James McDonald II

Oliver Findl

Monofocal vs. multifocal for refractive lens exchange

Should contrast or accommodation be emphasised in pursuit of best visual performance?

AS SPECTACLE independence becomes the goal for growing numbers of intraocular lens patients, controversy is building over which of the two leading IOL technologies is preferable: multifocal lenses or monovision using monofocal lenses? Two eminent ophthalmic surgeons debated the merits of these disparate approaches at a symposium sponsored by the Journal of Cataract and Refractive Surgery at the XXV Congress of the European Society of Cataract and Refractive Surgeons.

The general outlines of the debate are familiar. Multifocal lenses provide pseudo-accommodation within each eye individually and in both eyes together, often enough to allow reading and distance vision unaided. But do so at the expense of reducing the amount of light reaching the retina, and reducing contrast sensitivity.

Monofocal lenses, on the other hand, do a better job of transmitting light to the retina, preserving contrast. But two lenses of different strengths must be implanted and both eyes must be used to achieve this, which often fails to provide adequate near vision, and may interfere with depth perception and other binocular vision functions.

So the trade-off seems to be preserving contrast sensitivity vs. increasing the range of accommodation.

Arguing for monovision was James McDonald II, MD, Fayetteville, Arkansas, US. "Monovision is much more compatible with the human visual system," he said.

Dr McDonald cited research into binocular fusion and rivalry that illuminates the basic physiology and neuropsychology of vision, much of it conducted by Randolph Blake, PhD, Centennial Professor of Neurocognitive Science, Vanderbilt University, Nashville, Tennessee, US, and colleagues.

This research indicates that the entire human visual system "is very much structured to respond to contrast orientation," Dr McDonald said. He argued in essence that monovision is preferable because its ability to preserve contrast complements the visual system's built-in reliance on image contrast.

This systemic contrast orientation begins in the retina, where three sets of receptors respond to low, middle and high contrast frequencies, Dr McDonald said. Using animations he demonstrated how low frequency contrast shows basic outlines of objects, middle frequencies provide information about space and motion used when driving or moving rapidly, while high frequency contrast receptors fill in the fine detail and sharp edges we perceive in objects all around us.

Visual sensations generated by contrast at the retina continue through a series of neural processes that winnow information before passing it to the higher areas of the visual cortex where data are assembled into visual perception. Dr McDonald pointed out that very little neural processing power is applied to the data until it reaches the higher centres of the visual cortex, suggesting that the raw data of perception are directly related to initial contrast on the retina. Indeed, Dr Blake's research using functional MRI scans and other tests demonstrates that incoming image contrast is highly correlated with the magnitude of neural response in the primary visual cortex, and primary cortex response is almost directly related to the level of activity in the higher neural processing areas associated with visual and cognitive perception.

Moreover, this research shows that when confronted with conflicting images from the two eyes, the brain routinely suppresses one, sequentially producing neural responses to each that are nearly as strong as if the conflicting image were absent (binocular rivalry), and tends to integrate features common among the two images (binocular fusion).

Dr McDonald argued that the single retinal image produced by monofocal lenses complement these robust physiological mechanisms for sorting out conflicting visual inputs by providing maximum contrast images in each eye. "You are bringing to the visual cortex all the pure vision with one eye or the other. This is the process going on when you use monofocal IOLs."

Multifocal lenses superimpose multiple images on each retina, forcing the visual system to suppress extraneous information at the retina – without the benefit of the processing power of the higher visual cortex that is brought to bear in binocular imaging. Dr McDonald believes this relatively underpowered monocular suppression process is the source of contrast loss observed with multifocal lenses, producing ghosts, blurred edges and "waxy" vision.

"We are really overtaxing our visual system when we use a multifocal lens. Between the retina and visual cortex there are three places where the information is thrown away. By the time it gets to the visual cortex there is not enough information to clean up the image," Dr McDonald said.

Addressing the issue of accommodation range in monovision, Dr McDonald said that a target refraction of about -0.25 D in the dominant eye coupled with a differential of between -1.0 and -1.5 D in the non-dominant eye produces enough accommodation for most patients to see without spectacles at distant and intermediate ranges, and to read at ranges of about 60cm to 90cm. That works for most patients.

"With -1.25 dioptres, you can't read J1 up close, but most of my patients are reading computer screens on their desk rather than the bible in bed at night."

Dr McDonald offered statistics from his own monovision practice in support. Overall, at a -1.25 dioptre differential, 100 per cent of his patients reach 20/40 at distance and intermediate, and 88 per cent reach J2, with 74 per cent reporting complete spectacle independence.

Patients say multifocals work

Speaking up for multifocal lenses was Oliver Findl, MD, of Moorfields Eye Hospital, London, UK. The chief advantage of multifocal lenses is the range of accommodation, ranging from three to four dioptres. How this is accomplished, and what the breakdown between near and distance vision, and distance bias at various pupil sizes, varies by design. Generally, diffractive designs offer good distance and near vision, while refractive designs tend to do better at distance and intermediate, he noted. Lenses offering a bias toward near vision for reading at small pupil sizes and distance bias for night driving at large pupil size are also available.

Dr Findl acknowledged that multifocals split incoming light, simultaneously focusing multiple images on the retina. But he believes this does not present a problem for the human visual system.

"Two images are formed and they are superimposed so we have retinal rivalry. Depending on what we are looking at, one of the images is blurred. The brain picks the best image. The blurred image is not perceived," Dr Findl explained.

Dr Findl allowed that this dual focus does lead to some loss of contrast. Because our brain is adaptive this does not make such a big difference, he said. Indeed, research shows that only about 20 per cent of multifocal patients perceive haloes, and that most are not bothered by them, with most receding within one year.

Moreover, Dr Findl believes the overwhelming weight of clinical evidence supports multifocals as the best current solution for spectacle independence.

"By evidence I mean prospective, randomised, controlled trials. At the moment there is no evidence-based protocol or paper for monovision. However, there is for multifocals."

According to data from dozens of clinical studies conglomerated for a Cochrane review, there is no difference in outcomes for distance vision between multifocals, including both refractive and diffractive designs, and monofocal lenses.

"These are not monovision results, these are standard monofocal lenses with both eyes set for distance,' Dr Findl noted.

As expected, these studies also show that multifocal lenses were superior for near vision. And, of course, they show a higher incidence of "modest dysphotopsias", as Dr Findl put it. But glare and halo problems were also recorded in monofocal patients, albeit at lower rates, he pointed out.

Dr Findl also laid out several downsides to monovision. One is it may compromise binocular vision, though he acknowledged this may not be much of a problem with a 1.25 dioptre difference between the eyes.

A more substantial problem may be identifying the dominant eye for distance vision, which seems critical for a successful monovision result. Dr Findl noted that many patients cannot answer questions such as which eye they use to focus a camera or aim a rifle that might reveal the dominant eye. Also, having patients focus on an object through a hole in paper is not reliable in asymmetric cataract patients because they tend to favour the eye with better vision whether it is the dominant eye or not. Some high-tech dominance tests may also be unreliable and are cumbersome to use in this patient population, he said.

The prospect of adjusting to asymmetric vision also scares patients.

It is also tedious to explain to patients why the dominant eye needs to be operated first even if the cataract is worse in the other eye, Dr Findl said. If you operate on the non-dominant eye first, which leaves the patient myopic, they are usually quite disappointed with the outcome since their distance vision is blurred.

Asked by symposium moderator Thomas Kohnen MD, Frankfurt, Germany, what is the worst thing that could happen with each approach, Dr Findl responded that refractive outliers are unhappy, and mild posterior capsule opacification can significantly compromise vision.

For monovision, Dr McDonald replied that discomfort with the difference in refraction can be difficult, but it's fixable using a corneal procedure – which is much more difficult with a multifocal lens. He also pointed out that monofocal lenses are also better for patients who subsequently develop macular degeneration or other conditions that reduce contrast sensitivity.

To avoid problems with multifocal lenses – and monofocals – Dr Findl emphasised the importance of patient selection. To avoid problems with multifocals, he looks for patients who have a strong preference for spectacle independence, and always aims for a bilateral implant. He suggested avoiding multifocals for those who have demanding night vision requirements.

Dr Findl also recommended against multifocals for patients at risk for retinal or other eye conditions that might decrease contrast and vision. He warned, however, that these patients might also be poor candidates for monofocal IOLs, particularly if no vision-threatening cataract is present.

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