Recent Trends in Biometry

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AC	:	Anterior chamber
ACD	:	Anterior chamber depth
AK	:	Automated keratometer
AL	:	Axial length
ALK	:	Automated lamellar keratoplasty
A-Scan	:	Amplitude scan
BC	:	Base curve
B-mode	:	Basic scan
BSS	:	Balanced salt solution
CDC	:	Centers for disease control and prevention
CALF	:	Corrected axial length factor
CHM	:	Clinical history method
CL	:	Coherence length
CL	:	Contact lens
D	:	Diopter
d	:	Distance
ECCE	:	Extra capsular cataract extraction
ELP	:	Effective lens position
ESF	:	Estimated scaling factor
HZ	:	Hertz
ICCE	:	Intra capsular cataract extraction
ILM	:	Internal limiting membrane
IOL	:	Intraocular lens
IUS	:	Immersion ultrasound
K	:	Coneal refractive power in D
KHZ	:	Kilohertz
K-reading	:	Kertometry reading

List of Abbreviation (Cont.)

K-values	:	Keratometry values
LASIK	:	Laser assisted in situ keratomileusis
LD	:	Laser diode
LIB	:	Laser interference biometry
LOCS III	:	Lens opacity classification system III
LOCS III P	:	posterior subcapsular cataract
LOCS III No	:	Nuclear opalescence
LOCS III C	:	cortical cataract
m/ sec	:	Meters/second
µm	:	Micrometer
mm	:	Millimeter
µw	:	Microwatt
P	:	IOL power in D
PC	:	Posterior chamber
PCI	:	Partial coherence interferometry
PRK	:	Photorefractive keratoplasty
PHD	:	Photodetector
PMMA	:	Polymethylmethacrylates
PRL	:	Phakic refractive lens
PSC	:	Posterior subcapsular cataract
P-Scale	:	Posterior subcapsular cataract scale
R	:	Refractive error
RK	:	Radial keratotomy
RPE	:	Retinal pigment epithelium
RSS	:	Retrosilicone space.
SF	:	Surgeon factor
SNR	:	Signal to noise ratio
SRK	:	Sanders, Retzlaff and Kraff
t	:	Time
IR	:	Index of refraction
US	:	Ultrasound
V	:	Velocity
ZIOLM	:	Zeiss IOLMaster

Contents

Introduction

Harold Ridley's invention of the intraocular lens has had a major impact on the specialty of ophthalmology, both in terms of how its implantation is practiced and of benefit to patients **(Ridley, 1952).**

Cataracts had been treated for centuries using various forms of intra and extracapsular extraction (ICCE,ECCE). Avoidance of complications and attaining a high quality postoperative visual rehabilitation remained a difficult problem. The classic means of correcting postoperative aphakia with thick spectacles had been less than satisfactory because of visual distortions and aberrations inherent in high-powered lenses **(Ridley, 1984).**

Modern cataract surgery is not only a means of removing and replacing an opaque lens, it is now essentially a refractive procedure. With appropriate lens power calculations, sometimes combined with corneal molding via incisions or suture alterations, a patient's refractive error can be eliminated **(Apple and Sims, 1996).**

Ridley's first IOL operation was performed on a 45-year-old woman at St. Thomas' Hospital in London on November 29, 1949. The cataractous crystalline lens substance was removed by ECCE and the biconvex lOL was placed behind the iris onto the anterior surface of the posterior capsule. Ridley did this first implant in two stages—first the ECCE, then the implant three months later. His goal was to ensure that the eye was quiet after the ECCE so as to not to compound and confine any reaction caused by the implant itself **(Apple et al, 1989).**

Because the calculations for the anterior-posterior dimensions of the Ridley IOL were apparently based on measurements of the human crystalline lens, not properly accounting for the differences in refractive index between human lens protein and plastic, the initial lens was too thick. The first patient's refraction revealed a high myopic over-correction of over 14 diopters. However, her central Snellen visual acuity still improved to 20/60 **(Apple et al, 1989).**

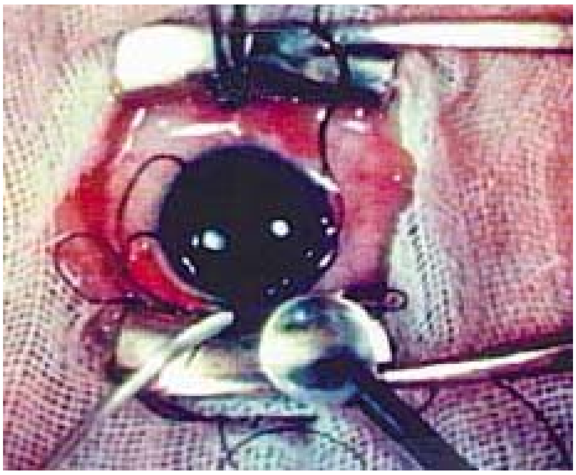

Fig. (1). Photograph extracted from an original film and subsequent video tape of Ridley's eighth IOL implantation, performed at St. Thomas' Hospital, May 8, 1951. Although the film is aged and the clarity is imperfect, the plastic biconvex disk is clearly visible in the upper center of the photograph held by forceps. The lens opacity has been removed by ECCE and the actual Insertion is occuring. This patient had 20/20 vision postoperatively. Note the relatively large 5 - 0 silk sutures and the gauze meshwork covering the operating field **(Quoted from Apple and Sims, 1996).**

Now, however, patients often expect 20/20 or better uncorrected visual acuity. Although good surgical techniques with low complication rates are important, biometry is often the most critical factor in obtaining the expected refractive result **(Connors et al, 2002).** Preoperative biometry can be performed in the outpatient clinic at the patient's first visit or at designated preadmission clinics **(Heatley et al, 2002).**

To optimize the accuracy of predicting the postoperative refraction, formulas have been developed to calculate IOL power on the basis of preoperative measurement of intraocular distances, especially axial length and keratometry. The most critical step is precise preoperative measurement of the axial length. A measurement error in axial length of 100 µm is estimated to result in a corresponding postoperative error of approximately 0.28 diopter (D) **(Findl et al, 2003).**

Fifty-four percent of the error in predicted refraction after IOL implantation is attributed to errors in axial length measurements, 8% to corneal power measurement error, and 38% to errors in the estimation of the postoperative anterior chamber depth (ACD) **(Olsen, 1992).** Errors in axial length measurement can result from combination of bias and imprecision **(Hennessy et al, 2003).**

Ridley's final choice of biomaterials for his invention was PMMA. He explains why: PMMA was light, with almost the same specific gravity, 1.09, as aqueous humor; so this material was chosen by good fortune for the very first lens implant at St. Thomas' Hospital **(Apple and Sims, 1996).**

Generations are:

I - Ridley lens, 1949
II - Early anterior chamber lenses, 1952-1962
III - Iris supported lenses, 1953 – 1973
IV - Modern anterior chamber lenses, 1963-present.
V - Modern posterior chamber lenses, 1975-present.
VI - Capsular intraocular lenses designed specifically for Implantation into the lens capsular bag, including both standard PMMA designs and pliable soft (foldable or expansile) lOLs **(Apple and Sims, 1996).**

In addition to the standard anterior and posterior chamber lenses used after cataract surgery, there are phakic lenses, occluder lenses, iris lenses, telescopic lenses, and other specialty lenses to accommodate any size eye in almost any situation **(Holladay, 2001).**

Today, the quality of corneal refractive procedures is improving. However, lens-related procedures are getting more popular. They include phakic intraocular lenses and a procedure like clear lens extraction with high power lens implantation. Clear lens extraction causes a loss of accommodation but is preferred if the patient is older than 45 years or has any degree of cataract **(Singh, 2005).**

Myopia can be corrected by 3 different means, as follows:

1- Optical devices (ie, glasses, contact lenses).
2- Corneal refractive procedures (ie, radial keratotomy [RK], automated lamellar keratoplasty [ALK],

photorefractive keratoplasty [PRK], laser-assisted in situ keratomileusis [LASIK]

3- Intraocular procedures (ie, clear lens extraction with or without lens implantation and the use of phakic intraocular lens [IOL] implants). **(Verma, 2005).**

At the extremes of myopia, implantation of a weak or even plano posterior chamber intraocular lens (IOL) is considered preferable to aphakia because it reduces complications associated with posterior capsule opacification **(Badr et al, 1995).**

However, precise biometry prediction in extremely long eyes requiring concave lenses has always been difficult **(Kohnen and Brauweiler, 1996).** The increasing popularity of clear lens extraction has brought increased expectations of predictable postoperative refraction with IOLs used in refractive surgery for high myopia **(Duffey and Leaming, 2003).**

Refractive surgery by phakic IOLs among the hyperopes is not as popular as in myopes, simply because it has not been available as long **(Singh, 2005).**

Preoperative Selection of IOL Power

1-Estimations of intraocular lens power based on the basic refraction of the eye

Experience has shown that when the basic refraction is accurate, a reasonable prediction of implant power is possible. However, there are many pitfalls in estimating the basic refraction. A reliable history of the refractive status before the onset of cataract is not always available **(Stenström, 1946).**

Also, the main components of the refraction of the eye (power of the cornea, depth of the anterior chamber, power of the lens, and axial length of the eye) show relatively little correlation between their normal range and the refraction in emmetropia as well as in ametropia. For example, the removal from the eye of a crystalline lens whose power is at either extreme of the normal range (15.5 to 23.9 D, mean = 19.7D) may alter the refraction by significantly different amounts **(Sorsby, 1971).**

Thus an error is possible if it is assumed that a standard power IOL exists that will retain emmetropia in an emmetropic eye after lens implantation. Furthermore, to achieve emmetropia or the preoperative basic refractive error, the power of the IOL should be less than that of the crystalline lens, since the IOL is in a more forward position than the crystalline lens **(Sorsby, 1971).**