SURGICAL CORRECTION OF ASTIGMATISM DURING CATARACT SURGERY

ESSAY
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LIST OF ABBREVIATIONS

AC	Anterior chamber
AK	Astigmatic keratotomy
ALK	Automated lamellar keratoplasty
ATR	Against the rule
BCVA	Best corrected visual acuity
CCI	Clear corneal incision
D	Diopter
FLK	Femtosecond laser keratomileusis
FSL	Femtosecond laser
IOL	Intraocular lens
IOP	Intraocular pressure
LAL	Light adjustable lens
LASIK	Laser-assisted in situ keratomileusis
LRI	Limbal relaxing incision
MICS	Mico-incision cataract surgery
MSICS	Manual small incision cataract surgery
NAPA	Nichamin's age and pachymetry adjusted nomogram
OCCI	Opposite clear corneal incisions
PCO	Posterior capsular opacification
PRK	Photorefractive keratectomy
RK	Radial keratotomy
SE	Spherical equivelant
SIA	Surgically induced astigmatism
STIOL	Staar toric intraocular lens
UCVA	Uncorrected visual acuity
UV	Ultraviolet
WTR	With the rule

INTRODUCTION

An increasingly important goal of modern cataract and implant surgery is to obtain the most desirable refractive outcome for the patients, and in so doing, decrease their dependence upon spectacle correction. Improvements in astigmatic outcomes are now possible by focusing upon and obtaining more accurate preoperative cylinder measurements, careful surgical planning and employing advanced postoperative enhancement techniques. Because of these refinements in technique and technology, the field of cataract and implant surgery has emerged as a true and recognized form of refractive surgery ***(Nichamin, 2003)***.

Visually significant astigmatism affects 15-30% of all patients undergoing cataract surgery. Refractive astigmatism is determined by corneal and lenticular components. Cataract surgery removes lenticular astigmatism but unmasks corneal astigmatism ***(Painter et al, 2010)***.

Astigmatism can be reduced or eliminated with several techniques; intra-operative approaches include selective positioning of the incision, relaxing incisions or toric intraocular lens (IOL) implantation. Excimer laser can be used to deal with astigmatism postoperatively ***(Amesbury and Miller, 2009)***. Minimizing postoperative astigmatism is particularly important for achieving optimal results ***(Devgan, 2007)***.

An elegant way to reduce pre-existing astigmatism at the time of surgery is to place the incision along the steep meridian, thereby inducing corneal flattening. By varying incision type,

length, width and location, the surgeon can reduce pre-existing astigmatism ***(Tehrani et al, 2003)***.

The use of peripheral arcuate astigmatic relaxing incisions has been shown to be safe and reliable. This technique provides for more predictable astigmatic outcomes and yields more consistent results than when relying solely upon a "tailored" phaco incision ***(Budak et al, 1998)***.

Toric IOL implantation is another valuable option for astigmatism correction in cataract patients. The toric IOL was devised by ***Shimizu et al***. in 1994 and has been used clinically since then. Several studies have analyzed the results of implantation of many models of toric IOLs and found this method to be effective in correcting astigmatism ***(Mendicute et al, 2008)***.

Bioptics is a surgical procedure that addresses refractive error by combining the use of corneal and lenticular surgical techniques. The procedure was originally developed for high and extreme refractive error with phakic IOL implantation, followed by programmed laser-assisted in situ keratomileusis (LASIK) one month later. Presently, a surgeon may combine any of the following techniques simultaneously or sequentially: photorefractive keratectomy (PRK), LASIK or wavefront-guided LASIK with implant technologies including toric IOL, multifocal IOL or monofocal IOL ***(Zaldivar and Grandin, 2006)***.

AIM OF THE WORK

To review the recent and most advanced modalities for correction of pre-existing astigmatism during cataract surgery that has grown recently to achieve the best postoperative uncorrected visual acuity.

OPTICS AND CLINICAL PICTURE OF ASTIGMATISM

Incidence and prevalence:

The incidence of regular astigmatism greater than 1.5 diopter (D) in cataractous patient is about 15-30%, due to this high percentage it is obvious that astigmatism has to be taken into account to achieve good optical quality within the majority of cataract patients ***(Bylsma, 2005).***

Optics of Astigmatism:

Instead of a single focal point, there are two focal lines, separated from each other by a focal interval (Sturm of conoid). At the diopteric mean of the focal lines, there is a cross section of the conoid of sturm that is circular .This circular patch of light rays is called the circle of least confusion: it represents the best overall focus of the sphero-cylinderical lens. The length of sturm of coniod is a measure of the degree of astigmatism and the correction of the error can only be accomplished by reducing these two foci into one. Toric lens is sphero-cylinderical lens which has spherical lens with a cylinderical lens superimposed upon it and so can correct astigmatism. It is formed by bending of a cylinderical surface so that the axis becomes an arc of a circle **(*Kohnen et al, 2008)***.

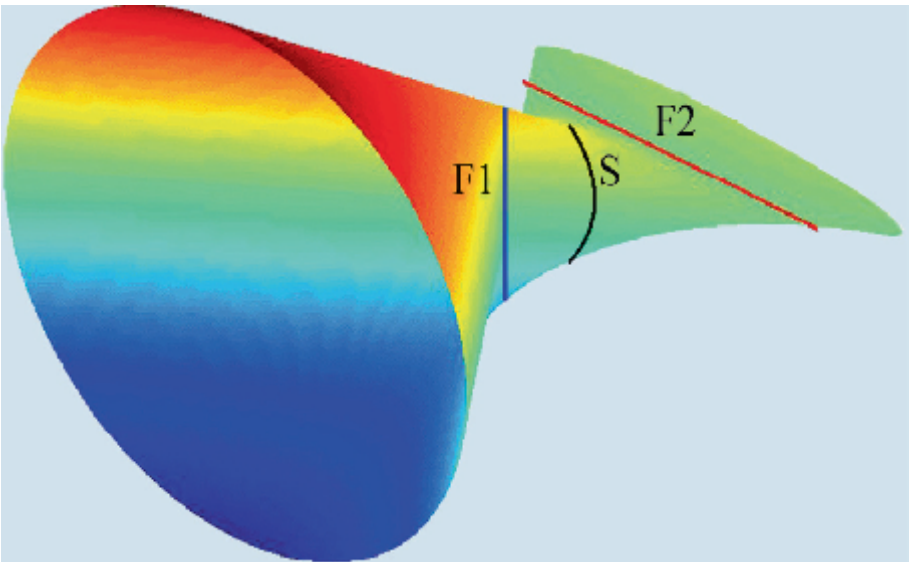

***Fig.1*:** *Sturm of Conoid.*

A bundle of rays is focused by an astigmatic optical system to two focal lines (F1 and F2). Between the foci the circle of least confusion can be found ***(Kohnen et al, 2008).***

Types of Astigmatism:

Regular where the two principal meridia are at right angle and the change from one meridian to another is gradual and regular hence it is susceptible to correction. In the great majority of these cases the meridia of greatest and least curvature are close to or actually vertical and horizontal, or vice versa. Should this not be so and provided the greatest and least meridia are at right angle, this type is called regular oblique astigmatism. When the axes are not at right angle but are crossed obliquely and the change is gradual, the optical system is still resolvable into a sphero- cylindrical combination, and the condition may be called bi - oblique astigmatism; it is not of very common occurrence.

Irregular astigmatism is a condition in which the major and minor meridia are not at right angle; and the change from one meridian to the other is not regular. It does not lend itself to adequate correction by spectacles ***(Duke –Elder's, 1995).***

Classification of regular astigmatism:

1. Simple astigmatism, where one of the foci falls upon the retina. The other focus may fall in front of or behind the retina, so that while one meridian is emmetropic, the other is either hypermetropic or myopic. These are respectively called simple hypermetropic and simple myopic astigmatism
2. Compound astigmatism, where neither of the two foci lies upon the retina but are both placed in front of or behind it. The state of the refraction is then entirely hypermetropic or entirely myopic. The former is known as compound hypermetropic, the latter compound myopic astigmatism.
3. Mixed astigmatism, where one focus is in front of and the other behind the retina, so that the refraction is hypermetropic in one meridian and myopic in the other.

The usual physiological type of astigmatism, wherein the vertical curve of the cornea is greater than the horizontal, is termed direct astigmatism or astigmatism "with the rule" (WTR), in contradiction to the opposite condition of indirect astigmatism or astigmatism “against the rule" (ATR) ***(Duke –Elder's, 1995).***