Laboratory-Measured MTF of IOLs and Clinical Performance

We read with interest the article by Esteve-Taboada et al.1 The authors measured the modulation transfer function (MTF) of three intraocular lenses (IOLs) using a corneal eye model with zero spherical aberration using monochromatic light. This means that corneal higher order aberrations and chromatic aberration were not taken into account for the evaluation, even though it has been shown that spherical aberration and chromatic aberration have a significant effect on visual acuity and contrast sensitivity.

The exclusion of spherical aberration in the measurement set-up follows the general guidelines of the International Organization of Standardization (ISO) for IOLs (ISO 11979-2:1999). The purpose of ISO standards, in general, is to ensure quality, safety, and efficiency, as well as to facilitate international trade.2 For this particular part of the standard, the primary purpose is to ensure manufacturing quality, and not in vivo performance.3 The current ISO standard provides the reader with a warning by stating that when it comes to MTF measurements “No inference should be made to performance in real eyes” (ISO 11979-2:2014, Clause C.2). In a previous commentary on a similar study by Artigas et al.,4 Norrby warned that the aberration-free ISO model eye is not valid for assessing aspherical lenses.4

The three lens designs in the study of Esteve-Taboada et al. are refractive/diffractive designs, which are known to affect chromatic aberrations. The TECNIS Symfony IOL is designed to correct chromatic aberration5 for all distances, whereas the trifocal lenses are expected to influence chromatic aberration for near and/or intermediate vision.6

Excluding chromatic aberration and spherical aberration in the measurement set-up has a significant influence on the measured values. To illustrate this effect, Figure 1 shows MTF measurements7 similar to those of Esteve-Taboada et al., but now using a model eye that includes corneal spherical aberration of 0.27 micrometers, and that also includes chromatic aberration by using white light and having suitable dispersive properties of the cornea and fluid medium in which the IOL is immersed. As such, the model eye represents the spherical aberration and chromatic aberration that is also found in an average human eye. The difference in MTF obtained in this eye model and the results obtained by Esteve-Taboada et al. is obvious, and cannot be explained by the slight difference in pupil size in both studies. The difference can only be explained by the fact that the measurement conditions for MTF in the chromatic eye model were more representative for the clinical situation.

The authors provide far-reaching statements concerning the implications of their findings toward clinical behavior, even though the understanding of the correlation with clinical outcomes is still limited for metrics based on measurements in a model eye. It must be understood that whatever correlation there may be, it will depend greatly on how the lenses were measured. An optimal correlation can only be achieved if the measurement conditions for MTF are representative for the clinical situation.

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Reply  
We have read with interest the comments made by Weeber et al. regarding our manuscript. First, we want to point out that we fully agree with all of the comments addressed by the authors. As was noted in our article, the modulation transfer functions of the intraocular lenses were obtained using an aberration-free model eye and a light source with a radiance peak centered on 545-nm wavelength. Therefore, the results shown in our study are only valid under the testing conditions described. It is clear that different results might be obtained for different testing conditions. Our study could be improved if different corneal profiles and different light sources had been included to simulate different testing conditions more representative for the clinical situation.

In addition, when the visual performance is being evaluated, many other factors that may influence the results should be taken into account. As stated in our study, in vivo studies would be necessary to fully understand the clinical performance of the intraocular lenses.

We appreciate the support of the authors of this letter to help us to explain the potential readers the limitations of our study and the main conclusions of our results.

REFERENCE  
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