Interrupted femtosecond laser delivery secondary to face mask–related fogging

Mahipal S. Sachdev, MD, Raghav Malik, MS, Gitansha Shreyas Sachdev, MS, FICO, Anagha Heroor, MS, DNB, Bharat R. Thoumungkan, MS

**Introduction:** An increase in face mask utilization has been noted during the COVID-19 pandemic. A rare complication of keratorefractive surgery where interruption of femtosecond-laser delivery was noted secondary to face-mask related fogging of the patient interface is reported.

**Patient and clinical findings:** Young patients with stable tear film and healthy ocular surface were advised femtosecond laser assisted laser in situ keratomileusis (3 eyes) and small-incision lenticule extraction (1 eye) for refractive errors. Intraoperative interruption of laser delivery was noted secondary to droplet condensation or fogging of the patient interface. The fogging developed secondary to the escape of humid exhaled breath.

**Diagnosis, intervention, and outcomes:** Incomplete delivery of the laser required aborting the procedure with retreatment at a later date. In eyes where partial laser delivery was obtained, the flap was manually dissected from the underlying stroma and the procedure was completed in the same sitting. All eyes achieved a final uncorrected distance visual acuity of 20/20 with no long-term sequelae.

**Conclusions:** Fogging of the patient interface is a rare complication secondary to face mask use. Sealing the top of the face mask with well-adhering micropore, readjustment of face masks, removing the mask prior to draping, and checking for droplet condensates on the interface prior to laser delivery may minimize the incidence.

JCRS Online Case Rep 2022; 10:1–3 Copyright © 2021 Published by Wolters Kluwer on behalf of ASCRS and ESCRS
area of fogging and defogging was seen inferiorly corresponding to the patients inhaled and exhaled breath (Figure 1, A and B). The femtosecond laser delivery was aborted (Video 1, available at http://links.lww.com/JC9/A352). The patient’s mask was readjusted, and a micropore was placed to prevent the exhaled air from exiting superiority. The eye was redocked with a new patient interface, and the laser was completed successfully with an uncorrected distance visual acuity (UDVA) of 20/20 at first postoperative day.

An 18-year-old female with a refractive error of −4.25 DS in both eyes was scheduled for LASIK using the Intralase (iFS 150KHz Advanced Femtosecond Laser). Although a uniform cut was obtained superiorly in both the eyes, the laser pattern was incomplete in the inferior half. A crescent blade was used to gently dissect the flap from the underlying stromal bed, followed by excimer laser delivery. Examination at postoperative day 1 revealed interface haze that subsided at 1 week with a UDVA of 20/20 in both eyes.

A 21-year-old man presented with a stable refractive error of −3.50 DS/−0.75 DC*20 and −3.50 DS/−0.50 DC*110 in the right and left eye, respectively. Small-incision lenticule extraction (SMILE) was planned. A large uncut area corresponding to attenuated femtosecond laser delivery was noted during the posterior lenticule cut (Figure 2, A), with corresponding lack of opaque bubble layer formation during the anterior lenticule cut (Figure 2, B and Video 2 available at, http://links.lww.com/JC9/A353). The procedure was aborted, and the patient underwent femtosecond laser–assisted LASIK for both eyes 3 months later and achieved a UDVA of 20/20 at first postoperative day.

**DISCUSSION**

The use of personal protective equipment, most commonly face masks along with maintenance of social distancing, remains the current protocol for prevention of COVID-19 disease transmission. Associated ocular side effects arise from outflow of exhaled warm breath, passing over the border of the mask onto the ocular surface. Resultant tear film evaporation and instability, hyperosmolarity, and a decline in the tear film turnover results in ocular surface damage and dry eye symptoms.³

Around the globe, the virus-related lockdown was followed by a slump in refractive surgical volume, especially during the second quarter of 2020. Some of the downturn was due to travel restrictions on patients and their apprehension at visiting healthcare facilities. Other factors included a huge hit on medical tourism and widespread unemployment and salary cuts, which deterred many prospective patients from pursuing refractive surgery. The overall reaction to the current pandemic has resembled the 5 stages of grief: denial, anger, bargaining, depression, and acceptance. Humankind has accepted that life must go on and has acclimatized to this new normal, including the usage of face masks. People who depend on spectacles for functional vision have had to contend with foggy lenses. This trivial but constant annoyance has motivated some of them to seek vision-correction procedures. This combined with 2 other factors have contributed to resurgence in refractive surgery since the second half of 2020: a delayed case load and a desire among patients to invest in themselves during an unpredictable time. This resurgence in laser vision-correction procedures, along with compulsion to wear face masks, has brought to light an unexpected complication.

The “Monte Carlo Simulation of Femtosecond Laser Filaments in a Foggy Medium” study stated that there are a variety of deleterious features of the atmospheric channel that may lead to serious signal fading and even the complete loss of signal altogether. In addition, absorption and scattering due to particulate matter in the atmosphere may significantly decrease the transmitted optical signal, whereas random atmospheric distortions due to optical turbulence can severely degrade the waveform quality of a signal-carrying laser beam, causing intensity fading and random signal losses at the receiver.⁴ Hence, decrease or attenuation of femtosecond laser through a foggy medium, such as a foggy patient interface, is expected. Similarly, Zhang et al. concluded that water clouds can significantly influence the propagation of a femtosecond laser pulse. Their calculation results indicate that the optical breakdown occurring in a water cloud has a considerable influence on the laser field.⁵

The patient interface of the Intralase IFS femtosecond laser consisting of a separate suction ring and an application cone is open to the external environment and, as such, vulnerable to it. Hence, escaped exhaled breath could easily seep in through the open cone and condense on the anterior surface of the patient interface lens. The laser beam passing through this fogged patient interface is thus attenuated, resulting in
uncut corneal tissue underneath. This is in contrast to SMILE wherein direct fogging of the patient interface surface results in interrupted femtosecond delivery.

In the first case, a crescent-shaped area of fogging was noted during femtosecond laser delivery with complete attenuation of the laser and corresponding uncut corneal tissue. The second patient, however, experienced partial fogging wherein a suboptimal opaque bubble layer was achieved because of decreased laser beam intensity. This required manual dissection of the flap from the stromal bed with a crescent blade and subsequent completion of the procedure. The reduced fogging in the latter case may be attributed to the use of a micropore tape used to seal the face mask, thereby reducing the amount of escaped exhaled air.

The applanating cone in SMILE is a closed system and, once applanated on the cornea and surrounding sclera with suction, is air and water tight. Patient anxiety during the procedure with subsequent hyperventilation may result in excessive exhalation. This hot humid breath on contact with the cool dehumidified air of the operating room reaches its dew point and condenses. In our case, the exhaled breath escaped through the pores of the mask and the opening of the drape sheet, condensing on the patient interface prior to corneal applanation. In addition, the fogging is not visible during the infrared light centration check.

In conclusion, use of face masks to prevent spread of COVID-19 has led to a unique set of complications in the ophthalmic operating room. Attenuation of femtosecond laser beam through foggy interfaces has scientifically been proven, and hence, all factors leading to that should be eliminated. Sealing the top of the face mask with well-adhering micropore and readjustment of face masks could be a few suggestions. In addition, the patients could be advised to remove the mask just prior to the draping procedure. However, clinicians should consider the risk of viral transmission from a patient without a mask, and a real-time polymerase chain reaction test for COVID-19 could be requested prior to the procedure. Removing masks also improves patient comfort by avoiding hypoxia and claustrophobia. The other concern with intraoperative mask wearing, during both laser refractive and intraocular surgery, could be a remote possibility of an increased risk for infection, secondary to exhaled moist breath over the operating field. The applanation cone surface should be checked for fogging or steam droplets before firing the laser and replaced if needed.

WHAT WAS KNOWN
- Face masks are presently the mainstay for prevention of disease transmission during the COVID-19 pandemic.
- Attenuation of femtosecond laser beam occurs through foggy medium.

WHAT THIS PAPER ADDS
- A rare complication of interface fogging with subsequent interruption of femtosecond laser delivery, secondary to face mask wear, is reported.
- Adjusting the masks, additional use of micropore, and replacing the fogged interface may be necessary to prevent this unique complication.

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Disclosures: None reported.

First author:
Mahipal S. Sachdev, MD
Centre For Sight, New Delhi, India