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CONFOCAL MICROSCOPY OF A FEMTOSECOND LASER LASIK FLAP BEFORE SEPARATION

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Abstract

Purpose—To describe stromal changes after a femtosecond laser LASIK flap was created but not separated.

Design—Case report.

Methods—As part of a randomized paired-eye study comparing LASIK flap creation by a femtosecond laser to a mechanical microkeratome, a femtosecond laser flap was successfully created on one eye of one patient, but the flap was not separated because of a flap-related complication in the fellow eye. Confocal microscopy of the femtosecond laser flap was performed before and at intervals after it was created.

Results—Activated keratocytes and interface haze were visible at 1 day after femtosecond laser treatment, with gradual resolution toward normal over 2 months. The femtosecond laser flap was easily separated four months after it was created.

Conclusion—Corneal photodisruption by the femtosecond laser is associated with transient keratocyte activation and corneal haze, but significant wound healing does not occur to hinder flap separation several months later.

BRIEF REPORT

Femtosecond lasers precisely photodisrupt the cornea to create dissections of any geometric configuration, while minimizing collateral tissue damage.^{1,2} Corneal haze is transiently higher after LASIK with the flap created by a femtosecond laser than with a mechanical microkeratome (Patel SV, et al. IOVS 2006;47 ARVO E-Abstract 4331). Because minimal haze has been detected after creating but not separating femtosecond laser flaps, haze has been suggested to result from subsequent flap separation or stromal ablation (Kesler-Diaz A, et al. IOVS 2006; ARVO E-Abstract 2731).

A 29 year-old, myopic female was enrolled in a randomized paired-eye study comparing LASIK flap creation by a 15 kHz femtosecond laser (IntraLase FS, IntraLase Corp., Irvine,

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CA) to flap creation with a mechanical microkeratome (Patel SV, et al. IOVS 2006;47 ARVO E-Abstract 4331). The study protocol required the femtosecond laser flap be created first; LASIK would then be performed on the fellow eye with the flap created by a mechanical microkeratome; finally, the femtosecond laser flap in the first eye would be separated and LASIK completed. Confocal microscopy was performed preoperatively per study protocol (Figure 1). A flap was successfully created in the left eye with the femtosecond laser (raster energy 2.2 μ J; side-cut energy, 2.5 μ J; raster spot and line separation, 11 and 9 μ m, respectively), but the flap was not separated and LASIK was not completed because a “button-hole” flap was created in the right eye. The cornea treated with the femtosecond laser was examined by confocal microscopy at intervals after flap creation. Both eyes were treated with a topical corticosteroid tapering dose over two months.

Confocal microscopy showed activated keratocytes in images centered at the interface as early as 1 day after the flap was created by the femtosecond laser (Figure 2). Increased reflected and scattered light (haze) was apparent, originating from keratocytes and possibly from extracellular matrix. Keratocyte activation and haze diminished at each examination over two months (Figure 3).

Four months after the button-hole complication, the patient was treated with photorefractive keratectomy in the right eye, obtaining 20/15 uncorrected vision. LASIK was successfully completed in the left eye by easily separating the flap that had been created by the femtosecond laser four months earlier.

Our case shows that photodisruption with the femtosecond laser causes keratocyte activation and corneal haze, even without tissue separation or stromal ablation. The findings are contrary to a rabbit study in which corneal haze was barely detectable after the femtosecond laser flaps were created but not lifted (Kesler-Diaz A, et al. IOVS 2006; ARVO E-Abstract 2731). The discrepancy could be explained by differences in the wound healing response between rabbits and humans, or by the use of different laser energy levels. Upgrades to the IntraLase femtosecond laser will reduce the energy required to create flaps, and are likely to be associated with reduced keratocyte activation and haze (Stapleton WM, et al. IOVS 2006; ARVO E-Abstract 2733). Although keratocyte activation is associated with a greater wound healing response,³ in our patient, the flap was easily separated four months after it was created. Despite increased haze after LASIK with the femtosecond laser, short-term results demonstrate refractive stability and vision equal to LASIK with microkeratomes (Patel SV, et al. IOVS 2006;47 ARVO E-Abstract 4331).

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Figure 1. Confocal microscopy image of the left cornea before the intended LASIK procedure at a depth that would correspond to the interface after the femtosecond laser flap would be created. Normal keratocyte nuclei are represented as bright objects against a dark background. Cell processes are typically not visible in confocal images of normal corneas.

Figure 2. Confocal microscopy image centered at the interface one day after the femtosecond laser LASIK flap was created but not separated. The keratocyte nuclei appear more granular and cellular processes are visible, consistent with keratocyte activation. The increased reflectivity and scatter from the activated cells, and possibly from the extracellular matrix, causes increased corneal haze.

Figure 3. Confocal microscopy image centered at the interface two months after the femtosecond laser LASIK flap was created but not separated. The keratocyte nuclei appear similar to preoperative, although some cellular processes are still evident. Keratocyte activation and corneal haze have largely diminished.