

ABSTRACT

In this thesis we measured optical aberrations of the ocular components to assess optical quality in different clinical situations. For this purpose two different experimental techniques were implemented: A laser ray tracing technique, to measure total aberrations in the human eye, and virtual ray tracing on corneal elevation data provided by a videokeratoscope to evaluate aberrations of the anterior corneal surface. An analysis of the accuracy and precision of both techniques is presented, using model surfaces and measurements on real eyes. Eye modelling using optical design software has also been used to evaluate theoretical aberrations in configurations not available experimentally. A cross-validation test of total and corneal aberrometry is performed by measuring aberrations in eyes where corneal aberrations are predominant: a pathology that degrades the corneal surface (keratoconus) and eyes without crystalline lens (aphakic eyes). In addition, measurements in keratoconus reveal that coma is the predominant aberration in this condition. Comparison of corneal and internal aberrations in both eyes of an unilateral aphakic subject allow to discuss the effects of interactions of corneal and internal aberrations and the potential role of the posterior cornea. The optical changes induced by corneal refractive surgery (LASIK) for myopia were evaluated in 14 eyes. We found a significant increase in total aberrations, which mostly can be attributed to changes in the anterior corneal aberrations. Direct comparison of corneal and total aberrations allowed assessment of the role of the pre-operative internal aberration in the individual optical outcomes. Also, this comparison revealed changes in the internal aberrations with LASIK, that must be attributed the posterior surface corneal aberrations. The optical performance of rigid gas permeable (RGP) contact lens was evaluated in four contact lens wearers, measuring anterior and total aberrations with and without their contact lenses. Aberrations decreased significantly with RGP lenses in those eyes with predominant corneal aberrations. Corneal and total aberrations were measured in a group of 10 eyes before and after cataract surgery with spherical intraocular lens (IOL). In vivo and in vitro measurements showed positive spherical aberration in the IOL, which increase with power. Optical aberrations in pseudophakic eyes do not decrease with respect to eyes of the same age because of the aberrations of the IOL —spherical aberration, and coma presumably induced by lens tilt and decentration—, the lack of balance between corneal and internal aberrations and the induced corneal aberrations by the incision. To advance in the understanding of the contribution of the crystalline lens to the optical quality we analyzed the possibilities of an optical methodology with optimization procedures to estimate refractive index distribution of the crystalline lens.