



J Trevor Woodhams

# Reduced contrast sensitivity could dim future for multifocal IOLs

Howard Larkin

MEASURED by magnification alone, the patient could see better up close through the eye with the multifocal intraocular lens than through the one with an accommodating IOL. But magnification wasn't the problem. The letter was clearer but there was "a shadow – a letter behind the letter," the patient complained.

What the patient saw – and didn't like – results from the light sharing inherent in the multifocal lens design, J Trevor Woodhams, MD, told a session of the 2007 American Society of Cataract and Refractive Surgery Symposium on Cataract, IOL and Refractive Surgery.

Multifocal lenses, whether diffractive or refractive, provide accommodation by focusing incoming light at several fixed distances. As a result, for any given distance brought into the focus plane, only a fraction of the light entering the lens is used to produce the image, often less than 50 per cent. By comparison, the accommodating lens focuses nearly 100 per cent of incoming light at any given point within its accommodation range.

The advantage of current multifocal lenses is a greater range of accommodation – typically about 3.5 diopters compared with about two diopters for accommodative lenses. The trade-off is reduced contrast sensitivity – but the increased magnification may not be worth the lost contrast, said Dr Woodhams, who disclosed a consulting arrangement with Eyeonics Inc., manufacturer of the Crystalens accommodating IOL.

Dr Woodhams illustrated his point with photographs simulating contrast loss prepared by a professional photographer on staff in his Atlanta, US, office. Compared with a maximum contrast photo under ideal conditions, a 25 per cent contrast drop noticeably reduces visual detail. At 50 per cent the "waxy" visual quality patients often complain of is evident. Add a little early cataract discoloration and functional vision can be significantly impaired, even though the patient may still read 20/20 on a high-

contrast standard chart, he noted.

The impact of reduced contrast sensitivity on vision quality is greater under scotopic conditions. This leads many refractive surgeons to recommend against multifocal lenses for patients with demanding low-light vision requirements, such as pilots and police officers. Patients at risk of retinal problems, including macular degeneration and diabetic retinopathies, also may be poor candidates for multifocal lenses due to the risk of compounding the contrast sensitivity loss associated with these conditions.

However, as the interview with the patient dissatisfied with the "shadows" behind letters suggests, contrast issues also may prove problematic for more typical patients, particularly those primarily seeking relief for presbyopia.

"This loss of optical quality is unlikely to go unnoticed by the younger, more active, so-called clear-lens refractive lens exchange patient," Dr Woodhams said.

Indeed, in a 13-patient study Dr Woodhams presented, patients with an accommodating lens in the dominant eye and a multifocal in the non-dominant preferred the accommodating lens 2-to-1 for distance vision. Many also preferred it for near vision despite the more restricted range of accommodation.

Dr Woodhams believes that contrast sensitivity problems could be the downfall of multifocal lenses. Even older cataract patients who might not notice the decrease in contrast as much as younger patients "will come to appreciate and eventually demand the superior optics of accommodative IOLs," he said. Hence the title of his talk: "Why Multifocal IOLs Will Not Prevail in the Race for a Surgical Correction of Presbyopic Ametropia."

## Measuring contrast loss

A big problem with contrast sensitivity is quantifying it. Current visual acuity tests, which mainly rely on high-contrast charts, do a poor job of assessing contrast sensitivity in vivo, Dr Woodhams noted.

However, the extent to which a given IOL

degrades contrast can objectively be measured and expressed through modulation transfer function, or MTF, values. These values are routinely used to assess the optical quality of photographic and other commercial lenses. Properly interpreted, MTF values could become a valuable proxy for contrast sensitivity loss in IOL patients and candidates, Dr Woodhams says.

MTF values express the efficiency with which a lens transmits the maximum contrast present in an incoming image at various frequencies. Frequency is typically defined as the number of black and white line pairs per millimetre, or lpm. The MTF value for a given lpm frequency is determined by dividing the ratio of the maximum difference in light and dark values observed through the lens by the ratio observed directly in the incoming image.

For example, if an image of 10lpm scores a maximum contrast of 9.1 on a scale of 10.0 through a lens, and 10.0 directly, the MTF value at that frequency would be .91 out of a possible 1.00. If the maximum value through the lens is 8.0 and the value directly 9.0, the MTF is .89. The higher the MTF value is, the more efficient the lens is at transmitting contrast at that frequency.

Generally speaking, lens MTF values drop as frequencies rise, resulting in finer textured patterns greying out sooner than bolder images viewed through the same lens under the same conditions. For photographic lenses, values above .6 are considered acceptable, with many high-end lenses displaying values of .9 or better across a wide range of lpm frequencies. When charted across lpm frequencies, how quickly MTF values drop into the .5 to .6 range is a pretty good indicator of how much contrast the lens allows.

Compared with monofocal and accommodating lenses, multifocal lenses performed poorly on MTF tests conducted by Dr Woodhams using a Visimetrics Opus optical quality measurement device. As a reference, he plotted a straight line representing the theoretical limit of resolution at each frequency, which

descends diagonally as frequencies increase.

MTF values for monofocal and accommodative lenses barely deviated from the 1.0 value represented by this line. But those for multifocal lenses dipped sharply away from the line, indicating a significant degradation of maximum contrast transmitted across virtually all frequencies.

"We would never put a lens of this quality for sale in the optical industry," he noted.

The MTF slope results are consistent with observed contrast sensitivity problems in some multifocal lens patients. Also, for purposes of determining the MTF of an entire optical system, the values of each component are multiplied by each other. For example, if a lens in a camera has an MTF of .8, and the film .9, and the printing process .8, the cumulative MTF of prints relative to the original image will be about .58. From a strictly optical perspective, this suggests that a multifocal lens could indeed significantly increase contrast sensitivity problems for patients who have even small losses due to retinal, neurological, tissue discoloration or opacification, or other causes.

However, interpreting the meaning of MTF curves is difficult because no standards currently exist, Dr Woodhams noted. He is using the point at which the curve dips below the 20/20 acuity threshold, but believes that the total area under the MTF curve may eventually prove more meaningful. MTF measurements may also be a valuable complement to wavefront measurements in assessing visual quality because they take into account the impact of light scattering, which wavefront measures do not.

Developing these measures – and applying them in making lens selections – could greatly improve patient functional outcomes and satisfaction, Dr Woodhams, said.

"The effect of contrast sensitivity on visual performance has been and continues to be grossly ignored by our profession."

[trevorw212@aol.com](mailto:trevorw212@aol.com)