A 53-year-old man had flap creation with a femtosecond laser during laser in situ keratomileusis for the treatment of hyperopia. During flap creation, a subepithelial vertical gas breakthrough approximately 4.0 mm × 4.0 mm in diameter was noted under the small superficial scar in the inferior para-central region of the left cornea. Because the flap cut was deep to the scar on anterior segment optical coherence tomography, the refractive laser ablation procedure was performed on the cornea on the same day. Subepithelial vertical gas breakthrough, a rare but serious intraoperative complication of femtosecond laser use, may be treated successfully.

CASE REPORT

The femtosecond laser is a safe and effective tool for corneal flap creation during laser in situ keratomileusis (LASIK). It has many advantages over the microkeratome, including predictability, reliability, good high-contrast visual acuity and contrast sensitivity outcomes, fewer complications, and increased patient satisfaction.1–5 Intraoperative flap complications of femtosecond laser–assisted LASIK are loss of suction, bleeding, epithelial defects, vertical gas breakthrough, anterior chamber gas bubbles, opaque bubble layers, flap tears, and interface debris.6 Vertical gas breakthrough is the escape of gas bubbles from the stromal dissection plane upward into the subepithelial space (partial thickness) or to the corneal surface (full thickness) during the keratectomy. To our knowledge, there are few reports of partial-thickness vertical gas breakthrough in the literature.2–11

In this report, we present a case of hyperopic LASIK in which vertical gas breakthrough occurred during femtosecond laser flap creation and was successfully managed with the same cut.

CASE REPORT

In 2013, a 53-year-old man with hyperopia and presbyopia presented for refractive surgery. At that time, multifocal intraocular lenses were not widely available in routine clinical practice and the patient could only afford refractive surgery with the goal of spectacle independence for distance vision. The patient was informed that after the surgery he would no longer need distance spectacles but would have to use lower spherical power spectacles for near vision. The patient gave written consent for the surgery.

Slit lamp examination showed a 1.0 mm diameter inferior para-central anterior stromal corneal scar in the left eye. The patient had no knowledge of when and how the scar developed. The non-cycloplegic refraction was +2.50 −0.75 × 10 in the right eye and +2.25 −0.50 × 140 in the left eye. The cycloplegic refraction was +2.75 −0.75 × 15 and +2.50 −0.50 × 150, respectively. The planned hyperopic correction was the manifest refraction, which was +2.50 −0.75 × 10 in the right eye and +2.50 −0.50 × 140 in the left eye. In both eyes, the uncorrected distance visual acuity (UDVA) was 0.50 logMAR and the corrected visual acuity with manifest refraction was 0.00 logMAR. Preoperatively, the central corneal pachymetry and keratometry were measured using corneal topography (Orbscan, Bausch & Lomb, Inc.). The central corneal pachymetry measurement was 535 μm in the right eye and 526 μm in the left eye, and the keratometric measurement was 43.5 @ 102/42.6 @ 12 and 43.6 @ 72/42.7 @ 162, respectively (Figure 1). The targeted correction was emmetropia for both eyes.

Laser in situ keratomileusis was performed on February 5, 2013, to treat the hyperopia. The LASIK flap in both eyes was created with a femtosecond laser (IntraLase 60 kHz, Abbott Medical Optics, Inc.), targeting 120 μm thickness instead of standard thickness of 110 μm because of the scar tissue on the cornea; the hinge was superior. The flap diameter setting was 9.1 mm for both eyes. Other parameters were raster energy 0.80 mJ per pulse,
0.85 μm/0.85 μm spot/line separation, hinge position 90 degrees with a hinge angle of 45 degrees, and side-cut energy 0.80 mJ with a side-cut angle of 110 degrees.

Flap creation in the right eye was uneventful. During flap creation in the raster mode in the left eye, subepithelial gas breakthrough (approximately 4.0 mm × 4.0 mm in diameter) was noted in the inferior paracentral region of the cornea between 5 o’clock and 6 o’clock (Figure 2). Thus, although the femtosecond laser flap was completed, the flap was not dissected. After slitlamp examination showed that the gas bubble has disappeared, anterior segment optical coherence tomography (AS-OCT) (Spectralis, Heidelberg Engineering GmbH) was performed. The AS-OCT image showed that the flap was regular, the lesion was superficial to the flap, and the flap thickness in the region of the lesion was between 83 μm and 99 μm (Figure 3). The flap thickness in the periphery of the normal corneal area was adjusted to be 119 μm. Because the lesion was superior to the flap, the surgeon continued the procedure by dissecting the flap. The flap could be lifted without buttonhole formation; however, the corneal epithelium was loose and easily separated in both eyes. The refractive ablation procedure was performed on the cornea using an excimer laser (WaveLight EyeQ, Alcon Laboratories, Inc.), and the flap was repositioned.

Six months after surgery, the manifest refraction was +0.25 diopter, as targeted. The UDVA was 0.00 logMAR. There were no postoperative complications.

DISCUSSION

Although the introduction of femtosecond laser technology has decreased the complications of LASIK flap creation, other complications, such as vertical gas breakthrough, have emerged.12 The patterned pulses of near-infrared wavelength energy used by the femtosecond laser create cuts at many intrastromal corneal points with minimal collateral harm to surrounding tissue. However, a small amount of microplasma generated by the femtosecond laser can result in the formation of cavitation gas bubbles.6

Vertical gas breakthrough is a rare complication that occurs during femtosecond flap creation as a result of the escape of gas bubbles from the dissection plane into the subepithelial space, especially if the cornea is weakened.1 A thin flap, previous radial keratotomy surgery, corneal scars, and local defects inside Bowman membrane1 or altered epithelium2 can cause focal or diffuse weakening of the corneal stroma and thus contribute to vertical gas breakthrough. The wound architecture and corneal clarity in the area of wound creation have been reported to predispose to vertical gas breakthrough.8

The most probable cause of the subepithelial vertical gas breakthrough in our case was scar tissue, which compromised the ability of the femtosecond laser to effectively ablate the corneal stroma within or posterior to it, or the resistance of the fibrotic tissue that prevented formation of a normal flap interface. If the scar tissue is at the plane of the ablation zone or at the central corneal visual axis, LASIK is usually contraindicated; if it is anterior to the zone, the laser flap depth settings must be posterior to it to avoid complications.10

As our case shows, even small scars (1.0 mm × 1.0 mm) can result in vertical gas breakthrough. We recommend waiting for 1.5 hours after vertical gas breakthrough before proceeding with the flap lift to allow the gas bubbles to expand and complete the dissection in the area of the breakthrough. The procedure can then be completed on the same
same-day flap creation because of the location of the central visual axis or the high probability of adverse outcomes (eg, repeated vertical gas breakthrough, buttonhole formation, flap tears). In the presence of this complication, AS-OCT can help the surgeon decide whether to continue with the LASIK procedure after the bubble disappears. If the decision is to continue, the surgeon should proceed cautiously. If the surgeon decides not to continue the procedure on the same day, a deeper recut could be attempted at a later time after the bubble dissipates.

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