OCT IMAGING

Potential clinical implications of femtosecond laser flap furrows unknown

by Cheryl Guttman Krader in Paris

Anterior segment OCT imaging (RTVue, OptoVue) post-LASIK revealed the presence of a stromal tissue gap between the distal flap edge and peripheral untouched cornea in eyes whose flap was fashioned with a 60 kHz femtosecond laser (IntraLase, AMO), reported James Lewis MD, at the XXVIII Congress of the ESCRS in Paris, France.

This newly described phenomenon was seen immediately after surgery and the first day post-op. This femtosecond furrow was more subtle one week after surgery. No such findings were observed in eyes whose flap was created with a mechanical microkeratome (One Use Plus SBK, Moria), said Dr Lewis, director of cornea and refractive surgery, Salus University, Elkins Park, PA, US. "The discovery of an early post-op stromal furrow nullifies any benefit of the 150 degree inverted-bevel side cut. The concept of tongue-in-groove tissue alignment can have no merit if there is no stromal apposition. The espoused theory of improved flap adhesion, enhanced biomechanical stability, and reduced risk of epithelial ingrowth are now highly suspect," he said.

The OCT images were captured in a two-surgeon, two-centre study involving two groups of 30 eyes each. Flaps were created using the femtosecond laser (90-degree side cut) or a mechanical microkeratome. Images were interpreted by a third, masked observer. Immediately after surgery, a furrow was observed in all femtosecond laser eyes. Its width was irregular from the surface to the bottom of the furrow, measuring at least 10 microns in all eyes, averaging 42 microns, and extending up to 62 microns in some cases, Dr Lewis reported.

With a mechanically constructed flap, a 5 to 10 micron gap separated the flap epithelium from the epithelium of the peripheral untouched cornea. In all of these cases the stromal edges were in perfect apposition for 360 degrees.

At one week, the OCT images suggested that the femtosecond furrow was filled with an epithelial plug, Dr Lewis said.

He theorised that the femtosecond laser may ablate and thereby remove stromal tissue. Another possibility, he said, is heat damage and resultant collagen foreshortening. Dr Lewis also suspected that the epithelial plug may erode as can happen in old RK incisions. He is currently using thermal imaging to detect excess heat generated during the femtosecond side cut. He is also studying flap apposition in eyes with a 150-degree inverted bevel. Further study is needed to explore whether the femtosecond furrow represents a peculiarity of an individual surgeon's technique, Dr Lewis said.

Although it appears that the gap becomes filled with epithelium, Dr Lewis said there is no evidence of an increased incidence of epithelial ingrowth after primary LASIK procedures performed with the 60k Hz femtosecond laser. Currently, epithelial ingrowth is a complication of late flap lifts regardless of the flap creation modality. As many surgeons are now choosing advanced surface ablation for LASIK enhancements, the issue becomes moot.

The increased biomechanical stability some attribute to femtosecond flaps is based on a false premise since no "tongue in groove" stromal contact is actually achieved. If, in the future, a femtosecond flap could be created without the furrow, the rabbit studies suggesting increased strength are still not applicable. These studies are based on full thickness bevelled penetrating keratoplasty incisions with an over-sized donor-recipient tissue diameter and over 10 times the amount of stroma to stroma contact as is in LASIK.

Dr Lewis calculated that a 150 degree bevelled incision offers only a 20 per cent increase in tissue apposition surface area as compared to a typical femtosecond vertical incision. Furthermore, mechanical microkeratomes often achieve an even greater stroma to stroma contact although the edge is not inverted.

Other proposed evidence of enhanced adhesion is based on a peculiar hooking of the flap with a measure of the force needed to gradually peel the flap from the underlying cornea. Flaps are not exposed to such an unusual force vector in non-experimental conditions making these comparisons irrelevant. Real proof would require data showing higher rates of trauma-induced flap loss or dislocation in mechanical flaps. Dr Lewis has shown repeatable 99 micron flap thicknesses with a mechanical microkeratome in a controlled study of over 500 eyes.

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