Strategies to achieve emmetropia after corneal surgery

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THE many different approaches to improving visual outcome in patients who have unsatisfactory vision after corneal surgery were discussed at a symposium at the 10th ESCRS Winter Refractive Surgery Meeting.

“While we would wish one intervention to be perfect, that’s not always the case with refractive surgery, whatever guise it takes,” said Emanuel Rosen FRCS FRCOphth, Manchester, UK, who co-chaired the session.

Tobias Neuhann MD, Munich, Germany, commenced the session by discussing his experience in using the ICL phakic IOL (Staar Surgical) as an adjunct to corneal refractive surgery.

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“Normally we try to do everything with LASIK but sometimes we can’t do that. With the ICL and LASIK we can have the two types of surgery in a nice marriage; it’s very helpful if you have both tools to help the patient,” he said.

Indications for combined ICL implantation and corneal refractive surgery include eyes with high refractive errors beyond the range that can be corrected with either modulus on its own, and eyes that require enhancement but are unsuitable for further corneal ablations.

Results not as good as when used in primary procedures

Dr Neuhann said, in his experience, ICL implantation could improve the vision of patients with suboptimal results following corneal surgery. However, patients’ visual outcomes were not always as good as those achieved in patients who are implanted with the lenses as a primary refractive procedure.

He noted that over the past three years he has performed ICL implantations in 27 eyes of 25 patients who had undergone previous corneal surgery. Eleven patients had undergone penetrating keratoplasty and 16 had undergone previous PRK.

Over a follow-up ranging from eight months to three years, refraction was fairly stable, although it fluctuated slightly. However, the predictability was relatively poor and there were some under- and overcorrections.

The majority of cases had a visual acuity of around 20/40 and some achieved no better than 20/60. In some cases corneal opacities may have contributed to their poor visual outcomes, he said. In addition, while BCVA remained unchanged in 16 eyes, the remaining eyes lost one or two lines.

“We still have something to learn about ICL power calculation and biometry with these lenses,” he added.

Paediatric refractive surgery

Professor Michael O’Keefe, University College Dublin, Ireland, turned the discussion to the controversial topic of refractive surgery in children.

He noted that the main indications for paediatric refractive surgery are anisometric amblyopia, refractive changes after congenital cataract surgery and accommodative strabismus. While a range of approaches have been used, including laser ablation, lens exchange and phakic IOLs, such procedures are rarely performed and there is still no published long-term data on their outcome, he added.

“Probably more than 15 million LASIK procedures have been performed, but if you look at the literature on paediatrics, not more than 1,000 have been done in all the publications to date”

Michael O’Keefe MD

Furthermore, pre-operative diagnostics can also be much more difficult to perform and the results of refraction are much less accurate.

Promising five-year results

The most important use of paediatric refractive surgery is in the treatment of unilateral high myopia, which is the most refractory form of anisometropic amblyopia. In all the studies done to date, compliance with unilateral contact lenses or high-power spectacle correction has been poor.

Dr O’Keefe noted that he has achieved promising results with LASIK in a small series of children with unilateral bilateral myopia. The two-year follow-up results of his study appeared in the January 2004 issue of the British Journal of Ophthalmology.

The study involved seven eyes of six children ranging from two to 12 years in age. Five of the children had unilateral amblyopia pre-operatively. One had bilateral high myopia. Their mean pre-operative spherical equivalent was -10 D and ranged from -5.00 D to -16.0 D and their pre-operative visual acuity ranged from hand movements to 6/18.

The five-year results from the study are now available, he noted. They show that postoperative refraction has remained fairly stable throughout the follow-up period and that five children achieved an improvement in visual acuity.

The mean postoperative spherical equivalent was -3.0 D, representing a mean improvement of 7.0 D. Postoperative visual acuity ranged from 6/6 to 6/60. One child gained no improvement because of non-compliance with postoperative patching.

“It is important to stress the importance of patching afterwards and one has to follow these children closely. You also have to do these surgeries early. If you perform refractive surgery on a child of eight with dense amblyopia you might do fantastic surgery but you will probably get no improved visual outcome.”

Caution re: PRK after LASIK

In the next presentation, Dan Epstein MD, PhD, Switzerland, cautioned against the use of surface ablations as an enhancement procedure in eyes which have previously undergone LASIK.

“The anecdotal impressions I have from colleagues who have used PRK after LASIK are that it works or it sometimes works; or that it doesn’t work and it’s dangerous, or I don’t know”

Dan Epstein MD, PhD

Surface ablation for LASIK enhancement offers the theoretical advantage that it leaves the residual stromal bed untouched, but the inherent limitations of such procedures make their results unpredictable, Dr Epstein said.

He noted that enhancement procedures are performed in around 5-15% of LASIK-treated eyes and there is a wealth of...
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**Treating hyperopic overshoot**

Mark Wevill FRCSed, Manchester, UK, told the symposium that hyperopic overshoot after LASIK is a problem that can be largely prevented by a consistent practice style and that, should it occur, there are a number of means to bring the patient to the desired refraction.

In young patients, a slight hyperopic overshoot will not necessarily be a problem. Such individuals generally have a good accommodative amplitude, and their residual hyperopia can help compensate for the effects of a progressive myopia.

“The hyperopic overshoot occurs because of increased evaporation of fluid from the stromal bed where the ablation is done. Then a higher proportion of corneal tissue relative to fluid is ablated”

Mark Wevill FRCSed

Hyperopic overshoots present more of a problem in older patients, where accommodation is poor and such problems as poor reading vision and other near vision tasks are likely to occur, Dr Wevill pointed out.

**Avoiding stromal dehydration**

Prevention of the complication involves ensuring a consistent surgical style and operating environment. Such measures will help prevent stromal dehydration, which is one of the main causes of hyperopic overcorrection.

“The hyperopic overshoot occurs because of increased evaporation of fluid from the stromal bed where the ablation is done. Then a higher proportion of corneal tissue relative to fluid is ablated,” he explained.

In the operating theatre it is important to have consistent temperature and humidity, Dr Wevill stressed. Higher ambient temperatures or lower humidity will result in increased evaporation and drying of the stromal bed. The range of temperature and humidity advised by laser manufacturers can be quite broad (e.g., 15 – 27 °C, and 35-65% humidity). Constancy within the range is more important than remaining in the range, he added.

Factors that can alter the temperature and humidity of the operating environment include additional people in the room. Addition of a laser plume extractor and the presence of air conditioning blowing onto the ablation zone increases evaporation and causes drying of the stromal bed. During surgery, stromal bed dehydration can also result from the flap being lifted for too long. The risk is greatest with large refractive corrections and large optical zones. Surgeons should also make sure that the time from opening the flap to starting ablation is as consistent as possible and should minimise steps that need to be taken once the flap has been opened.

Treatment of overcorrection involves first ruling out other factors such as striae and higher order aberrations (HOAs). Striae should be treated as early as possible with such techniques as hydrating the flap, lifting the flap or stripping the epithelium. Later treatments include lifting and suturing or heating and smoothing. HOAs can imitate a simple hyperopic overcorrection and the equivalent refraction of the eye is affected by the pupil diameter. HOA-related “hyperopia” is best treated with a wavefront retreatment, but such procedures require good-quality raw data, good registration, tracking and patient cooperation, he emphasised.

Pharmacological approaches are controversial or unproven but include early cessation of steroids to induce regression and the application of tightly fitting, extended-wear contact lenses in combination with topical ketorolac tromethamine 0.5% (Acular), Dr Wevill said.

When performing repeat LASIK, re-lifting the original flap is generally better than cutting a new one, even years after a primary procedure, he noted. However, there are cases where cutting a new flap is preferable. They include original flaps that have an edge in the conjunctival vascular arcade or flaps that are too small for a wavefront or hyperopic treatment with large blend zones, he added.

**Wavefront enhancements**

Wayne Crewe-Brown, MB ChB M.Med (Ophth), Manchester, UK, told the symposium that it is now virtually beyond doubt that wavefront-guided enhancement surgery can improve visual function even in eyes that have had good refractive and visual acuity results following conventional LASIK.

“We have all seen patients who have what look like good results but are unhappy with their vision. The concept of 20/20 versus ‘20/happy’ is very real. There is a group of unhappy patients out there who we are starting to make happy again and I think it is important that all of us are aware of what can be achieved with wavefront technology.”

Wayne Crewe-Brown, MB ChB M.Med (Ophth)

In addition, he and his associates achieved even better results in their own series of 33 patients, in whom 45% had reduction in their total HOAs and 61% had reduction in their spherical aberrations. Dr Crewe-Brown said that they have achieved similar results in eyes that underwent wavefront-guided enhancements. He noted that although there was not always improvement in visual acuity, particularly in those cases that were 20/20 already, patients consistently reported an improvement in visual function.

**Case examples**

As examples of the kinds of improvement that can be achieved with wavefront-guided enhancements, Dr Crewe-Brown presented details of two patients who underwent repeat LASIK with the CustomCornea system.

The first patient was a young woman who had good visual acuity (6/6-1) and fairly good refractive results ±0.50/+0.75 x5 in one eye after primary LASIK. However, her total aberration RMS was 1.81. Wavefront-guided retreatment left visual acuity unchanged, improved the refraction to +0.00/0.25 x73 and reduced the total aberrations RMS to 0.74.

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In contrast to PRK, phototherapeutic keratectomy (PTK) is a surface ablation procedure that may be considered in eyes that have undergone LASIK. It may be a useful option for indications where only a small amount of tissue needs to be removed, for example, in eyes that require reduction of post-LASIK spherical aberration.
Another patient was undercorrected (-2.0 D/-0.25D x8) and required correction to achieve a visual acuity of 6/6. Moreover, he had total aberration RMS of 4.65 and experienced significant night vision problems as a result. After wavefront-guided enhancement refraction improved to -0.25 D /-0.25 D x70, uncorrected visual acuity was 6/6 and the total aberration RMS was reduced to 0.88.

"We did patient questionnaires and the message of ‘20/happy’ came through loud and clear. This has also been backed up by patients I have treated on the VISX platform and will be the subject of a future presentation.”

Wayne Crewe-Brown, MB ChB M.Med (Ophth)

“Most companies now have built-in radial energy compensation but there may not be a ‘one size fits all’ compensation matrix and more sophisticated algorithms must be developed”

He noted that laser ablations could be used to treat all of the aberrations of the cornea, but only the spherical aberration of the crystalline lens. Treating crystalline lens aberrations beyond that will result in initially very good results, but the aberrations will return over time. The reference axis of topographers, keratometers, refractors and the aberrometers is the visual axis (near vertex normal). Since all the measurements are referenced to this axis, ideal centre for treatment should be the visual axis also, Dr Holladay said. Pupil-centred treatments will induce coma and tilt, he added. In addition, iris registration should become standard in eye trackers because they can track both the rotational and translational movements of the eye.

Customised radial compensation

The calibration of the laser’s radial compensation function may also need to be customised. The fall-off of radial energy is not symmetrical in each eye and the radial compensation of the left eye will generally need to be approximately the mirror image of the right eye. Radial compensation will also need to be different for steep eyes than it is for flat eyes, he continued.

“An individual compensation matrix will have to be used. If not corrected, peripheral loss of ablation efficacy will most likely induce spherical, coma and other HOAs. Most companies now have built-in radial energy compensation but there may not be a ‘one size fits all’ compensation matrix and more sophisticated algorithms must be developed.”

Finally, the optimal degree of asphericity may differ between patients, Dr Holladay said. For example, the ideal postoperative Q-value might be more prolate in an older patient than is the case in the normal human eye, in order to compensate for the decreasing negative spherical aberration of the crystalline lens with age. In a young patient, a slightly more prolate cornea can help anticipate changes that will take place in the crystalline lens later in life, he added.