Modelling Aberrations from Surface Measurements of ex-vivo isolated Human Crystalline Lenses

Christina Schwarz, Eva Acosta*, Juan M. Bueno, Concepción Molero# and Pablo Artal
Laboratorio de Óptica, Universidad de Murcia, Campus de Espinardo (Ed. CIOyN), 30071 Murcia, SPAIN
*Facultad de Física, Universidad de Santiago de Compostela, SPAIN
#Servicio de Oftalmología, Hospital Universitario Virgen de la Arrixaca, Murcia, SPAIN
christina.schwarz@alu.um.es

INTRODUCTION

The aberrations of the crystalline lens result from both, the shape of their surface and the refractive index distribution. We measured the anterior and posterior surfaces of isolated (fully accommodated) ex-vivo human crystalline lenses. From this geometrical data, the lens aberrations were predicted when assuming a constant refractive index or a gradient refractive index (GRIN). Computed aberrations were compared with experimental measurements in some of the lenses.

METHODS

Shadow Photography

While the crystalline lens was back-illuminated, a CCD camera recorded shadow-images of meridians 10° apart.

Laser Ray-Tracing

As the translation stage moves the laser beam through the meridional plane of the lens, the camera records images of the trajectories.

RESULTS

Can we accurately predict the measured back-focal distance from geometrical data?

Measured versus predicted aberrations: impact of surface fitting and refractive index

CONCLUSIONS

- The shape of ex-vivo human crystalline lenses was measured using a custom built shadow photography technique.
- Hyperbolas produce the best fitting to the lens surfaces.
- The changes of the lens radius with the meridian angle are larger in the anterior surface.
- Lens back-focal distance and aberrations were predicted by ray-tracing from the 3D reconstructed lenses using three fitting functions and two refractive index models.
- Predicted aberrations were compared with measured aberrations in three of the lenses.
- Although we found some average agreement in astigmatism and spherical aberration, this procedure is not adequate for an accurate prediction of the aberrations. This is due to limitations involved in the surface measurements, the fitting procedure, the refractive index assumptions and the experimental measurement noise.