Management after two consecutive suction losses during small-incision lenticule extraction: A case report

LUANYING WEI, TIANTIAN QI, NAN LI, QIANG SHI, SHENGJIAN MI and CHENG PEI

Department of Ophthalmology, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an, Shaanxi 710061, P.R. China

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Abstract. Suction loss is a small-incision lenticule extraction (SMILE) surgery complication which may compromise postoperative visual quality. Most instances of intraoperative suction loss can be promptly remedied; however, the reports of two consecutive suction losses leading to an incomplete procedure are limited. In the present case report a 24-year-old man underwent SMILE at the General Hospital of Ningxia Medical University (Yinchuan, China); the surgery was successfully completed in the right eye, nevertheless, the left eye experienced two consecutive suction losses, resulting in incomplete treatment. At ~1.5 months post operation, the patient presented to The First Affiliated Hospital of Xi'an Jiaotong University (Xi'an, China) where the treating physicians were unaware of the exact details of the first procedure. At that time, the uncorrected distance visual acuity in the left eye was 20/400, and the corrected distance visual acuity was 20/16. Subsequently, the patient received femtosecond laser-assisted *in situ* keratomileusis surgery for the left eye. At the 1-month postoperative visit, the uncorrected distance visual acuity had improved to 20/13. The present case demonstrates that suction loss carries a certain probability (0.17-5.06%) during SMILE, with two consecutive intraoperative suction losses being even more uncommon; however, with remedial measures, favorable postoperative visual outcomes can be secured.

Introduction

Myopia is a type of refractive error marked by the elongation of the eyeball; this anatomical change causes light rays to focus in front of the retina rather than directly on it, resulting in blurred vision when viewing distant objects. Historically regarded as a harmless condition that can be easily corrected, myopia has become a notable global public health issue. Its growing severity stems from two key factors: A rise in its prevalence worldwide, which is largely attributed to increased educational pressures, prolonged near work and limited time spent outdoors, and the link between high myopia (as well as pathological myopia) and severe, vision-endangering complications such as scleral thinning, chorioretinal atrophy and tractional maculopathy (1). Both the World Health Organization and the International Myopia Institute have identified myopia as an expanding epidemic. These organizations forecast that by 2050, nearly half of the global population will be myopic, and ~10% will suffer from high myopia (2,3). Furthermore, parallel to the high incidence of myopia, astigmatism also exhibits a notable prevalence profile, with an estimated pooled prevalence of ~40% in adults across World Health Organization regions and even higher in Asia (1,4,5).

Small-incision lenticule extraction (SMILE) is a relatively new flapless laser refractive procedure for correcting myopia and myopic astigmatism, which has been clinically practiced worldwide for more than a decade (6,7). The procedure involves two main steps: First, a femtosecond laser is used to create an intrastromal lenticule (a small, lens-shaped piece of corneal tissue), and second, this lenticule is removed through a tiny corneal incision measuring 2-3 mm (8). SMILE has similar visual and refractive outcomes compared with femtosecond laser-assisted *in situ* keratomileusis (FS-LASIK) (9). This flapless approach with smaller corneal wound could reduce the risk for dry eye and improve the maintenance of the corneal biomechanical integrity (10); however, suction loss is a complication experienced during SMILE which could affect the surgery, with an incidence rate ranging from 0.17-5.06% (11).

Management strategies for suction loss include immediate re-SMILE, delayed re-SMILE and conversion to other surgical methods such as LASIK, Laser-Assisted Subepithelial Keratectomy (LASEK) or Trans-Epithelial Photorefractive Keratectomy (TPRK), among others, and the management approaches vary depending on different suction loss stages. Most of the methods yield good results and patients have a high level of satisfaction. The risk factors for suction loss comprise a larger cap diameter, higher astigmatism, anxiety-related eye movement and lack of surgical experience (12). Numerous investigations have reported the occurrence of suction loss during SMILE and the corresponding treatment measures (13,14), but to the best of our knowledge, reports on two consecutive suction losses during the operation remain limited. The present report is a case in which two consecutive

Correspondence to: Professor Qiang Shi, Department of Ophthalmology, The First Affiliated Hospital of Xi'an Jiaotong University, 277 West Yanta Road, Xi'an, Shaanxi 710061, P.R. China
E-mail: shiqiang@xjtufh.edu.cn

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suction losses occurred in one eye during SMILE surgery, resulting in an incomplete operation. Notably, the patient subsequently underwent elective FS-LASIK surgery where the treating physicians were unaware of the exact details of first procedure, and favorable visual acuity outcomes were finally achieved.

Case report

The present report describes the case of a 24-year-old man who underwent SMILE at General Hospital of Ningxia Medical University (Yinchuan, China) in January 2025. The surgery was successfully completed in the right eye, however, the left eye experienced two consecutive suction losses, resulting in incomplete treatment. At ~1.5 months post operation, in March 2025, the patient presented at The First Affiliated Hospital of Xi'an Jiaotong University (Xi'an, China) for a pre-employment medical examination. At that time, except for the preoperative examination records prior to the first SMILE surgery that the patient had brought with him, no records regarding the specific design parameters and detailed procedures of the previous SMILE surgery were received. However, the patient was eager to complete the pre-employment medical examination to avoid affecting his job application, so we directly performed preoperative examinations on him.

Ophthalmic examination findings included: the uncorrected distance visual acuity (UDVA), right eye 20/20 and left eye 20/400; corrected distance visual acuity, left eye 20/16; and intraocular pressure, right eye 13.3 and left eye 21.3 mmHg. The bilateral eyelid opening and closing were normal, without congestion or edema. In addition, the upper and lower lacrimal puncta were properly positioned, with no secretion reflux observed upon lacrimal sac compression, and lacrimal duct irrigation was unobstructed. The tear break-up time was 6 sec, there was no congestion or edema and both corneas were transparent, with no keratic precipitates. The surgical incisions were visible, without epithelial ingrowth or corneal haze. The sclera had no icterus and the anterior chamber was moderately deep with clear aqueous humor; the iris texture was clear, without iridodonesis or anterior/posterior synechiae; and the bilateral pupils were round, equal in size (3 mm in diameter), with brisk direct light reflexes. The lens was properly positioned and transparent and the vitreous showed mild liquefaction. Furthermore, at the fundus the bilateral optic discs had clear margins and a pale red color (cup-to-disc ratio=0.2); macular light reflex was present, leopard spot fundus was observed and the retina was flat without obvious abnormalities. The patient had no reported history of ocular trauma or systemic diseases such as diabetes, heart disease or hypertension. The patient disclosed that he underwent bilateral SMILE surgery at a local hospital 1.5 months previously; the right eye surgery was uneventful with satisfactory postoperative recovery, whereas the left eye surgery was terminated prematurely due to intraoperative suction loss. No other ocular complications were identified preoperatively.

Corneal topography system Sirius (software version phoenix.1; Costruzione Strumenti Oftalmici Srl) showed the left eye had a thinnest corneal thickness of 511 μm, flat keratometry of 43.4 diopter (D) and steep keratometry of 44.1 D. Anterior segment optical coherence tomography (AS-OCT; Optovue, Inc.) revealed a corneal cap thickness of 136 μm in the left eye from the previous SMILE surgery (Fig. 1).

Based on these preoperative examination results, FS-LASIK was designed for the left eye of the patient, with a flap thickness of 105 μm, a flap diameter of 8.6 mm and a customized Q-value of -0.24. The patient was admitted to the present hospital in March 2025, and the FS-LASIK-Q operation proceeded after 1 day with no complications; the UDVA was 20/20. The last follow-up was performed at the 1-month postoperative visit in April 2025; at that time, the UDVA was 20/13, the flat keratometry was 39.8 D and steep keratometry was 40.0 D, the cornea was transparent and the incision was well-healed. No complications were observed, and the patient remained in a stable condition with satisfactory surgical outcomes.

At ~2 weeks after the FS-LASIK-Q operation, the videos of the first SMILE surgery of the patient were received from the local hospital and were analyzed to gain experience. During the first suction loss, a small part of the bulbar conjunctiva in the upper area could be observed entering the negative pressure area when establishing negative pressure before laser scanning (Fig. 2A). Subsequently, during the cutting of the lens edge, there was a slight upward displacement (<0.3 mm) of the eye position (Fig. 2B). At the instant before suction loss during cap cutting, the center of the cap was separated from the center of the lens and the eye position shifted upward ~1 mm (Fig. 2C). These sequential positional deviations disrupted the alignment between the laser scanning trajectory and the predesigned surgical zone, which directly contributed to the progressive first suction loss that occurred when 90% of the cap scanning was completed, and the range was approaching to cover the lens. The bubbles dispersed to the limbus within the upper one-third range of the cornea at that time, which turned the cornea white (Fig. 2D). Consequently, the surgeons decided to continue with SMILE without making any modifications to the original treatment plan and re-establish negative pressure for cap scanning.

When establishing negative pressure for the second time and before conducting laser scanning, the cutting line of the lens edge could be observed, the upper peripheral corneal area was in a state of bubble dispersion and the bulbar conjunctiva in the upper part entered the negative pressure surface (Fig. 3A). Then the surgeon restarted cap scanning, the center of the cap basically coincided with that of the lens, everything went smoothly until the cap scanning was completed; however, when making the cap incision, the eye position started to move upward again (Fig. 3B). Therefore, the scanning of the cap incision was carried out during the displacement, and in the end the cap incision was not completed, it was in a misaligned position (Fig. 3C). Later the surgeons attempted to separate the incision manually, but it was unsuccessful. Due to the dispersed bubbles above the cornea affecting the surgeon's observation of the scanning status and completion degree of the cap incision, the surgeon did not try to make a mechanical incision.

Discussion

In the present case, the reasons why the patient suffered two consecutive suction losses and the SMILE surgery was

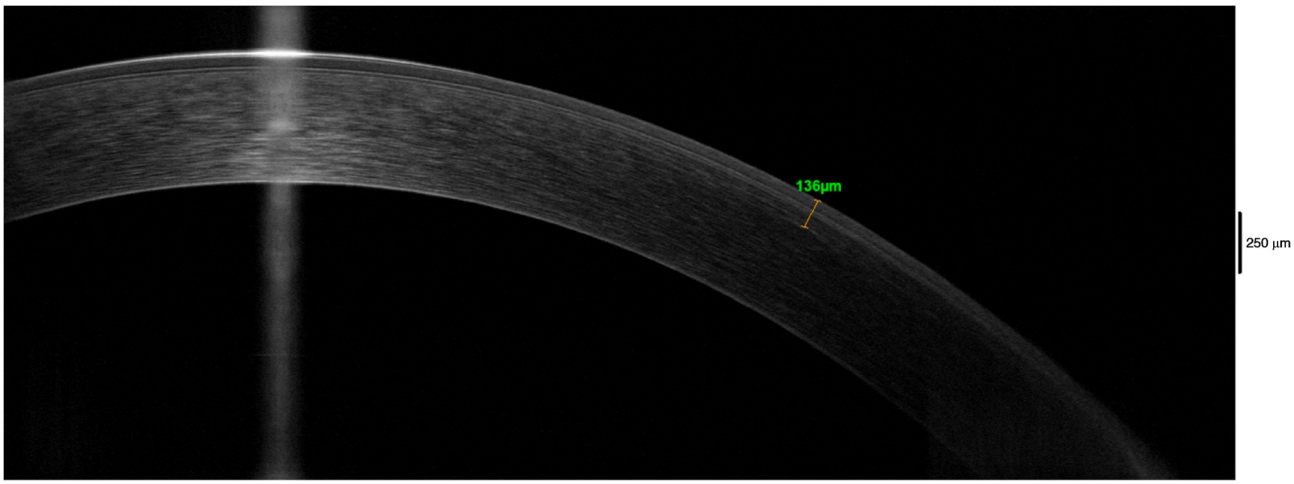

Figure 1. Cap thickness of the left eye after SMILE measured by anterior segment optical coherence tomography. 'Cap' refers to the thin corneal tissue layer retained post-lenticule removal in SMILE. SMILE, small-incision lenticule extraction.

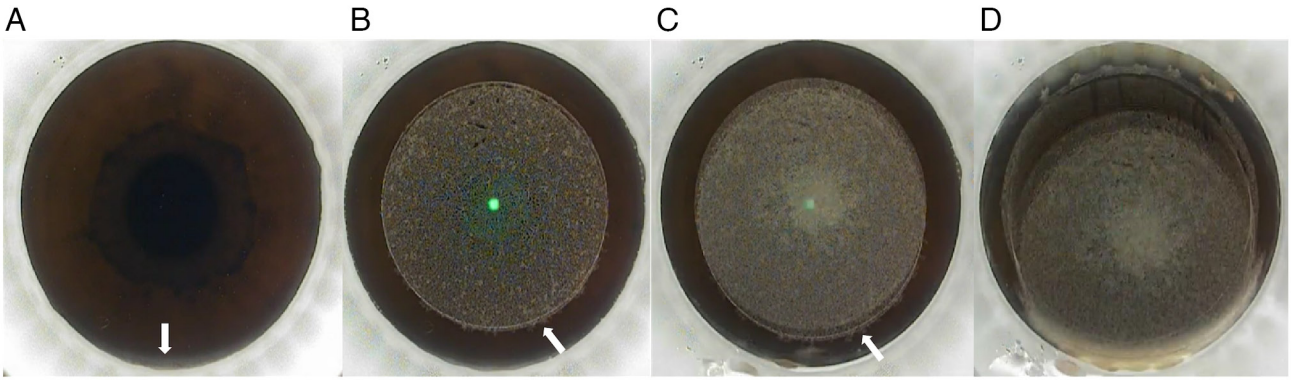

Figure 2. Intraoperative images for the first suction losses during SMILE surgery on the left eye. All images are presented from the perspective of the surgeon and appear upside down (a common presentation of surgical microscopic views). (A) A small part of the bulbar conjunctiva (white arrow; the bulbar conjunctiva is a thin, transparent membrane covering the outer surface of the eyeball). (B) A slight upward displacement (<0.3 mm) of the eye position (white arrow; eye position displacement refers to the slight movement of the eyeball from its ideal surgical position during the operation). (C) The eye position shifted upward ~1 mm (white arrow). (D) The progressive first suction loss occurred (suction loss refers to a condition in SMILE surgery where the surgical suction ring loses stable adherence to the eye, which may affect the subsequent surgical steps). SMILE, small-incision lenticule extraction.

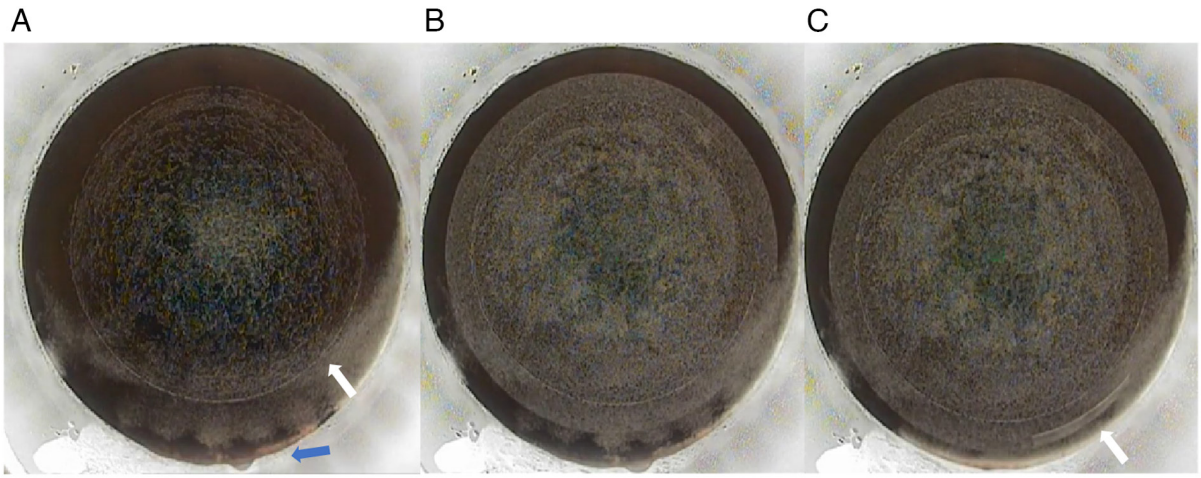

Figure 3. Intraoperative images for the second suction losses during SMILE surgery on the left eye. All images are presented from the perspective of the surgeon and appear upside down. (A) The cutting line of the lens edge (white arrow; the lenticule is a small, lens-shaped corneal tissue fragment removed during SMILE surgery) and the presence of bubble dispersion plus bulbar conjunctiva (blue arrow; bubble dispersion refers to the scattered distribution of small air bubbles generated during the surgical process). (B) The cap scanning was completed. (C) The cap incision was incomplete with a misaligned manner (white arrow; misaligned incision means the surgical incision for opening the corneal cap does not match the preset path, resulting in incomplete incision). SMILE, small-incision lenticule extraction.

incomplete mainly include three aspects: First, anxiety-related eye movement, where the patient showed uncontrolled upward eyeball rotation; second, the patient had a small corneal longitudinal diameter, with conjunctivalization of the superior corneal limbus, which caused the negative suction unstable; and third, due to the lack of surgical experience, the surgeon did not choose to make a manual cap incision after the failure of creating a cap incision during the second suction loss.

When the process and outcome of the first SMILE surgery remain unknown, some preoperative preparations are required for designing the second surgery; for example, the visual acuity, intraocular pressure, ocular axis, computerized optometry, corneal thickness and corneal topography parameters. This can be measured using AS-OCT to assess the thickness of epithelial, cap and lenticule and using a slit lamp microscope to exam the status of the cornea and other ocular surface structures are necessary.

There are three appropriate elective surgical approaches after the suction losses in this case to consider. First, for FS-LASIK, it is necessary to precisely design the corneal flap thickness and diameter, ensuring the flap thickness is thinner than the corneal cap depth from the initial SMILE surgery and does not overlap with the first laser scan to avoid misalignment. The second approach is LASEK or TPRK; the advantage of this choice is that there is no risk of misalignment. However, the complications include slow recovery, infections, pain and corneal haze (15,16). The third approach is making a manual cap incision. If the status of cap thickness, diameter and incision completion degree are clear, this choice is recommended. This recommendation is based on the fact that manual incision is consistent with the original surgical procedure of SMILE, eliminating the need for switching to an alternative surgical plan. More importantly, it aligns with the core feature of SMILE surgery-no corneal flap creation- and thus minimizes corneal damage; however, there is still a risk of failing to remove the lenticule, which comprises the following circumstances: i) Failure to identify the upper and lower layers of the lenticule; ii) incomplete lenticule dissection due to progressive displacement; and iii) inconsistency between the location and depth of the incision. Furthermore, the surgical timing needs to be considered; if elective FS-LASIK, LASEK or TPRK is selected, preoperative re-evaluation is required. The elective surgery can be performed only when parameters such as corneal morphology and refractive power are consistent with those examination results before the first SMILE surgery. If a cap incision is manually created to remove the lenticule, surgical intervention should be performed as soon as possible.

Ultimately, the present team decided to perform FS-LASIK taking into consideration the overall circumstances, and the details were as follows: On the one hand, the specific eye condition after SMILE was unclear before the operation videos were received, particularly the status of the laser scanning during the aspiration process. On the other hand, the preoperative examination results cannot show exact lens and cap scanning lines and their thickness. To ensure safety as well as considering the patient's need for rapid visual recovery, FS-LASIK was selected as the surgical approach in the end. Furthermore, there are some key points for intraoperative procedures: First, the central alignment should be precise; second, the patient should be reassured to alleviate anxiety and pre-operative fixation training should be conducted to improve cooperation; third, it is necessary to design a thinner flap to prevent layer misalignment; and finally, the corneal flap should be dissected gently and slowly to avoid involving the underlying completed lenticule.

The present study has some limitations: i) The present study is a single-case report with a small sample size, and the generalizability of the research conclusions needs to be further verified by multi-center studies with large sample sizes; and ii) the follow-up period is relatively short, and the long-term efficacy (such as corneal stability >1 year after surgery) still requires extended follow-up for further observation. In response to the aforementioned limitations, it is the plan to perform multi-center retrospective studies in the future and to expand the sample size and extend the follow-up period, to provide more sufficient clinical evidence for the management of intraoperative suction loss during SMILE surgery.

In conclusion, the present case demonstrates that suction loss carries a certain probability (0.17-5.06%) during SMILE, with two consecutive intraoperative suction losses being even more uncommon. However, with remedial measures, favorable postoperative visual outcomes can be secured.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

LW, QS and CP designed the study and coordinated the clinical evaluation. TQ, QS and SM participated in the diagnosis and treatment of the patient. LW, TQ, NL and QS were responsible for data collection and clinical evaluation of corneal conditions before and after surgery. All authors contributed to the analysis and interpretation of the laboratory and imaging data and participated in the writing of the original draft and figure preparation. QS, SM and CP supervised the study. LW and TQ critically reviewed and revised the manuscript. SM and CP confirm the authenticity of all the raw data. All authors have read and approved the final version of the manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Competing interests

The authors declare that they have no competing interests.

Use of artificial intelligence tools

During the preparation of this work, artificial intelligence tool Doubao (ByteDance, Version 11.9.1, based on Doubao-Seed-1.8) was used to improve the readability and language of the manuscript, and subsequently, the authors revised and edited the content produced by Doubao as necessary, taking full responsibility for the ultimate content of the present manuscript.

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