Femtosecond laser effective for use in penetrating keratoplasty

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in Las Vegas

THE ability to create custom overlapping incision shapes makes femtosecond laser keratoplasty a corneal surgeon’s “dream come true”, according to William W Culbertson MD, the Higgins’ Professor of Ophthalmology and director of the Bascom Palmer Eye Institute Laser Vision Center in Miami.

He notes that the technology permits full-thickness grafting with a peripheral lamellar wound configuration, and increases the surface area for stromal healing. The ultimate goal, he said, is to create a self-sealing wound.

Speaking at a session of the annual AAO conference, Dr Culbertson reported on the first eight cases of penetrating keratoplasty at his institution using the IntraLase femtosecond laser. Seven patients had pseudophakic corneal edema and one had keratoconus. In all cases, the laser was used to create a top-hat shape in the cornea. In determining the correct depth for the lamellar cut, he said that the surgeons “tried to split the cornea in half”.

Six months after the procedure, uncorrected visual acuity ranged from 20/25 to 20/200 and best corrected visual acuity ranged from 20/20 to 20/80. The patient who saw only 20/80 had limited visual potential, Dr Culbertson explained.

The average sphere equivalent was -2.35 and the average cylinder was +4.78. Dr Culbertson explained that many patients still had their sutures in when these measurements were taken, and that the data were skewed by one patient who had her sutures in until four months after the procedure.

Endothelial cell density after six months was “good”, with a value of 2206 cells per mm². This compares favourably with standard PK, he said.

Dr Culbertson emphasised that careful pre-operative planning is essential in performing the procedure. For example, he said that surgeons at his institution use a topographic pachymetry device such as the Orbscan (Bausch & Lomb) or the Visante O C T (Zeiss) to refine the procedure and show where the incision should be. The surgeons confirm the results of topographic pachymetry using central and mid-peripheral pachymetry.

A history of the top hat
Jose I Barraquer MD was the first person to describe the top hat configuration for penetrating keratoplasty, in about 1960. The potential advantages of top hat-shaped penetrating keratoplasty are earlier, stronger wound healing, faster rehabilitation, the transplantation of more endothelial cells because of the larger posterior diameter, and a lower risk of neovascularisation because the anterior graft margins are at a greater distance from the limbus.

Use of the femtosecond laser also provides several advantages. It allows for a programmable cut pattern, a nearly infinite variety of possible shapes, precise dimensions, an exact match between the donor and host, and greater preservation of the endothelium because less manipulation is required.

The US FDA has approved the IntraLase femtosecond laser for performing the anterior side cut, the lamellar cut, the posterior side cut, and the full-thickness cut. Other shapes that have been used in penetrating keratoplasty include the top hat, the mushroom, and the zigzag.

“We haven’t yet learned what kind of incision is best for this procedure,” he said.

Dr Culbertson said that although there are still many unanswered questions when it comes to femtosecond laser keratoplasty, “It’s an evolving technology with limitless potential.” He predicted that by the year 2010, the femtosecond laser would be used in three-fourths of all corneal surgeries in the developed world.

The eventual elimination of sutures?
Dr Culbertson said that he and his colleagues saw an exaggerated healing process and fibrosis at the incision site, perhaps as a result of stimulation by the laser. Terrence P O’Brien MD, one of the panellists for the session and professor of ophthalmology as well as the director of refractive eye surgery at the Bascom Palmer Eye Institute campus in the Palm Beaches, asked whether this exaggerated healing at the graft host junction triggered by the femtosecond laser-corneal tissue interaction might permit earlier removal of the sutures.

“That’s what we thought, which is why we removed the sutures early in a couple of patients,” Dr Culbertson replied. “But I think we may have paid the price for that in terms of more astigmatism.”

When Dr O’Brien asked whether the procedure might someday be used in combination with tissue adhesive and/or laser corneal welding instead of sutures, Dr Culbertson said that he predicted it would.

“I think the next step would be to use tissue adhesive and maybe just a few sutures,” he said.

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takes six months to return with conventional penetrating keratoplasty and three months to return with Descemet’s Stripping Endothelial Keratoplasty (DSEK).

“The femtosecond laser PKP procedure appears to have a rate of recovery of vision that may be competitive with DSEK,” he said.

In showing a slide of an eye that had undergone the procedure, Dr Steinert drew the audience’s attention to the smoothness of the contour at the incision, with excellent alignment of both the anterior and posterior curvatures. He also pointed to a shadow that he explained was the suture.

“The suture is mid-depth; it didn’t go to the apex of the tissue,” he said. “Despite that the suture was mid-depth, the posterior tissue is in perfect alignment and perfect apposition. This demonstrates that the zigzag incision is biomechanically favourable and stable.”

Why a zigzag is best
Dr Steinert explained that the femtosecond laser makes a wide variety of cut patterns possible, including the standard, top hat, mushroom, Christmas tree, zigzag, and zig square. He said that he quickly settled on the zigzag shape because it provides a hermetic wound seal, and because the angled edge provides a smooth transition between the host and donor tissue.

He said that using the femtosecond laser provides better-quality vision, with less astigmatism and fewer aberrations, compared with transplants using a conventional trephine.

“The laser does a better job from an optical standpoint, and there’s faster recovery of vision,” he said.

Dr Steinert concluded that femtosecond laser corneal transplant is technically feasible and produces better results than those seen with conventional transplant. The zigzag configuration is only possible with laser incisions, he emphasised. He said that the next step in research would be to compare conventional corneal transplantation with that using the femtosecond laser.

“We’re taking a tool from primary refractive surgery, and giving it to the transplant surgeon,” he said.

“We need the astigmatism reduced when we perform corneal surgery,” said Amar Agarwal MD of Dr Agarwal’s Eye Hospital in Chennai, India, in an interview with EuroTimes. He said that use of the femtosecond laser was a good way to reduce the amount of astigmatism.

“The zigzag technique of Roger Steinert is a very good technique. It helps the normal healing much better. Using the IntraLase one can easily do it. It also won the film festival award at ARS 2007,” Dr Agarwal added.

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