The technological evolution allowed the standardization of cataract surgery from a practical point of view. The replacement of the affected eye lens is followed by implanting a foldable artificial eye lens which refractively restores the ocular diopter. The current challenge is the best quality of eyesight. The eyesight is a complex process in which the perception of visual stimulations is determined by numerous factors: anatomical, optical, neurological perception and processing. There is also a great variety of adjusting mechanisms that compensate the errors which may occur in the optic system (the Stiles-Crawford effect). The only factor that a cataract surgery can have an impact on is the optical factor. The main causes for optical quality decrease of a system are diffraction, aberrations and dispersion. These three phenomena cause an image of a dot to produce a diffuse circle on the retina. 90% are low order aberrations (canting, defocusing, astigmatism) that are usually eliminated through a biometry and a thorough surgical technique. There are also high order aberrations, though, that affect the quality of eyesight, such as spherical aberration and coma.

Keywords: cataract, defocusing, astigmatism, biometry, quality of eyesight

INTRODUCTION

The spherical aberration is the refraction difference between the central rays and the peripheral rays that penetrate an optic system. The spherical aberration is considered positive when the peripheral rays are more refracted than the central ones and negative when opposite. It is the only rotationally symmetrical of the high order aberrations with an impact on the quality of eyesight.

Can the spherical aberration be corrected?

The front surface of the cornea is aspherical, prolate, being more cambered in the center than in the periphery. It has a positive spherical aberration, with an average value of + 0.27 μm. Artificial lenses, in their turn, bring in a positive spherical aberration. The key is the aspherical refinement of the eye lenses in three main alternatives:

- the prolate front surface of the Tecnis lenses, which correct entirely the spherical aberration of the cornea by bringing in a negative spherical aberration of -0.27 μm
- the oblate back surface of the IQ lenses that partially correct the asphericity of the cornea, by giving in a negative asphericity of -0.20 μm
- a biconvex lens which has both surfaces prolate and a neutral spherical aberration (0).
MATERIAL AND METHODS

There is a pilot study that comprises 120 eyes that have been operated on for cataract, by the same surgeon, between 2011 and 2012.

The surgical technique is facoemulsification with a Stelariss device, on a 1.8 mm incision, with the appropriate widening for implantation of 2.2 (akreos, I.Q, SA, Zeiss spherical and aspherical) and 2.8 for Tecnis and Sensar eye lenses)

Exclusion criteria:
- visual acuity lower than 0.7
- post-op refraction over 0.75 dsf or cylinder over 0.75dcm
- preexistent corneal diseases, glaucoma or intraocular pressure over 21 mmHg
- retinal or optic nerve diseases
- atypical surgical progress
- patients with pupil diameter under 3mm. At patients with small pupils, senile miosis, high order aberrations are dominated by asymmetrical aberrations, so they cannot be compensated by the symmetrical IOL design.

RESULTS AND DISCUSSIONS

The post-op inspection, after six weeks, has been performed by the same person and followed up:
- visual acuity, refraction and optical correction
- testing the sensitivity to contrast
- intraocular pressure
- observation of the posterior pole

I chose the six weeks range because
- I considered the post-op healing period closed
- The opacification of the posterior capsule does not interfere
- belated neuroadaptation phenomena do not occur

For testing the sensitivity to contrast I have used an LCD-type device, used in testing the sensitivity to contrast in photopic conditions, CC-100 series TOPCON.

The examination of the curves of sensitivity to contrast for the aspherical eye lenses taken under study.

One can observe, from the chart below, that in what concerns the photopic sensitivity to contrast, there are no statistically considerable differences between the four types of aspherical eye lenses. Therefore, the sensible decision for improving the quality of life is to choose the eye lenses that provide the best focus depth.
Must the spherical aberration be corrected?

The answer is a controversy and needs establishing some objective criteria to measure the quality of the ocular diopter that determines the quality of eyesight.

The quality of eyesight is mainly determined by:

- visual acuity, a quantitative parameter. A good visual acuity is obtained through a biometry and a good surgical technique.

- contrast sensitivity, a qualitative parameter.

Contrast sensitivity is the result of the optical modulation transfer function, together with the neuroretinal transfer function. The modulation transfer function measures the optical performance and reflects the ability of a lens (or an optic system) to reproduce the clarity of an image.

Eliminating the optical aberrations from the system increases transfer function, thus increasing the sensitivity to contrast.

It has been demonstrated though (by Nio and co.), that maintaining a positive spherical aberration creates a pseudoaccomodation or myopisation, thus an increase of focus depth. Being determined by the spatial frequency, pseudoaccomodation is defined as the difference between the optimal focus for 4 cpd and 16 cpd.

Therefore, cataract surgery should ensure a fine tuning between visual acuity and contrast sensitivity, on one hand, and the depth of focus on the other, in a system that does not adjust.

In default of customization of corneal asphericity, the following options occur:

1. Full correction of a hypothetical positive value of + 0.27 μm, which determines a great sensitivity to contrast, though codependent on a perfect focus. A defocusing of +/-0.5 dsf cancels the difference between the aspherical and spherical eye lenses (Holladay). The decentration (more than 0.4 mm) or canting (more than 7°) of the eye lenses with a negative asphericity determines the occurrence of order 2 and 3 aberrations, that is astigmatism and coma.

2. Partial correction of asphericity, maintaining the same risk of decentration and canting.

3. Primum non nocere, using neutral, aspherical eye lenses, to render that balance between a good sensitivity to contrast and a useful focus depth. By pseudoaccomodation, it offers patients a certain independence for...
intermediate and short sight. The homogenous distribution of refraction power all over the surface helps the potential decentration of these eye lenses not to produce additional aberrations.

After the cataract surgery, the original eye lens is replaced with an artificial one. Originally, spherical artificial eye lenses were used, which were giving the optic system positive spherical aberrations. Subsequently, the idea of aspherical refinement of artificial lenses emerged, to correct the spherical aberrations of the cornea. That is how eye lenses were created, which are either neutral from the point of view of asphericity (zero asphericity, Bausch&Lomb), either they try to partially neutralize the positive aberrations of the cornea (Alcon, negative asphericity -0.20), or totally (AMO, negative asphericity -0.27, Zeiss -0.26).

The conclusions of the Academy for Quality of Eyesight: there are currently three types of eye lenses on the market:

- standard, spherical lenses, which induce positive spherical aberrations, especially harmful for larger pupils.
- lenses which induce negative spherical aberrations and eliminate or reduce pseudoaccomodation and which may induce considerable aberrations through decentration.
- neutral lenses (with 0 asphericity) which preserve pseudoaccomodation and are relatively immune to decentration.

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