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Major review

Refractive lens exchange



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ABSTRACT

Advances in small incision surgery have enabled cataract surgery to evolve from being concerned primarily with the safe removal of the opaque crystalline lens to a procedure refined to yield the best possible postoperative refractive result. As the outcomes of cataract surgery have improved, the use of lens surgery as a refractive modality in patients without cataracts (clear lens extraction) has increased in popularity. The removal of the crystalline lens for refractive purposes, or so-called refractive lens exchange (RLE), offers distinct advantages over corneal refractive surgery in selected cases. Nevertheless, in some middle-aged patients with high refractive errors, corneal refractive surgery can be a safe and effective treatment. In addition, the use of multifocal lenses offers an alternative for the correction of presbyopia. A further advantage of RLE is that it simultaneously eliminates the need for cataract surgery in the future. The keys for success in RLE are effectiveness and consistency in the refractive outcome, providing at the same time surgical and postoperative safety. To achieve these goals, adequate indications following strict risk/benefit criteria and refractive precision based on accurate preoperative protocols for IOL calculation and selection are mandatory, together with an appropriate choice of surgical procedure based on the surgeon's skills, minimizing complications.

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1. Historical background of refractive lens extraction

The first to propose refractive lens surgery in high myopia was probably the French Abbé Desmonceaux in 1776. He recommended the operation to Baron Michael Johann de Wenzel. As no publication by Wenzel exists, we do not know whether he ever performed such surgery.^{22,48,144}

The first surgeon who systematically performed refractive lens extraction despite opposition of contemporary ophthalmic authorities was Vincenz Fukala. Born into a Polish family in Zolkiew (Żółkiew) in Polish Galicia (at present in Ukraine) in 1847,^{46,62,133} he studied medicine in Vienna and specialized in ophthalmology under Karl Ferdinand von Arlt. For many years he worked as an ophthalmologist in Pilsen (Pilsen-Karlsbad) and Karlove Vary, and finally he returned to Vienna, where he died in 1911. Further biographical details and his other clinical achievements, including surgical methods for treating ectropion in chronic blepharitis, orbital surgery, and history of ophthalmology studies are presented elsewhere.¹³⁴

Fukala's indications for surgery included poor vision, inability to work, and myopia of -13 diopters (D) or higher. He operated only on children with progressive myopia and on young adults, with an upper age limit of about 40 years. In myopia of about -18 D, he recommended operating on both eyes in to establish binocular vision.⁴⁷ In cases of progressive myopia in children between five and ten years of age, he decided also to operate on patients with -10 diopters. He was opposed to operations on patients with advanced pathological changes in the fundus, including chorioretinopathy and chorioretinitis.⁴⁷

Fukala's operation included clear lens removal with subsequent needling and extraction of swollen lens material. After topical antiseptics with a solution of sublimate (1:5,000), he removed the lens and waited several days until the lens fragments were swollen before washing out the lens material.^{49,53} Postoperatively, he treated the eye with atropine. When intraocular inflammation, pain, or photophobia occurred, he removed any remaining swollen lens material by needling. Rarely, if the pressure had risen, he performed an iridectomy. In 1890 he had successfully treated 19 patients between ages 8 and 23 years. In his book published in 1891 (Fig. 1), he reported his surgical procedure involving careful dissection of the lens capsule via crosswise sections.⁵⁴ Fukala feared that excessive lens swelling after dissection could lead to iritis, a rise in pressure, and pain. To avoid these complications, he recommended making a small, crosswise incision in the capsule when carrying out his first operations. After the surgery, most of his patients had good visual acuity and worked for the first time in their lives. Fukala performed the first lens dissection on April 3, 1887, and in 1889 was the first to lecture on the surgical treatment of high-degree myopia.⁵⁰

Fukala's operation was opposed by many renowned ophthalmologists of his time, including Donders and Fuchs L. Fukala continued operating on myopic eyes, however, which led to the propagation of this method. In 1894, Fukala reported

on 44 patients who successfully underwent surgery from 1887 to 1894, observing a three- to five-fold increase in visual acuity.⁵¹ In 1896, Fukala reported that several other surgeons also routinely operated on highly myopic patients, namely, Schweigger in Berlin, Pflüger in Bern, Thier in Aachen, von Hippel in Halle, and Sattler in Leipzig.⁵²

Fukala's drive and competence ultimately convinced some sceptical colleagues of the efficacy of his surgical method of lens dissection. Von Hippel wrote: "Fukala's operation was initially regarded with suspicion, yet within a short time more and more ophthalmologists came out in favor of this surgical procedure ... perhaps those of you who are sceptical or reject it could abandon your theoretical doubts to enable patients (who for so long had to do without both) to work and enjoy life".¹⁴⁷ This operation was, however, rarely carried out in the United States.⁶⁰ Barnes wrote: "Up to this writing, there have been about 2500 of the operations reported from abroad, while, after a painstaking search of the literature of this subject, I have found not quite fifty cases reported in America".¹⁷ Wilmer presented one case of the operation in which the visual acuity improved in *Archives of Ophthalmology* in 1898.¹⁵⁰ Over 3,000 patients with high myopia underwent surgery in Europe at the turn of the century.

At the beginning of the 20th century, it was realized that retinal detachment, at the time untreatable, occurred months or years after surgery in many cases. As a consequence, refractive lens extraction was gradually abandoned in the following decades.

An intensive development of new concepts and techniques in lens surgery in the second half of the 20th century led towards refractive lens extraction again. The introduction of the first posterior chamber intraocular lens (IOL) by Harold Ridley in 1949 was the first big step in contemporary cataract surgery. At that time often only a part of the lens was removed, with residual pieces of cortex or nucleus left in place and many postoperative complications. In 1952 Baron implanted the first anterior chamber IOL fixated in the iridocorneal angle. The concept of lens emulsification with ultrasound and also the irrigation/aspiration technique in phacoemulsification of cataract surgery appeared. Complete and much easier lens removal significantly decreased the number of post-surgical complications. Another great step in lens surgery was the invention of a foldable intraocular lens in the 1980s that allowed implantation through small incisions. Materials for IOL production were also changing, from polymethyl methacrylate to silicone and acrylic lenses. This was the beginning of micro-incision cataract surgery (MICS). More and more patients could achieve better vision as they were undergoing not only simple cataract removal, but also correction of pre-existing refractive error, spherical and cylindrical errors, and protection from UV light. Total independence from glasses became possible with the development of multifocal IOLs.⁷⁰

The publications of Colin et al³⁰ re-addressed more recently the problem of refractive lens surgery in high myopes, and the concept regained popularity, as the choice of possibilities, surgical techniques, and intraocular lenses was broader than ever before.

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