Wavefront-guided ablation with iris registration provides superior correction of astigmatism

Reibead O’Hineachian
in Monte Carlo

NEW wavefront-guided laser systems with iris registration appear to provide a more accurate correction of astigmatism than systems without iris registration, according to a series of presentations at the 10th Winter Refractive Surgery Meeting of the ESCRS.

Wavefront aberrometry can unmask the genuine cylinder axis, while correction for cyclotorsion with iris registration will prevent misalignment of the laser ablation. The combination of those features will in turn reduce residual refractive error, said Paolo Vinciguerra, MD, Istituto Clinico Humanitas, Italy.

Appearances can be deceiving

Higher order aberrations (HOAs) can create a skewed appearance of the cylinder’s true axis and can also masquerade as cylinder in some cases, he noted. By simulating the correction of HOAs alone it is possible to define the angle and amount of astigmatism more accurately, he continued.

To illustrate this concept he presented some examples of eyes where the appearance of cylinder changed when HOAs were subtracted from the wavefront error.

The first case was an eye with a pre-operative sphere of -6.25 D and a pre-operative cylinder of -0.25 D at 10° with some superior steepening. A simulation of the postoperative refractive error after correction of coma alone, using Nidek’s OPD-based Final Fit software, showed that the genuine astigmatism was -1.9 D at 40°.

The second example was an eye in which initial wavefront assessment suggested a cylinder of 0.75 D. However, a simulated correction of trefoil showed that there was actually no astigmatism at all. “In this case, if you had programmed the laser to correct the trefoil and then correct the astigmatism you would have induced astigmatism.”

Once the true axis of astigmatism has been defined it is necessary to have an eye tracker that will take cyclotorsion into account. Consequences of axis misalignment include induced cylinder, undercorrection and the induction of new HOAs.

He noted that HOAs are very sensitive to axis errors. For example, in the case of trefoil, 3° of error means 25% less correction of HOA and 10° means 50% less correction.

Results provide proof of principle

To show what can be achieved with wavefront-guided ablations with accurate axis alignment, Dr Vinciguerra presented the results of 406 eyes that underwent LASEK with OPD-based Final Fit software with a NIDEK EC-5000 excimer laser. In all cases genuine cylinder axis and power were calculated with Final Fit and treatment was performed with a tracker that monitored cyclotorsion.

At 12 months’ follow-up, the mean spherical equivalent had improved from a pre-operative value of -5.29 D (range: -16.50 to +5.50 D) to -0.18 D, mean sphere improved from -4.86 D to -0.09 D and mean cylinder improved from -0.86 D to -0.18. In addition, 85% were within 0.5 D of intended refraction, and only 5% were more than 1.0 D outside of intended refraction.

Furthermore, UCVA was equal to or better than 20/20 in 98% of eyes. As regards safety, BCVA remained unchanged in 43% of eyes, 45% gained one line, 11% gained two or more lines and only 1% lost one line.

“Analysis of genuine cylinder power and axis after correction of HOA provides better correction of refractive defects with consequent tissue sparing. Intraoperative correct axis alignment with cyclotorsion error detection is mandatory to reduce residual refractive error and aberrations.”

Iris registration and high cylinder treatments

Further support for iris registration for tracking cyclotorsion came from a comparative study presented by Gustavo E Tamayo MD, Bogota Colombia.

The study compared visual and refractive results in patients with high cylinder errors who underwent wavefront-guided LASIK either with or without iris registration. It showed that the group treated with iris registration had significantly greater improvement in postoperative visual acuity and reduction in postoperative cylinder than the manual registration group.

The study included 116 patients with a high amount of cylinder who underwent LASIK with the VISX CustomVue® system. One group of 59 patients had a pre-operative cylinder of 2.2 D under treatment with iris registration while the remaining 57 patients who had a pre-operative cylinder of 2.3 D underwent treatment without iris registration. After a mean follow-up of 2.5 months, the mean residual postoperative cylinder was 50% less in the iris registration group than in the manual marking group (0.2 D vs. 0.4 D).

In addition, the proportion achieving a UCVA of 20/20 was significantly higher in the iris registration group (92% vs. 82%).

Upright vs. supine cyclotorsion

Dr Tamayo noted iris registration takes into account the cyclotorsion that results from changing from an upright position, when undergoing wavefront aberrometry, to a supine position, when undergoing laser ablation. Iris registration also means the ablation pattern is unaffected by the pupil centroid shift that occurs when moving from dimly lit conditions of wavefront diagnostics to the brighter conditions of laser treatment.

Studies have shown that moving from an upright to a supine position induces from 2.2° to 4.3° of cyclotorsion. One study (Swami, Steinert et al, AJO, 2002) showed that 8% had over 10° of cyclotorsion; another study showed that 25% had more than 7° of cyclotorsion.

He added that there is a linear correlation between axis misalignment during treatment and undercorrection of astigmatism. A misalignment of 2° will undercorrect cylinder by 7%; a 7° error will undercorrect it by 25%.

“Wavefront ablations using iris registration technology results in better visual quality and less cylinder than ablations using manual registration techniques. This technology will help physicians continue to refine and improve results, especially in patients who have a high amount of cylinder pre-operatively,” Dr Tamayo said.