Rare intraoperative complication of femtosecond flap creation: Successful management of subepithelial vertical gas breakthrough

Ozgun Melike Gedar Totuk, MD, Kerem Kabadayi, MS, Sevgi Tongal, MD

From the Department of Ophthalmology (Gedar Totuk), Bahçeşehir University Faculty of Medicine, Bahçeşehir University Faculty of Medicine (Kabadayi), and Ataköy Dunyagaz Hospital (Tongal), Istanbul, Turkey.

Presented at the XXXI Congress of the European Society of Cataract and Refractive Surgeons, Amsterdam, the Netherlands, October 2013.

Corresponding author: Ozgun Melike Gedar Totuk, MD, Bahçeşehir University Faculty of Medicine, Department of Ophthalmology, Yeşilısahra Mah. Batman Sok. No:66-68 Sahrayicedit, Kadıköy, Istanbul, Turkey. Email: melikegedar@gmail.com.

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 paracentral 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.

© 2019 ASCRS and ESCRS
Published by Elsevier Inc.
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 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.

Although the epithelial wound had healed by the first postoperative day, a bandage contact lens was applied for 3 days to prevent epithelial defect formation and protect the loose epithelium from trauma (Figure 4).

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 membrane 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
day. We used AS-OCT to determine whether the flap plane was created in the area of the vertical gas breakthrough. In this case, the targeted 120 μm flap thickness was deep enough to reach the posterior of the scar tissue. The para-central location of the vertical gas breakthrough in this case allowed the surgeon to resume the operation.

The morbidity associated with vertical gas breakthrough complications is variable and can range from minimal corneal damage to significant corneal tearing. Few cases of subepithelial vertical gas breakthrough have been reported in the literature. The predisposing factors were reported to be thin flap creation (100 μm) and previous refractive procedures. The cases reported in the literature were completed successfully with the same flap on the same day, as in our case.

In conclusion, subepithelial vertical gas breakthrough is a rare intraoperative complication of femtosecond laser surgery. Many patients cannot remember the event that caused the scar, and most are surprised to learn that they have a scar. If an identifiable event such as a recent corneal ulcer occurred, additional caution might be required. Epithelial, basement membrane, and stromal remodeling might not yet be complete, and weak areas can provide the path of least resistance for vertical gas breakthrough. Because the causes of femtosecond laser–related subepithelial vertical gas breakthrough are not well defined, it is not possible to take effective precautions in the preoperative period. Detection of this complication intraoperatively might not allow 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.

REFERENCES

Disclosures: None of the authors has a financial or proprietary interest in any material or method mentioned.