KERATOPLASTY TECHNIQUES

Better surgery is yielding better visual outcomes

by Roibeard O’Eineachain in Milan

The advent of the femtosecond laser corneal trephination and lamellar keratoplasty procedures has totally changed the kinds of visual results that corneal grafts can achieve, according to presentations at the XXX Congress of the ESCRS.

"The old days of keratoplasty patients being optical cripples, dependent on hard, rigid, gas permeable contact lenses, are fortunately over," said Roger Steinert MD, Gavin Herbert Eye Institute, UC Irvine, Irvine, California, US. Dr Steinert is also a consultant to AMO.

He noted that femtosecond laser trephination enables much more precise matching of donor buttons to host excision sites in penetrating keratoplasty (PK) procedures. In addition, new femtosecond laser technology is showing promise in excising host tissue right down to Descemet's membrane in deep anterior lamellar keratoplasty (DALK) procedures.

Zig-zag is best

One of the main advantages that femtosecond lasers have over conventional trephination is the range of side-cut options the laser provides, enabling a close interlocking of the graft and host tissue. That can result in better visual outcomes and earlier suture removal. The side-cut patterns include the top hat, the mushroom and the zig-zag, he said.

The top-hat pattern has advantages for patients with endothelial disease since it involves the removal of the least amount of corneal tissue and can provide a fairly unbroken contour of the anterior refractive surface. However, the "rim" of the top-hat shaped corneal button does not always self-seal with the host cornea, which means that it can lose some of its advantages over a conventional straight-cut trephination.

The mushroom side-cut pattern has advantages in keratoconus patients in that it sacrifices a relatively small amount of the host endothelium, however, it does not automatically align with the anterior surface or create a hermetic seal.

Meanwhile, the zig-zag side-cut pattern has advantages for indications involving both anterior and endothelial corneal pathology in that it maintains a hermetically sealed wound, requiring minimal suture tension.

In a study Dr Steinert’s group presented at ARVO 2012, patients undergoing keratoplasty with the femtosecond laser had a mean manifest cylinder of around 3.0 D from about three postoperative months onward. That is about 1.5 D less astigmatism than occurs with conventional PK, he noted.

Furthermore, in another study they conducted, visual acuity was 20/40 or better at three months’ follow-up in 81 per cent of eyes that underwent PK with femtosecond laser-enabled zig-zag trephination. By comparison, only 45 per cent of those who underwent the graft procedure with conventional trephination achieved 20/40 (P = 0.03) (Fard et al, Ophthalmology 2009; 116:1638-43).

The superior BCVA results achieved with femtosecond laser-assisted keratoplasty may result from the reduction in irregular astigmatism it provides. Dr Steinert noted that in yet another study, the laser-assisted procedures induced fewer anterior surface higher order aberrations than penetrating and Descemet's stripping automated endothelial keratoplasty (DSEK) induced fewer anterior surface HOAs than the other techniques. However DSAEK induced more posterior surface HOAs than the other two techniques (Chamberlain et al, Cornea 2012;31:6-13).

Dr Steinert also described a new procedure for performing DALK. The technique involves ultralow energy multi-pass technique with the 150 kHz iFS interlace laser. Results achieved so far in laboratory studies indicate that the technique can cleave the stroma from Descemet's membrane without the irregular ridges that have occurred with other deep anterior lamellar femtosecond dissection techniques, Dr Steinert said.

Keeping the interface clear

A smooth, optical lamellar surface, whether it is Descemet's membrane or a posterior stromal surface in the host cornea in DALK or as graft tissue in DSAEK, is key to achieving optimum visual outcomes with lamellar graft procedures, said Donald Tan MD, Singapore National Eye Centre, Singapore.

"DALK is now equivalent to penetrating keratoplasty with regards to best spectacle corrected visual acuity and astigmatism if you reach Descemet’s membrane in your trephination of the host cornea. Similarly, DSAEK has faster visual recovery and better uncorrected visual acuity than PK. But, unless you’re talking about DMEK, achieving a best-corrected vision of 6/6 vision may not always be achievable with endothelial keratoplasty procedures," he said.

He noted that, in a study comparing big bubble-DALK (with complete baring of Descemet’s membrane) and manual dissection DALK (with residual posterior stroma) in keratoconus patients, he and his associates were able to show that big-bubble DALK resulted in visual acuity equal to that achieved with PK (Han et al, Am J Ophthalmol 2009;148:744-751).

That is, around two-thirds of patients who underwent PK or DALK with the big-bubble technique achieved a visual acuity of 20/20, compared to only 20 per cent of patients who underwent DALK with manual stromal dissection, he said.

Big bubble better

Endothelial keratoplasty procedures like DSAEK typically provide greatly superior uncorrected and best-corrected visual acuity than PK procedures, since they leave the cornea’s refractive components largely intact and are essentially sutureless. However, the presence of a stroma-to-stroma interface between donor and recipient, and higher order aberrations from the donor may make the visual outcomes of DSAEK less than ideal in some eyes.

Dr Tan noted, for example, that in a retrospective study involving patients who underwent keratoplasty procedures during the years 2006-2010, the mean one-year uncorrected and best corrected visual acuities in eyes that had undergone DSAEK with a Sheets Glide insertion technique were 20/40 and 20/30, respectively. That compared to respective values of 20/100 and 20/50, respectively in those that had undergone PK (Ang et al, Ophthalmology 2012; 119: 2239-2244).

Moreover, the mean postoperative astigmatism was only 1.7 D after DSAEK, compared to 3.0 D after PK. In addition, the amount of endothelial cell loss was only 22.4 per cent after DSAEK compared to 40.0 per cent after PK, suggesting that long-term endothelial failure was less likely in DSAEK.

"There is some evidence that ultra-thin DSAEK procedures, or DMEK, can produce better visual outcomes. Such procedures however involve more challenging surgery, especially DMEK, and might entail greater endothelial cell loss but still offers the best possible visual quality," Dr Tan added.