ABSTRACT

PURPOSE: To describe the morphological characteristics of microfolds that appear at the corneal flap after LASIK, as seen under confocal microscopy.

METHODS: Twenty-one eyes that had undergone LASIK were examined, all within 3 weeks to 1 month after surgery. A central scan of the total corneal thickness was obtained by using confocal microscopy in vivo. Confocal images were captured and digitized. The longitudinal orientation (vertical, horizontal, and oblique) and morphological characteristics of the microfolds were described and recorded.

RESULTS: Six eyes had folds at the central corneal flap, visible as linear distortions in the confocal images: one fold had a vertical orientation, two were horizontal, and three were oblique. The folds were visible from the epithelial basal cell layer to the stromal portion of the flap and were deeper than Bowman’s layer.

CONCLUSIONS: Confocal microscopy allowed visualization of microfolds after LASIK. With the appropriate software, it is possible to analyze the morphological characteristics of these folds. Flap microfolds after LASIK are deeper than Bowman’s layer.

PATIENTS AND METHODS

PATIENT POPULATION

Twenty-one eyes of 11 patients without complication after LASIK were examined using confocal microscopy. All observations were made within 3 weeks to 1 month after surgery. All surgical procedures were performed using a Hansatome microkeratome (Chiron Vision Corp, Claremont, Calif) to create a 160-µm corneal flap and the VISX Star S2 excimer laser system (VISX, Santa Ana, Calif). The mean preoperative spherical equivalent refraction was $-5.27 \pm 1.22$ diopters (D) (range: $-3.50$ to $-7.25$ D), and the mean postoperative visual acuity was $\geq 20/30$ in all of the corneas examined.

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A confocal microscope (Confoscan; Fortune Technologies, Vigonza, Italy) was used to obtain a central corneal scan of each eye. The front lens of the microscope was disinfected with 70% isopropyl alcohol wipes before and after each examination. A drop of gel (Viscotears; Ciba Vision, Duluth, Ga) was placed on the tip of the front lens to provide an immersion liquid within which the front lens could move forward and backward without eye contact to obtain a full-thickness central corneal scan. Each scan consisted of two full-thickness corneal sequences, with 350 images in total, which were digitized using NAVIS software V.3.1.2. (NIDEK, Gamagori, Japan). Each image represented a coronal section of approximately 340×255 µm. Each scan was stored in the computer’s memory.

The longitudinal orientation (vertical, horizontal, and oblique) of each detected flap microfold was then described.

**RESULTS**

Uncorrected visual acuity was ≥20/30 in all eyes after LASIK, and best spectacle-corrected visual acuity was 20/20 in all cases. Mean spherical equivalent refraction after surgery was −0.22±0.52 D. Slit-lamp examination revealed corneal flap microfolds in eight (38%) eyes, six of these eight eyes showed microfolds by confocal microscopy. Thirteen eyes did not show microfolds by confocal microscopy and slit-lamp examination.

The superficial epithelial cells were normal in all of the examined corneas. The subepithelial nerve plexus was absent in all of the central corneas. Flap interfaces were determined by detecting the presence of hyperreflective particles at the corneal stroma (Fig 1).

Corneal flap microfolds were visible as irregular linear distortions against the normal background structures in the confocal images with defined limits and presenting wide and narrow portions (Figs 2 and 3). In
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six (28.5%) eyes, flap microfolds were found in the confocal scan. Two were visible at the epithelial basal cell layer (see Fig 2), all were visible at the stromal portion of the flap, and all were deeper than Bowman’s layer (see Fig 3). No folds were visible deeper than the flap interface. One fold had a vertical orientation, two were horizontal, and three were oblique (see Fig 3). At the retroablation zone, activate keratocytes were present in all of the examined corneas (Fig 4). The deeper stroma showed normal morphologic keratocytes and normal endothelial cells in all corneas.

DISCUSSION

Previous confocal reports have described the absence of a subepithelial nerve plexus in the early stages of the cornea after LASIK and the return of this plexus at the center of the cornea 6 months after surgery.7,8 The detection of bright particles at the interface by confocal microscopy after LASIK has been consistently described in human corneas in previous studies.8-10 Several theories attempt to explain the presence of these particles at the interface. Kaufman et al11 attributed the particles to surface debris on the microkeratome blades probably caused by sterile wax or oil-like material. Hirst and Vandeleur12 attributed them to exposure of the methylcellulose sponges to the excimer laser beam during the stromal ablation. At the present time, the origin of this interface debris is unknown.

Severe corneal flap folds represent an early postoperative complication that affects visual acuity after LASIK and requires surgical repositioning as soon as possible.6,13 Carpel et al14 reported the presence of fine lattice lines that could represent microfolds within the flap after LASIK and which do not produce a significant visual problem.14 Kohnen et al15 reported reticular folds in a LASIK flap by confocal microscopy, and observed that reticular folds after LASIK involved the entire thickness of the corneal flap.

We examined 21 central corneas of 11 satisfied LASIK patients using in vivo confocal microscopy, looking for corneal flap microfolds. The detection of flap microfolds by confocal microscopy after LASIK is a consistent finding, and previous reports have described these microfolds at Bowman’s layer in >94% of the examined corneas.8,10 By contrast, the present report identified corneal flap microfolds in only 28.5% of the examined corneas, probably because we only scanned the center of each cornea on a single occasion. Thus, it is possible that many microfolds were outside of the cornea area scanned by the confocal microscope. Flap microfolds were visible starting at the epithelial basal cell level in two eyes, and the superficial epithelium was normal in these cases. This could be explained by the remodeling and increase of thickness of the epithelium that has been reported in corneal epithelium after LASIK.16,17 Corneal flap microfolds have previously been described at Bowman’s layer using in vivo confocal microscopy.8,10 In contrast, the present study identified microfolds at the stromal portion of the flap, deeper than Bowman’s layer but before the flap interface, as described previously by Kohnen et al.15 It is possible that these folds were bigger than those described in Bowman’s layer. The folds were deeper than Bowman’s layer because the folds in the images were surrounded by keratocytes (see Fig 4). It is possible that microfolds were observed from Bowman’s layer to the underlying stroma because after a corneal flap had been performed both surfaces—the posterior corneal flap and the anterior stromal bed—matched perfectly. Charman18 described that after the excimer laser ablation is done, a mismatch between the stromal bed surface and the posterior corneal flap surface occur, and may cause striae because of wrinkling.

Behind the interface, at the ablation zone, the keratocytes showed as hyper-reflective objects with visible cytoplasm processes, which are the same characteristics that have been described as activated keratocytes in previous reports.8,10,19,20

The purpose of the present study was to describe corneal flap microfolds by in vivo confocal microscopy in patients with satisfactory postoperative visual acuity after uncomplicated LASIK. Future studies should attempt to determine whether these microfolds produce visual complications and identify the factors that contribute to the development of these microfolds.
# REFERENCES


