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In vitro Optical Quality Measurements of Three Intraocular Lens Models Having Identical Platform

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Cataract is the opacification of the crystalline lens in the eye that causes cloudy vision and, if left untreated, even blindness. It can be treated by surgically replacing the opacified lens with a clear, artificial IOL. The currently available IOLs on the market can be categorized according to their focality (monofocal, bifocal, or trifocal), material composition (PMMA, silicone, hydrophilic acyrlic, or hydrophobic acrylic), and optical profile (refractive, diffractive, or apodized diffractive). The quality of the patient's vision after the cataract surgery is mainly influenced by the optical performance of the implanted IOL. Numerous studies compared the optical qualities of different IOL designs in an effort to investigate their characteristics and match their optical behavior to individual patients' needs. The differences in the optical quality of various IOLs can be caused by the diversity in the material and the optical profile they employ. Using an optical bench, this laboratory study compared the optical qualities of three different IOLs, a monofocal (ZEISS CT ASPHINA 409 M), a bifocal (ZEISS AT LISA 809 M), and a trifocal (ZEISS AT LISA Tri 839 MP) IOL, all of which feature the same biomaterial and optical profile.

The results of this study showed the highest far focus MTF value in the monofocal IOL group at 3 mm pupil size. At the same pupil size, the bifocal IOL group showed the highest near focus MTF value, while the trifocal IOL group showed the highest intermediate focus

MTF value. When a comparison was made between the bifocal and trifocal groups, the prior group showed higher far and near foci MTF values, while the latter group showed superior intermediate focus MTF values. These measured MTF values were visualized and confirmed by the TFS: the trifocal group showed three distinct peaks in the TFS that correspond to its base power, intermediate add, and near add. The TFS of the bifocal group showed a typical bifocal V-pattern formed by its two MTF peaks at far and near focal points. The monofocal group only showed one peak dedicated to the far focus and no peak for intermediate or near foci. The results of the measured SR values as well as the images of the USAF 1951 Target also parallel the measured MTF values. Clearly, the monofocal group fails to provide functional vision in intermediate and near distances because it only possesses one dioptric power. The bifocal group is able to efficiently provide both far and near vision, yet shows inadequate performance for intermediate vision. Only the trifocal group successfully generates functional vision in all three distances at the expense of resolution efficiency for all three distances. All of the studied parameters showed both quantitative and qualitative attenuations when measured at a larger pupil aperture (4.5 mm), an effect that can be ascribed to the increase in the amount of light entering the eye which, in turn, also augments the magnitude of the optical aberrations that negatively affect the optical quality.

The results of this study were similar to those observed in previous studies and comply with the intended purpose of each IOL design. To the author's knowledge, this is the first study to compare the optical qualities of three different IOLs that are based on the same biomaterial and optical platform. It is, however, important to note that all the assessed IOLs feature a base power of +21.0 D. Therefore, the results cannot represent nor predict the quality of the same IOLs at other dioptric powers. Furthermore, as all the measurements were performed with an aberration-free cornea, the results of this study merely take into account the optical aberrations of the assessed IOL itself and neglects the potential adverse effects

each individual patient's actual optical aberration would have on the IOL's optical quality *in vivo*.

Several studies reported that IOL tilt or decentration may have a degrading impact on the optical quality. Therefore, future laboratory studies evaluating their effects may help further evaluate the optical behavior of each IOL in a more realistic clinical situation.