Customised aspheric IOL selection new step in evolution of refractive cataract surgery

Mark Packer

THE three aspheric IOLs on the market – the Z9000 (Toricx, AMO), SN 60WF (Acrysof IQ, Alcon), and the LI61 (SolPort AO, Bausch & Lomb) – each with a different design and a customised approach to implant selection, based on pre-operative corneal spherical aberration, should optimise the outcome for individual patients, according to speakers at the annual ASCRS Symposium on Cataract, IOI, and Refractive Surgery.

Multiple clinical studies evaluating image quality, contrast sensitivity, contrast acuity, and simulated night driving indicate that correcting spherical aberration (Z(4,0)) with an aspheric pseudophakic IOL can provide cataract surgery patients with enhanced quality of vision, noted Mark Packer MD.

He discussed the elements involved in customising aspheric IOL selection and presented initial study results from a small number of eyes that demonstrated the feasibility of such an approach.

“Aspheric IOLs were developed to mimic the situation of the youthful eye where the negative spherical aberration in the crystalline lens compensates for positive spherical aberration in the cornea. To reach that balance on a patient-by-patient basis, we need to tailor our aspheric IOL selection according to the individual’s pre-operative corneal aberration,” said Dr Packer, clinical associate professor of ophthalmology, Oregon Health & Science University, Eugene, Oregon, US.

Dr Packer is conducting a study in which all cataract surgery patients with otherwise healthy eyes who do not desire presbyopia-correcting IOLs are eligible to enrol. Results from 18 eyes of 12 patients indicate aspheric IOL choice can be successfully customised.

The eyes had a mean pre-operative corneal spherical aberration of +0.24 microns. Ten eyes received the Z9000 IOL, seven were implanted with the SN 60WF, and one eye received the LI61.

Analyses of postoperative total spherical aberration showed that the achieved mean value was very close to zero whether considering all 18 eyes (+0.0065 ± 0.060 microns) or the subgroups receiving the LI61 (0.025 microns), SN 60WF (0.0073 ± 0.063 microns) or Z9000 (-0.019 ± 0.061 microns) IOLs.

Additional analyses demonstrated the postoperative total spherical aberration could be targeted with good accuracy based on knowledge of the spherical aberration in the pre-operative cornea and in the aspheric lens. The mean difference between the predicted postoperative spherical aberration and the measured value was 0.052 microns for all 18 eyes. This value was 0.040 microns off-target for the recipient of the LI61 IOL and 0.052 microns off-target in the groups implanted with the SN 60WF and Z9000 IOLs. The individual IOL values were not statistically different compared with the group mean.

“Remember that surgery induces about plus or minus 0.03 microns of spherical aberration, and so it appears we can target a postoperative value very closely and within the range of the surgically induced amount,” Dr Packer said.

Dr Packer is continuing to expand his study with additional cases and will be analysing outcomes of psychometric testing with contrast sensitivity to delineate actual improvements in functional vision achieved from this customised approach.

He also observed that the 18 eyes in his study had an average postoperative pupil size of 3.5mm.

“Some critics say that implanting an aspheric lens in older people is likely to have no benefit since they tend to have very small pupils. However, these data would suggest otherwise,” Dr Packer said.

Tailoring lens choice

“Just as laser refractive surgery has evolved into a customised procedure taking into account the individual’s pre-operative higher order aberrations to optimise quality of vision outcomes, we can now begin to customise cataract surgery by patient-specific selection of an aspheric lens,” commented Dr Holladay, clinical professor of ophthalmology, Baylor College of Medicine, Houston, TX. Jack Holladay, MD, MSEE, FACS

Support for customising aspheric IOL selection is derived from understanding that there is a fairly wide spread of corneal spherical aberration within the population. “In 2002, we first reported the mean corneal spherical aberration was +0.27 microns in a group of about 70 cataract patients, and a series of studies published over the following years have reported a nearly identical result. However, spherical aberration values within the population are normally distributed around that mean, and only about 35 per cent of eyes have a value of +0.27 microns,” explained Dr Holladay.

The Z9000 IOL was designed with -0.27 microns of negative spherical aberration to compensate for that average population value. The SN 60WF IOL has -0.20 microns of spherical aberration chosen based on studies in a model eye, while the LI61 is spherical aberration neutral.

“On a theoretical basis, considering population values, just under two-thirds of eyes would be expected to benefit most from the Z9000 IOL, about 30 per cent would be predicted to do best with the SN 60WF, and a small proportion, about five per cent, would be best served with the LI61. However, there are also a few eyes, such as in patients who are status post hyperopic LASIK, that have negative pre-operative corneal spherical aberration and would be expected to achieve the best outcome after implantation of a spherical IOL,” noted Dr Packer.

Three steps to customisation

Step 1 in customised aspheric IOL selection is to establish the postoperative spherical aberration target. Although the optimum value remains controversial, and is a topic for further research, both Dr Packer and Dr Holladay believe patients achieve the best visual performance if the Z(4,0) goal is set for 0 microns.

“Some suggest aiming for a slightly positive target based on the results of a study showing that the mean spherical aberration was slightly positive (+0.110 microns) in a group of 25 young adults with 20/15 or better UCVA. However, a similar mean value (+0.128 microns) was found in another study of more than 500 eyes of subjects presenting for refractive surgery,” said Dr Packer.

Furthermore, Pablo Artal and colleagues have shown that eyes with no spherical aberration perform better than eyes with positive spherical aberration with respect to both better visual acuity and better contrast sensitivity, he said.

Dr Holladay noted that as another benefit, eyes with no spherical aberration would experience no change in refractive error as pupil size changes. However, if that target is missed, it is better to err slightly on the negative side, he said.

“When the pupil constricts for near vision, the eye undesirably becomes hyperopic if it has positive spherical aberration while it will be myopic if the spherical aberration is slightly negative. In addition, we know from experience with presbyopic LASIK, centre ‘near’ aspheric multifocal IOLs, and hyperopic LASIK, that negative spherical aberration makes the centre part of the cornea more powerful and improves near vision. Therefore, erring on the side of negative spherical aberration in cataract surgery patients who have little or no accommodation will afford better reading vision,” he explained.

Step 2 in aspheric IOL customisation is to measure corneal spherical aberration. A direct measurement can be obtained from topographic evaluation using either the O PO-Scan (Nidek) or the Pentacam (Oculus) or by topography-based wavefront analysis using the aberrometer (software version 3.3, Tracey Technologies). Surgeons who do not have any of those instruments can purchase software (VOI-LCT) from Sarver and Associates (www.sawision.com) that will calculate the Zernike (4.0) value for corneal spherical aberration using imported files from other marketed topography units.

Regardless of the method used, Dr Holladay noted that the Zernike spherical aberration term should always be selected based on analysis with a 6.0mm zone and eighth order terms because those were the parameters used to derive the spherical aberration values for the marketed aspheric IOLs.

He added, “In the future, we can expect to see more aspheric IOL options on the market as well as software upgrades so that more topographers will provide data on corneal spherical aberration directly and eliminate the need for separate software.”

Step 3 in the process is IOL selection. For that purpose, Dr Packer uses a “best fit” chart, which also factors in an average of 0.03 microns of surgically induced spherical aberration.

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