Folding and injecting IOLs temporarily reduces optical quality

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in Paris

THE optical quality of foldable IOLs decreases significantly immediately following injection through a cartridge system but the lenses regain their original optical quality in a short time, according to Rainer Rawer PhD, University of Karlsruhe, Karlsruhe, Germany.

Dr Rawer presented a study at the XXII Congress of the ESCRS in which he and his associates measured the optical quality of ten different types of foldable IOL before and after injecting them through a cartridge. They found that the optical quality of foldable IOLs decreased up to 70% over the first 20 minutes after injection and that most IOLs regain their optical quality 30 minutes after injection

"The injection process itself did not permanently influence the optical imaging quality of the analysed IOLs. However the imaging quality among the different IOL types varied widely," said. Dr Rawer

All of the measured foldable IOLs reached their original optical imaging quality within 40 minutes of insertion. The usually slightly thinner +13 D lenses regained their original optical imaging quality more quickly than the slightly thicker +26 D lenses, he observed.

Higher dioptric powers have increased spherical aberration

Dr Rawer noted that IOLs with +13 D have very little spherical aberration, while +26 D IOLs have considerable spherical aberration. This factor was influencing IOL imaging quality, which varied significantly, especially in the high dioptre group of lenses.

Dr Rawer employed the injection methods, injectors, cartridges, and viscoelastics as specified by the individual manufacturers (Acri.Tec, Acrimed, Alcon, AMO, B&L, Pharmacia, PolyTECH, and ThinOptix). He tested two different refractive powers, +13.0 D and +26.0 D, for each IOL type. He took measurements before, and in five-minute intervals after the injection over a maximum time of 40 minutes for each IOL.

To assess imaging quality, the investigators determined the Strehl ratio and the ISO criteria (EN/ISO 11979-2). The Strehl ratio is the comparison of the tested lens to the ideal lens, and is derived from both the Modulation Transfer Function (MTF) and Point Spread Function (PSF). The ISO criteria are derived by the modulation of the MTF at a frequency of 100-line pairs/mm as defined in international industry standard EN/ISO 11979-2.

The study showed that the Strehl ratio of the +26.0 D IOLs (high dioptre group) varied by up to 50% of the value of the best measured IOL in this group. In the +13.0 D group, there was a substantial difference (up to 20%) in the imaging quality, which although not related to the spherical aberration, was probably related to lens texture and hence production quality, he said.

Dr Rawer explained that an IOL's optical properties are determined not only by its geometric form but by its surface qualities, such as the roughness of the lens material.

Aspheric designs have higher optical quality

There were three principle design types among the tested IOLs: symmetrical spherical, asymmetrical spherical, and aspherical. The Strehl ratio of the aspherical corrected IOLs was up to 20% better than the ratio of the standard, spherical + 26.0 D IOLs.

The two so called 'aberration corrected' IOLs showed a Strehl ratio of 10% to 15% less then the best measured aspherical lenses (+26 D), but still 10% better then standard symmetrical spherical designs as expected, he said. Dr Rawer explained that this was because the ISO measurement parameters do not account for eccentricity of the natural cornea these lenses are supposed to compensate for.

Because of the ongoing trend to micro-incision surgery, cartridge diameters are decreasing. Foldable IOLs must be designed to maintain their optical integrity under the increased mechanical stress of insertion, he stressed.

"The injection does not affect the long term imaging quality of the tested IOLs. What we learned though is that the imaging quality of the tested foldable IOLs differed substantially - one did not match the ISO requirements. Ophthalmic surgeons should consider the imaging quality of the IOL when choosing one, as the variance in IOL imaging quality has a major influence on the visual acuity of the patient," he noted.

IOL imaging quality is a combination of resolution, contrast and field of vision. The ITIV Institute in Karlsruhe, Germany developed the MTF measurement system to measure monofocal as well as multifocal IOLs and contact lenses according to the international standard (EN/ISO 11979-2) (www.iol-test.org).

The MTF automated measurement system consists of a 'green' HeNe-laser source (546 nm wavelength), a filter, a pinhole lens to create parallel laser light rays, a subsequent blind to limit the light to a diameter of 3.0 mm on the IOL, and an artificial cornea. The test IOL rests in a physiological solution to simulate *in vivo* conditions. This is crucial for achieving measurement results relevant for *in vivo use*. The system attaches to a microscope and a 12-bit CCD digital camera.

The Modulation Transfer Function curve describes the contrast in dependency on the structure density imaged through an optical system. This density is also called spatial frequency (a high or a low number of lines per mm for example). The MTF is derived by plotting the contrast level at different spatial frequencies. The MTF can be derived from the PSF by Fourier transformation. The Strehl-Ratio simplifies the information from the MTF and the PSF to a single number. Compared to other simplifications like the ISO criteria it is independent from the optical design type and the focal length of the tested IOL.

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