therapy) are often ineffective because of poor patient compliance, contact-lens intolerance,

or high anisometropia. Corneal refractive surgery (LASIK, SMILE) is not applicable in high myopia, thin corneas, or other contraindications.

A phakic intraocular lens (PIOL) is a lens implanted into the eye while preserving the natural crystalline lens and is effective for correcting high myopia (-3.0 to -20.0 D and higher). Posterior-chamber ICL (Visian ICL, EVO ICL and others) is the most widely used type. Recent studies confirm the importance of this method in improving visual acuity, contrast sensitivity, and partial binocular vision in patients with amblyopia.

High myopia, conventionally defined as a spherical equivalent of -6.00 D or greater, is one of the most common refractive errors worldwide and is particularly prevalent in Asian populations. When high myopia is unilateral or markedly asymmetric, anisometropia develops. Persistent anisometropia during the sensitive period of visual development, and even later, produces anisometropic amblyopia — a reduction of best-corrected visual acuity that cannot be explained by structural ocular disease alone and is not fully corrected by optical means. Amblyopia is not merely a

reduction in Snellen acuity. It is accompanied by impaired contrast sensitivity, reduced stereoacuity, and abnormal binocular interaction. Conventional management — spectacles, contact lenses and occlusion or penalization — frequently fails in high anisometropia. Spectacle correction produces aniseikonia and prismatic imbalance; contact-lens wear is limited by intolerance, poor hygiene or non-compliance; occlusion is poorly tolerated in older children and adults. Corneal laser procedures (LASIK, SMILE, PRK) are often contraindicated because of insufficient residual stromal thickness, abnormal topography, or extreme refractive error. Phakic intraocular lenses (PIOLs), and in particular posterior-chamber implantable collamer lenses (ICL / EVO ICL), occupy an important niche in this setting. They correct a wide range of myopia (approximately -3.00 D to -20.00 D) while preserving the natural crystalline lens and corneal architecture. Because the lens is placed close to the nodal point of the eye, optical quality is high, higher-order aberrations are relatively low, and the retinal image size is closer to physiological than with high-powered spectacles. Several clinical series have shown that ICL implantation in high myopic anisometropic amblyopia can improve corrected distance visual acuity (CDVA) by a mean of two to three lines, increase contrast sensitivity and, in a subset of patients, partially restore near stereopsis. Endothelial cell loss after modern central-port ICL models is typically reported in the range of approximately 3–11% in the first years, and serious complications (pupillary block, clinically significant cataract, retinal detachment) are uncommon when inclusion criteria are respected. Nevertheless, visual recovery after PIOL implantation is not instantaneous and is not identical in amblyopic and non-amblyopic eyes. Immediate optical defocus is eliminated, yet neural adaptation — the process by which the visual cortex re-weights previously deprived input — requires time. The dynamics of this adaptation, the contribution of adjunctive visual therapy (occlusion, perceptual learning, binocular training), and the differences between mild, moderate and severe amblyopia remain incompletely described in adult and late-adolescent cohorts. The purpose of the present study was therefore to evaluate clinically the stages of visual recovery after phakic IOL implantation in patients with high myopia, to compare amblyopic and non-amblyopic eyes, and to assess the additional effect of visual training and occlusion in amblyopic patients.

The aim of the work is to perform a clinical evaluation of visual recovery after phakic IOL implantation in patients with high myopia and amblyopia, and to analyze efficacy, safety, and functional outcomes on

the basis of literature data.

Purpose. This study aimed to determine the stages of visual-function recovery after phakic IOL implantation in patients with high myopia, to identify differences between amblyopic and non-amblyopic patients, and to study the effectiveness of additional visual therapy in amblyopic patients.

METHODS

An observational clinical study was conducted in 80 patients aged 18–45 years with high myopia (40 eyes). The mean manifest refraction of the patients was Patients were divided into amblyopic and non-amblyopic groups. Visual-acuity parameters were assessed from the first postoperative day up to 6 months. Patients were classified into three degrees: mild — visual acuity 0.6–0.8; moderate — visual acuity 0.3–0.5; severe — 0.1–0.2. Patients underwent visometry, binocular vision assessment, and OCT examinations. Additional visual training and occlusion were performed in amblyopic patients.

The present findings are consistent with published series of posterior-chamber ICL implantation in high myopic anisometropic amblyopia. Zhang et al. reported a mean gain of about three lines of logMAR CDVA in adult amblyopic eyes, a significant rise in contrast sensitivity and partial recovery of near stereopsis in some patients, without severe complications. Pediatric and adolescent series have likewise shown significant improvement in CDVA and refractive stability when conventional therapy had failed and corneal surgery was unsuitable. Larger refractive cohorts confirm that the gain in lines of acuity is often greater in higher myopia, because preoperative CDVA is more limited and anisometropic image minification is removed once the ICL is in place.

Three practical conclusions follow from the staged recovery observed here.

First, the early jump in acuity is optical: the retinal image is focused and magnified toward a more physiological size. This explains why even adult amblyopic eyes can gain lines within days.

Second, further improvement over weeks reflects neurovisual adaptation. The adult visual system retains residual plasticity, but the rate is slower than in young children. Therefore CDVA at day 1 must not be taken as the final result in amblyopic eyes.

Third, adjunctive therapy remains useful after optical barriers have been removed. Occlusion and visual training are more acceptable once anisometropia is surgically reduced, because the previously amblyopic eye now receives a clear, similarly sized image. Compliance is still the limiting factor, as reported in

pediatric ICL studies.

Safety considerations are unchanged from the general ICL literature: adequate anterior chamber depth, correct vault, endothelial monitoring and peripheral retinal assessment in high myopes. Reported endothelial cell loss with modern ported ICLs is usually modest in the first years; cataract and pupillary block are uncommon with current designs when sizing is correct. These risks must be balanced against the functional cost of leaving high anisometropic amblyopia untreated.

Limitations of the present work include the observational design, the incomplete numerical characterization of mean preoperative refraction in the source protocol, and the need for longer follow-up to confirm stability of neural gains. Larger controlled comparisons of ICL plus visual therapy versus ICL alone would strengthen the evidence.

RESULTS

After surgery, visual function recovered in three stages. Early (24–72 hours): visual acuity increased to 1.0 (good), haze decreased. Intermediate (1–4 weeks): contrast sensitivity and binocular vision improved, 0.6–0.8 (mild decrease). Late (4–8 weeks): vision stabilized at 0.3–0.5 (moderate degree) according to the Snellen chart. Recovery was slower in amblyopic patients, but additional visual therapy was effective.

CONCLUSION

PIOL implantation in patients with high myopia provides not only rapid optical correction but also stable neurovisual adaptation and significantly improves quality of vision. Although the rate of amblyopic recovery is slower, clinically important improvement is observed when combined with additional visual therapy. These results allow PIOL to be recommended as an effective and safe solution for high-risk patients and expand the possibilities of modern refractive surgery.

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