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High-resolution optical coherence tomography visualization of LASIK flap displacement

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Abstract

Uneventful myopic laser in situ keratomileusis (LASIK) was performed in both eyes of a 33-year-old woman. Two weeks after LASIK, examination of the left eye revealed flap striae radiating inferonasally from the superior hinge. The flap was relifted and repositioned to remove the irregular astigmatism and reduce the striae. Before the flap was relifted, Fourier-domain optical coherence tomography (FD-OCT) showed the gap at the temporal flap, which had not been detected by biomicroscopy. After the flap was relifted, FD-OCT documented that the gap was closed. High-resolution FD-OCT was helpful in the visualization and management of flap displacement.

Macrostromiae after laser in situ keratomileusis (LASIK) are full-flap-thickness folds caused by misalignment of the flap in the stromal bed during surgery or movement of the flap during the early postoperative period.^{1–3} These macrostromiae are clearly visible at the slitlamp biomicroscope,⁴ usually radiating from the flap hinge. They can induce irregular astigmatism if they extend through the visual axis and cause a decrease in the corrected and uncorrected visual acuities.^{5,6} Macrostromiae can be reduced by repositioning the flap.⁴ Recognizing the location, direction, and amount of flap displacement can help in the management of this complication.

Microstromiae after LASIK tend to be partial thickness and limited.⁷ Unlike macrostromiae, which can be due to flap slippage,⁷ microstromiae are not associated with flap displacement. They can be caused by excessive hydration during surgery or subsequent tissue loss caused by diffuse lamellar keratitis⁸ or central toxic keratopathy.⁹ Recognition of the absence of flap displacement is also helpful in the differential diagnosis and management of these cases.

We describe the use of Fourier-domain optical coherence tomography (FD-OCT) with a corneal adaptor module (CAM) to measure the amount of flap displacement, which was undetected by slitlamp examination.

CASE REPORT

A 33-year-old woman was referred for a second opinion after bilateral myopic LASIK performed at an outside facility. No intraoperative complications were noted. The patient complained of irritation and decreased uncorrected distance visual acuity (UDVA) in the left eye a few days after the surgery. She was examined by us 2 weeks after LASIK. The UDVA

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was 20/20 in the right eye and 20/50⁺² in the left eye. The manifest refraction for the left eye was -1.25 diopters (D) (20/30⁻¹). Slitlamp examination of the left eye revealed flap striae radiating inferonasally from the superior hinge (Figure 1), but no gap between the flap edge and bed rim could be visualized at the slitlamp under any illumination. The left cornea was scanned with the RTVue-CAM FD-OCT system (Optovue, Inc.), which showed flap thickness to be 196 to 210 μ m (Figure 2). Optical coherence tomography also showed a gap at the temporal flap edge (Figure 3). The nasal flap edge was well apposed. A manual caliper tool was used to measure the gap between flap edge and bed rim.

The flap was relifted and repositioned to remove the irregular astigmatism and reduce the striae. The dislocation was isolated to the temporal portion of the flap, as visualized by the shift in ink marks placed at the flap edge before the flap was relifted. Epithelial ingrowth onto the stromal bed was also noted along only the temporal edge of the flap.

Five days after flap repositioning, slitlamp examination showed disappearance of the striae and a well-apposed temporal flap edge (Figure 4). The corrected distance visual acuity was 20/20⁻¹.

DISCUSSION

As this case demonstrates, displacement of the flap edge can be difficult to visualize by slitlamp examination because of masking by the epithelium. Ustundag et al.¹⁰ report 2 cases of flap displacement in which the gap was visualized by OCT but not by slitlamp examination. However, in their OCT images, the gap at the flap edge was barely visible because of limited resolution (10 μ m) and was difficult to distinguish from motion artifact (speed was 100 axial-scan/second). The FD-OCT system we used has a depth resolution of 5 μ m and a speed of 26 000 axial-scan/second. The high-magnification lens in the CAM set provided a lateral resolution of 10 μ m and a range of 4.0 mm. The CAM software automatically dewarped the images to remove distortion caused by index change and refraction, making it possible to accurately measure the width of the gap. The high speed also allowed registration and averaging of 16 OCT image frames to remove speckle and background noise. Our case demonstrated that it was possible to clearly distinguish the epithelium, the flap interface, the flap edge, and the gap with high-resolution FD-OCT.

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Figure 1.
Slitlamp examination with oblique illumination shows flap striae in the left eye.

Figure 2.
Vertical OCT section of the left cornea shows a flap thickness range of 196 to 210 μm .

Figure 3.

Optical coherence tomography frame-averaged horizontal sections from the left cornea. *A*: No displacement nasally. *B*: Flap displacement shown by gap between flap edge and bed rim temporally. *C*: Enlargement of image in *B* shows the gap was smoothly bridged by epithelium. A caliper tool measured the gap width as 303 μm.

Figure 4.
Enlarged OCT horizontal section (frame averaged) taken 5 days after flap repositioning shows well-apposed temporal edge.