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Ray-Tracing Prediction of Intraocular Lenses Power: Effect of Corneal Aberrations

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Abstract

Purpose: The standard estimation of the required power of intraocular lenses (IOLs) based in empirical correlations have serious limitations especially in patients with elevated corneal aberrations. This is the case in cataract patients that underwent LASIK refractive surgery. We developed an improved procedure based in customized ray-tracing to predict the optimum IOL power. It was applied to both normal and post-LASIK patients and the impact of the corneal aberrations evaluated.

Methods: We developed a customized computational procedure based in exact polychromatic ray-tracing through pseudophakic eyes. In the model, different eye's parameters were incorporated: corneal aberrations, axial length, anterior chamber depth data and IOL parameters (geometry and optical properties). The optimum required power of the IOL for each eye was that maximizing retinal image quality for a 4-mm pupil diameter. For every eye, IOL power prediction was obtained with and without including the higher order aberrations of the cornea in the calculations. The complete procedure was applied to a group of cataract patients, 18 normal and 10 who had previous LASIK surgery (both myopic and hyperopic). The optimum IOL power was estimated from accurate post-operative refraction and compared with both the ray-tracing and the standard empirical predictions.

Results: In patients with normal corneal aberrations; i.e., root-mean squared (RMS) below 0.35 microns, the difference between the IOL powers predicted using the ray-tracing approach with and without

considering the corneal aberrations was lower than 0.5D. The accuracy of the power predictions with the ray-tracing procedure was similar to that obtained with standard calculations for these eyes. However, the scenario was quite different in the case of patients with larger corneal aberrations, for example most post-LASIK patients. The effect of corneal aberrations in the power predictions was more significant. For those eyes with corneal RMS larger than 0.45 microns, we found differences of 2D between ray-tracing and standard predictions. In these patients, the ray-tracing prediction incorporating corneal aberration was more precise than both single and double-K standard empirical formulas.

Conclusions: We have developed a robust customized ray-tracing procedure to predict the optimum IOL power. The power predicted in cataract patients with large corneal aberrations using this method was closer to the optimum value compared to data obtained with empirical formulas.

Keywords: aberrations • intraocular lens • cataract