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EMVPO2012_5710_012 STUDENT PRESENTATION

Expected Visual Acuity and Depth of Focus with spherical and aspheric Intraocular Lenses

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Summary

Expected visual acuity (VA) and depth of focus (DOF) of both spherical and aspheric intraocular lenses (IOLs) are calculated from the in vitro Modulation Transfer Function. The resulting VAs were similar for both types of design but DOF were larger in eyes implanted with spherical IOLs.

Introduction

Intraocular lenses (IOLs) implantation is a common procedure in cataract surgery that has been greatly improved over the last decades. Several studies have shown that the average normal human cornea has a positive spherical aberration (SA). In young eyes, this SA is partially compensated by the negative SA of internal optics [1]. However, spherical IOLs also present a positive SA, thus further degrading retinal image quality. Alternatively, IOLs with aspheric surfaces may compensate corneal SA [2] but they may also reduce de depth of focus (DOF) [3]. The standard way to describe the in vitro optical imaging quality of IOLs is the Modulation Transfer Function (MTF), but non-standard designs (such as multifocal IOLs) may require other additional measurements [4]. In this work we propose to use the same magnitudes utilized to assess visual performance, such as visual acuity (VA) and the Contrast Sensitivity Function (CSF) also to report the results of optical bench measurements of IOLs. In particular, here we compare the VA and DOF predicted from in vitro measurements of spherical versus aspheric IOLs obtained on a model eye.

Discussion

The IOLs are placed on a model eye built according to the ISO standard requirements except for the artificial cornea, which induces an amount of positive SA similar to the natural human cornea. The MTF is firstly obtained for each IOL at the best image plane (0 Diopter defocus), for large (4.3 mm) and small (2.4 mm) IOL pupils. The through-focus MTF was then measured for different amounts of defocus (in steps of 0.1D). The expected CSF is then obtained as the product of the optical MTF and a generic Neural Transfer Function (NTF) [5]: CSF = (MTF)x(NTF). The predicted VA (in cycles per degree) is obtained as the cut-off frequency of the CSF. Note that the VA obtained in this way is the prediction for the particular model eye used (which includes the IOL) and a generic neural system. Figure 1 compares the through-focus VA for two IOL models, one spherical (upper panel) and one aspheric (lower panel). At the best image plane (0D) and for the two pupil diameters (2.4 and 4.3 mm)

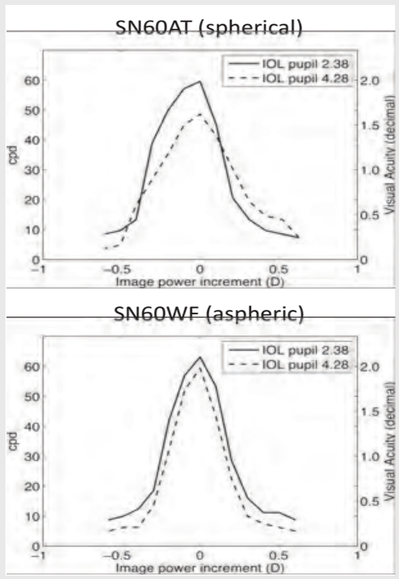

Fig. 1: Potential visual acuity for each lens and IOL pupil as a function of defocus

	IOL pupil (mm)	Sph.*	Asph.*
25cpd (VA 0.8)	2.38 4.28	0.56D 0.59D	0.50D 0,42D
15cpd (VA 0.5)	2.38 4.28	0.69D 0.84D	0.67D 0.54D

Table 1: Depth of focus of each IOL for visual acuities of 0.8 and 0.5 (decimal).

both IOLs present values higher than 30cpd (equivalent decimal VA of 1.0). Furthermore, for the small pupil both IOLs show peak values of 60cpd (VA of 2.0), which mean that the VA will be only limited by the Nyquist frequency of the cone mosaic. The spherical IOL shows a lower VA for the larger pupil. On the contrary, the aspheric IOL shows almost no difference between small or large pupils, but at the cost of a lower DOF. The DOF values (Table 1) are obtained from the bandwidths of these curves at the frequencies of 25cpd and 15cpd (equivalent to decimal VAs of 0.8 and 0.5, respectively) according to the limits for normal and mild vision loss, respectively, given by the World Health Organization.

Conclusions

A simple method is proposed to report in vitro measurements of optical performance of IOLs (within model eyes) in terms of expected visual quality (VA and CSF) by considering a generic neural response (NTF). The results obtained so far agree with previous clinical studies [6], in which no statistically significant difference in VA was found between patients implanted with spherical and aspheric IOLs. The non-compensated SA in the spherical IOL causes a moderate reduction of VA only for large pupils.

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