Femtosecond laser produces good results as technology continues to evolve

Devon Schuyler
in Las Vegas

A CONSENSUS appears to be forming that femtosecond laser technology represents a significant improvement over mechanical microkeratomes for LASIK flap creation, but the debate about which femtosecond laser to use is only beginning.

In a study presented at the annual AAO meeting, Vance Michael Thompson MD of Sioux Falls, South Dakota, concluded that the IntraLase femtosecond laser (IntraLase) produced better flap structure, biomechanical stability, and visual results compared with the Zyoptix XP microkeratome (Bausch & Lomb). Dr Thompson is a consultant for IntraLase.

“The IntraLase femtosecond technology is the safest and most accurate way to make a flap known to man,” Dr Thompson told EuroTimes.

He said that the device provides precise, computer-controlled flap dimensions that allow for a specific distance, diameter, centration, hinge position and size, and flap edge angle.

Dr Thompson reported that when three masked observers examined the stromal surface quality of flaps, they graded those cut with the IntraLase as being significantly smoother than those cut with the Zyoptix XP. This is due to the dry stromal hydration. He said that both of these advantages should lead to better vision.

Another advantage of the IntraLase is that the flaps have a sharp edge, which makes them less prone to epithelial ingrowth when the flap is re-lifted than those cut with a microkeratome.

The device cuts the cornea at a precise thickness, whereas the microkeratome cuts deeper in the periphery with poor diameter and centration control. Flaps cut with the IntraLase also have minimal variability in central thickness across different flaps. This should lead to superior biomechanical stability.

Finally, the IntraLase also allows for the creation of custom flaps, including shaped edge and contoured flaps, he explained.

**Advantages and disadvantages of the DaVinci femtosecond device**

In a second presentation, Christophe Nguyen MD reported results from a pilot study using the new DaVinci femtosecond laser (Ziemer). He found that the device created highly precise cuts, worked quickly, and that microbubbles disappeared rapidly.

Dr Nguyen, a surgeon at Jules Gonin Eye Hospital in Lausanne, Switzerland who has no financial interest in the DaVinci, told EuroTimes that technical breakthroughs allow the device to work with a reduced energy threshold.

“Accordingly, collateral damages are decreased and the precision of the cut is increased,” he said.

He also pointed out the device’s mobility allows the refractive surgeon to create LASIK flaps and perform laser excimer ablation using a single workstation.

The pulse duration with the DaVinci is 250 femtoseconds, which is shorter than the 600 to 800 femtoseconds of the IntraLase device. It also has a much higher repetition rate than the IntraLase (measured in MHz rather than in KHz). As a result, the energy threshold for photodisruption is minimised. Finally, lower pulse energy and smaller shock waves lead to smaller cavitation bubbles and higher precision.

In the negative side, the device does not yet permit vertical cuts to be made. As the cutting process takes place in the horizontal plane, flap dimensions are still influenced by keratometry. For flap edge, the DaVinci cuts at a fixed angle with a tapered edge, whereas the IntraLase can cut at various angles.

In order to evaluate the device, Dr Nguyen and his co-investigators created LASIK flaps on six human corneas just before enucleation for melanoma. Four of the flaps were lifted; these were evaluated for thickness, edge shape, and surface characteristics. Two of the flaps were not lifted; these underwent analysis of the cutting plane.

A vacuum ring was used on all cases. The vacuum time was one minute long and there was no suction loss, epithelial defect, or buttonhole. Tiny bubbles appeared in the interface, but these disappeared as soon as the flap was lifted. The flap was easily separated, he reported.

The researchers attempted to create flaps with an 8.5 diameter and 5.2-mm hinge size in six eyes. The average diameter was 8.56 mm and the average hinge size was 4.5 mm. They attempted to create flaps with a thickness of 110 µg; the average flap thickness was 116.8 µg in the four lifted flaps.

Cuts had a tapered shape and no epithelial defects, and the stromal bed was smooth. Optical microscopy revealed regular flap thickness, no disorganisation of collagen, and a regular stromal bed.

Dr Nguyen cautioned that further studies are needed to confirm the results of this preliminary and pilot study. He said that future versions of the DaVinci will allow surgeons to perform customised cuts for astigmatism, will be capable of performing penetrating and lamellar keratoplasty, and will be able to create a pocket for inlay surgery.

**Femtosecond laser “terrific”**

“The femtosecond laser is definitely a terrific instrument,” said Prof Amar Agarwal, who was one of the session’s moderators. Prof Agarwal told EuroTimes that a device such as the IntraLase is able to address some of the flap-related problems associated with blade microkeratomes.

“In comparison to a blade microkeratome, the IntraLase flap has a more predictable thickness and diameter and has a planar contour from side to side. As a result of its inherent precision and the fact that nothing moves across the cornea during the process of flap creation, minor complications and side effects are minimal and transient and serious complications are rare,” he said.

He cautioned that cost is an issue with femtosecond lasers, and that they may cause two minor complications. The first is Transient Light Sensitivity (TLS) syndrome, in which patients with good vision develop photophobia in the absence of any apparent finding on examination. Symptoms improve within one week of treatment with corticosteroid drops, leaving no residual abnormality or symptoms. The second complication is intrastral inflammation localised around the edge of the flap, which occurs two to seven days following flap creation.

Despite these advances in femtosecond laser technology, Prof Agarwal said that the next step in research should be to develop intrastral lasers that can correct vision without creating a flap.

thompson@siouxvalley.org
christophe.nguyen@ophtal.vd.ch
dragarwal@vani.com