



**Karolinska
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Institutionen för Klinisk Neurovetenskap

Ocular aberrations and visual quality in aspherical and multifocal contact lenses

AKADEMISK AVHANDLING

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ABSTRACT

Good visual quality and precise accommodation are required to be able to focus objects at distance and near, and are essential in order to be able to perform most tasks in life. Most eyes are not ideal eyes, i.e., they have different refractive errors which distort the produced image. The well-known refractive errors (lower order aberrations), myopia, hyperopia and astigmatism, have long been correctable. In addition to these common errors, irregularities in the refractive media create higher order aberrations, which are described by the Zernike polynomials. To achieve a higher level of visual quality, it is important to correct aberrations. Spherical aberration and chromatic aberration, present in polychromatic light, serve as cues for accurate accommodation in order to provide a clear image of the object. It is of interest to know how a reduction or increase of certain aberrations might affect visual quality and accommodation.

The aim of this project was to develop techniques to measure the changes in optical aberrations and accommodation in subjects while wearing standard contact lenses, and lenses with aberration control and to find new strategies to enhance the fitting of these lenses in order to achieve a higher level of visual quality.

Using an aberrometer, residual spherical aberration was evaluated with a standard contact lens and with a lens with spherical aberration control. Visual quality (i.e. visual acuity and contrast sensitivity) was also evaluated with the different contact lenses. Aberration and accommodation were measured with and without accommodative cues present. Accommodation was evaluated with a multifocal contact lens with a near reading addition.

The results show that it is possible to evaluate residual spherical aberration with contact lenses on the eye, but the change in aberration gave no difference in visual acuity or contrast sensitivity at distance or near with the methods used. Spherical aberration and chromatic aberration were shown not to be strong directional cues for accommodation, indicating that there are other cues more important for directional information. Since the multifocal contact lens, a centre distance design with reading addition +1.00, was not able to relax the accommodation for the subjects, it is therefore unlikely that subjects with reduced accommodative ability can effectively be treated with such a lens.

In conclusion, a wavefront measurement should be performed both with and without contact lenses, in order to know the amount of aberration in the eye and to note any change from a contact lens. The relatively small change in spherical aberration that non-customised lenses induce does not affect visual acuity, contrast sensitivity or accommodation. These lenses may then be fitted without worrying about affecting accommodation and they do not seem suitable to be fitted on young subjects with the ability to accommodate with the purpose of reducing their accommodative load. There is still reason to believe that there are subgroups of patients who can achieve better visual quality, but more sensitive clinical methods have to be developed.

Keywords: Contact lenses, Spherical aberration, Accommodation, Chromatic aberration, Visual acuity, Contrast sensitivity

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