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Modern Cataract Surgery: Unfinished Business and Unanswered Questions

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Abstract. We summarize information, based on clinicopathologic studies over the past decade, on various cataract intraocular lens (IOL) procedures and modern "specialized" IOLs, that will help surgeons continuously improve long-term results for cataract patients. Although most operations do initally provide excellent refractive correction and visual rehabilitation, late complications occur. These sometimes are missed because they are outside of the routine period of follow-up care. We have tried to determine if the various techniques and IOLs truly deliver the long-term results that we desire. Most safety and efficacy information is derived from the manufacturer and is passed through the U.S. Food and Drug Administration (FDA). This is often based on limited, relatively short-term observations made by the manufacturer. After a lens receives FDA approval, there are few means to assess the outcome of each procedure and lens years later. We rarely hear of a 10- or 20-year follow-up study. We have found that one of the best means to assess long-term results is pathologic analyses. We discuss recently studied aspects of pathologic reactions, such as posterior capsule opacification, intracapsular fibrosis, glistenings, intralenticular opacification, and other issues with the various IOL platforms; we then present a clinicopathological overview of tissues and IOLs from our database. These include hydrophobic and hydrophilic acrylic designs, plate lenses, and a dual optic lens. (**Surv Ophthalmol 56**:S3–S53, 2011. © 2011 Elsevier Inc.)

Key words. Posterior capsule opacification • intracapsular fibrosis • glistenings • clinicopathological analysis • intraocular lenses

I. Introduction

A. BACKGROUND, EVOLUTION, AND GOALS

Since Harold Ridley's introduction of the intraocular lens (IOL) in 1949,[87,116] (Figs. 1 and 2) there have been huge improvements to this device (Table 1). Some of the more recent lens designs today address not only the clarity of optical transmission, but also depth of focus, in many cases providing results that mimic the human lens. Some of these newer specialized IOL designs have received the designation "premium" lenses and understandably have gained significant market share. Unfortunately, once an IOL, or any device for that matter, has earned approval by the U.S. Food and Drug Administration (FDA), its long-term performance and clinical outcome data are seldom readily available, making objective monitoring challenging and not always feasible. The implications here can be clinical as well as medicolegal. Although such lenses are stated to provide "premium" results, early and especially late complications do occur, and it is therefore wise to identify and to follow these carefully. We have attempted to do so with clinicopathologic studies throughout the past decade.[2,3] We provide a brief update on modern cataract surgery, focusing on salient features of the surgical techniques, as well as discussing some of the specialized IOLs (including "premium lenses") that we have personally studied in our laboratory (Fig. 3).

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† Deceased.

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Fig. 1. Sir Harold Ridley, circa 1950. From Apple DJ.[116] Reprinted with permission from SLACK Incorporated.

TABLE 1

Evolution of Intraocular Lenses

Generation	Dates and Types (approximate)
I	1949–1954 Original Ridley posterior chamber, PMMA IOL manufactured by Rayner, Ltd., UK
II	1952–1962 Early AC IOL
III	1953–1973 Iris-supported, including iridiocapsular IOL implanted after ECCE
IV	1963–1992 Transition towards modern AC IOLs
V	1977–1992 Transition to and maturation of posterior chamber IOLs
VI	1992–2000 Modern IOLs a) Monofocal IOLs designed specifically for in-the-bag implantation - Small, single piece modified C-loop designs - Foldabe IOLs, designed for small incision surgery b) AC IOLs - Kelman (flexibility) - Choyce (footplates) - Clemente (fine-tuning, no-hole, three-point fixation)
VII	2005–Present Modern flexible, "specialized" IOLs (often designated as "premium") Designed for special functions (refractive surgery, MICS, presbyopic correction, multifocal, accommodative IOL, telescopic IOL, light adjustable IOL, etc.)

ECCE = extracapsular surgery; IOL = intraocular lens; MICS = microincision cataract surgery; PMMA = poly (methyl) methacrylate.

Most publications regarding these lenses, including advertisements in ophthalmic journals and other periodicals, deal almost exclusively with optical or refractive considerations, focusing on the efficacy of each lens in achieving its intended function (accommodation, multifocality, etc.). Although surgeons are constantly reminded to underpromise and over-deliver, the manufacturers tend to emphasize and promote the best case scenarios: the sterling functional refractive results that can be obtained with these lenses. In contrast, we address various complications based on our clinicopathologic evaluations, including undesired tissue responses that may lead to suboptimal results.

Fig. 2. Sir Harold Ridley's original IOL (1949) was a rigid "acrylic" poly (methyl) methacrylate (PMMA) disk. From Apple DJ.[116] Reprinted with permission from SLACK Incorporated.

Most lenses perform well in the first years after implantation. It is only after 4 or 5 years that deleterious effects such as post-surgical fibrosis (see Section II.B) may develop. We have identified several designs for study in our laboratory. By analyzing their intermediate and long-term effects, we can provide manufacturers and surgeons with insights related to biocompatibility that may help improve tomorrow's long-term results. By focusing