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"Virtual Cataract Surgery": A Customized Model to Predict the Optical Performance of Eyes Implanted With IOLs

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Abstract

Purpose: To elaborate powerful modeling techniques for predicting the optical performance of eyes implanted with different types of intraocular lenses (IOLs). This approach will allow us to perform "virtual cataract surgery" with different IOL designs and physical parameters potentially occurring during actual surgery.

Methods: We developed a computer model to predict the optical performance of individual eyes after IOL implantation. The approach has been validated in a group of patients implanted with different IOLs. In these patients, corneal wavefront aberrations were calculated from elevations provided by videokeratography; ocular aberrations were measured using our own high–dynamic range Hartmann–Shack wavefront sensor. We estimated misalignments (IOL tilt, decentration and ocular angle kappa) with a new instrument developed based on recording Purkinje images. By using this model for particular corneal aberrations and IOL parameters (intrinsic optical design details plus geometric location data), we obtained the overall aberrations after surgery to be compared with actual aberrations directly measured with the wavefront sensor.

Results: The aberrations of implanted eyes predicted by our personalized computer model were well–correlated with the actual aberration measured in each patient. This demonstrated that our approach

is adequate in evaluating the actual optical performance of different types of lenses. This allows us to perform a large number of "virtual" surgeries to test the performance of current or future IOL designs.

Conclusions: We developed a virtual surgery approach to predict the optical performance in pseudophakic eyes. In a particular patient, we were able to obtain the eye's optical performance for a particular IOL and geometric data after surgery. This virtual surgery allows us to predict surgical outcomes with different IOL types. This approach is quite powerful and especially adequate to study future aberration–correction IOL designs.

Keywords: refractive surgery: phakic IOL • refractive surgery: optical quality • optical properties