Evaluation of Quality of Vision with Diffractive Aspheric Multifocal Intraocular Lenses Implantation after Phacoemulsification

Thesis
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ABSTRACT

Multifocal IOL implantation whether refractive or hybrid diffractive-refractive adds another option for cataract surgeons. The optical zones of a zonal refractive lens direct light to either the distance or near focus and each zone act as an independent lens. Diffractive lenses divide incoming light into multiple wavefronts using small steps on the optic surface which can be designed to produce 2 sharp focal points by wavefront interference but unlike the refractive lenses they create two lens powers and thus two images. Hybrid lenses combine both the refractive and diffractive technology.

ReSTOR and ReZoom multifocal IOLs provide excellent visual performance. Although contrast sensitivity is reduced compared to monofocal IOLs, patients with multifocal IOLs have the privilege of spectacle independence after cataract surgery.

Key Words:

Correction of Presbyopia, Multifocal IOLs, Quality of Vision.

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LIST OF ABBREVIATIONS

Add	Addition	MTF	Modulation transfer function
BCDVA	Best corrected distance visual acuity	OTF	Optical transfer function
BDCNVA	Best distance-corrected near visual acuity	PCO	Posterior capsular opacification
Cpd	Cycles per degree	PresbyLASIK	Presbyopic Laser insitu keratomileusis
CS	Contrast sensitivity	PSF	Point Spread Function
IOL	Intraocular lens	UCDVA	Uncorrected distance visual acuity
LECs	Lens epithelial cells	UCNVA	Uncorrected near visual acuity
MFIOL	Multifocal intraocular lens	UV	Ultraviolet

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Introduction

Traditionally monofocal intraocular lenses (IOLs) with a single fixed focal length can provide excellent distance vision after cataract surgery. However, near to intermediate visual performance is often inadequate and can leave patients dependent on spectacles for near-vision tasks as computer work or reading. An alternative treatment is implantation of new-generation multifocal IOLs, which give a more acceptable range of near through distance vision as well as increased spectacle independence. ***(Alfonso et al., 2007)***

Early designs of multifocal intraocular lenses (MFIOL) simultaneously create images on the retina that are conjugate with 2 or more depth planes. These simultaneous vision IOLs provide distance, intermediate, and near correction within the area of the pupil. When the eye views a distant object, a sharp retinal image is provided by the parts of the lens within the pupillary area that have the distance correction and a somewhat blurred image by the other parts of the lens as these images are superimposed on the retina. ***(Montés-Micó and Alió, 2003)*** The unwanted effect of the light in the out-of-focus image is a reduction in contrast of the in-focus-image. This reduced image contrast and the unwanted visual phenomena including glare and haloes, often reduce the quality of vision for patients with multifocal IOL implantation. This drawback can be minimized by creating different amounts of refracted-diffracted light on the different foci. Another approach takes into consideration the pupil and the optical design of the IOL, which create different amounts of light on the different foci depending on pupil diameter. ***(Montés-Micó et al., 2004)***

Aim of the work:

1. To evaluate the performance and visual outcome of the Acrysof ReSTOR SN6AD3 apodized diffractive aspheric multifocal IOL (Alcon laboratories, Inc.) compared to that of the ReZoom hydrophobic acrylic refractive multifocal IOL (Abbott Medical Optics, Inc., Santa Ana, CA, USA) for cataractous patients.
2. Assessment of the quality of vision after Acrysof ReSTOR SN6AD3 and ReZoom multifocal IOL implantation as regards the contrast sensitivity, point spread function, and modulation transfer function for each IOL.
3. Identifying the possible intraoperative and postoperative complications that may affect the quality of vision after multifocal intraocular lens implantation.
4. Determination of the methods to optimize the results of multifocal lens implantation.

Review of Literature

The quality of the retinal image in a phakic human eye mainly depends on the optical performance of the cornea and the crystalline lens. Aberrations of the cornea originate mainly from its anterior surface which has a positive spherical aberration. This is neutralized by the negative spherical aberration of the human crystalline lens in youth. ***(Artal et al., 2002)*** Cataract development in aging eyes produces positive spherical aberration worsening the quality of vision. Replacing the crystalline lens with a spherical IOL that has a positive spherical aberration will not correct the error created by cataract as the pseudophakic eye now has a large amount of positive spherical aberration due to contributions from both the cornea and the IOL. ***(Kershner, 2003)*** This alters the functional vision by lowering the contrast sensitivity (CS). ***(Mencucci et al., 2007)***

The modified aspheric IOL has a surface curve that becomes flatter toward the lens periphery the farther it is from the optical center. The benefit of making 1 or both surfaces of the IOL aspheric was analyzed and studies have proved that such a design provided a significant improvement in the retinal image contrast and visual performance. ***(Kershner, 2003)***

Despite the improved visual performance after aspheric IOL implantation, most patients with monofocal IOLs remain dependent on spectacles for near vision. Modern cataract surgery enables treatment of cataract and (oncoming) presbyopia in cataract patients. ***(Dolders et al., 2004)*** Although monofocal IOLs are effective in improving vision after cataract surgery, the loss of accommodation is not restored by implantation of these IOLs. ***(Nijkamp et al., 2004)***