

“Ridge Sign” to Identify Anterior-Posterior Plane in Small-Incision Lenticule Extraction

Tushya Om Parkash, Rohit Om Parkash, Sehar Om Parkash

Department of Refractive Surgery, Dr Om Parkash Eye Institute, Amritsar, India

Correspondence: Tushya Om Parkash, Email tushya@aol.in



Purpose: To describe the “Ridge Sign” as a conclusive indicator for differentiating the anterior and posterior lenticular planes in Small Incision Lenticule Extraction (SMILE).

Methods: Femtosecond laser application for SMILE was performed. Anterior and posterior planes were dissected. “Ridge sign” was elucidated prior to proceeding with the final dissection of the anterior plane.

Our sign helps to identify anterior and posterior lenticular planes in SMILE. This sign describes a lenticular ridge noted at the junction between the dissected and undissected halves of both planes. This ridge is formed as the lenticule is attached to the cap on one side and to the stromal bed on the other side. Here, the cap is lifted with the blunt dissector’s arm at the junction of the anterior and posterior dissected planes prior to the final dissection of the anterior plane. This maneuver enhances the visibility of the ridge sign and confirms correct initial anterior plane dissection, thereby preventing inadvertent cap lenticular adhesion.

Results: In our study, 400 eyes undergoing SMILE procedures using the VisuMax femtosecond laser were included. In 96% of cases, the cap interface was separated first with ridge sign observed in all. In 4% of cases with wrong initial separation of the lenticule interface, the ridge sign was absent. Successful lenticule extraction was achieved in 100% of cases.

Conclusion: This confirmatory sign helps to dissect the anterior plane ahead of the posterior plane, thereby ensuring smooth lenticule extraction and preventing inadvertent cap lenticular adhesion, lenticule tears, or partial lenticular dissection.

Keywords: SMILE, lenticule dissection, cap lenticular adhesion

Introduction

Small-Incision Lenticule Extraction (SMILE), a flapless and minimally invasive form of laser vision correction, is used to correct myopia, including astigmatism. SMILE is comparable to femtosecond laser-assisted in situ keratomileusis in terms of safety, efficacy, and predictability.¹ Moreover, it offers better ocular surface stability, biomechanical strength, and a lower induction rate of spherical aberration.²

In the realm of refractive surgery, SMILE has emerged as a revolutionary technique, offering patients promising visual outcomes with minimal invasiveness. However, challenges persist in accurately identifying tissue planes, notably the anterior (cap) interface, which poses difficulties even for experienced surgeons, particularly during the learning curve. Unintended posterior plane dissections and subsequent lenticule retrieval attempts present significant complications, including cap incision tear or avulsion, retention of residual lenticular fragments, and the formation of false passages. Addressing these challenges is imperative for optimizing surgical safety and efficacy in SMILE procedures. We introduce a novel technique for correct tissue plane identification in SMILE.

Patients and Methods

Inclusion criteria for the study involved individuals with spherical myopia up to −10 D and myopic astigmatism up to 5 D cyl. Additionally, participants needed to be at least 18 years old, have a corrected distance visual acuity (CDVA) of ≥ 6/7.5, and not have any ocular conditions besides myopia. Exclusion criteria for the SMILE procedure comprised unstable refraction, topographic evidence of forme fruste keratoconus, significant ocular diseases, prior corneal surgery,

autoimmune diseases or medications affecting wound healing, and pregnant or lactating patients. Furthermore, the central corneal thickness as determined by OCULUS Pentacam (OCULUS, Germany) needed to be more than 500 μm , with the calculated residual stromal bed post-treatment being greater than 290 μm . Confirmation of a regular topographic pattern was conducted using the OCULUS Pentacam.

Surgical Technique

Ethical clearance was obtained from the institutional review board, and the study conformed to the tenets of the Declaration of Helsinki. Written informed consent was obtained from all patients.

In our study, the femtosecond laser (Visumax 500; Carl Zeiss Meditec) energy settings were 145–150 nJ, and the parameters were set according to the patient's refractive error. The surgeons' preferences for an anterior cap depth of 120 μm , a side-cut width of 2–3.5 mm, and an optical zone of 6.0–6.5 mm optical zone were selected. A 1 mm transition zone was added for astigmatic treatment. As the operating surgeon gained experience, the size of the side cut on the cap was methodically reduced from 3.5 mm to 2 mm.

Suction was activated and femtosecond laser small-incision lenticule extraction was completed. We observed a double ring, where the outer ring corresponded to the cap cut, and the inner ring corresponded to the lenticule cut. The hooked end of the dissector was used to open the cap-side cut. Thereafter, the dissector was used to delineate the anterior dissection plane anterior to the lenticule on one side of the side-cut for small anterior pocket creation, followed by delineation of the posterior dissection plane posterior to the lenticule on the other side of the side-cut for posterior pocket creation.

At this point in time, the creation of the two pockets was confirmed by the ridge sign. (Figure 1a and b). Our ridge sign was visualized in the form of a sloping and hanging ridge attached to the cap on one side and the stromal bed on the opposite side. Subsequently, we inserted the blunt dissector in the anterior dissection plane so that the arm of the instrument was at the junction of the dissected and undissected halves of both planes. The visualization of the sign was enhanced when the arm of the instrument was gently nudged anteriorly at the junction of the dissected and undissected halves, thus enabling a clearer view of the sloping and hanging lenticular ridge attached to the cap on one side and the stromal bed on the other side.

Following confirmation of anterior lenticular plane entry by a blunt dissector, the anterior plane was dissected. The posterior plane was dissected through the posterior channel. Dissection was completed and the lenticule was removed using microforceps.

Follow-up appointments were scheduled for 1 day, 1 week, and 1 month postoperatively. The postoperative care regimen included administering preservative-free moxifloxacin dexamethasone, and sodium hyaluronate lubricating drops four times daily each for 1 week, followed by the use of only lubricating drops as needed for up to 3 months.

Results

A total of 400 SMILE procedures were performed between January 2021 to August 2023 of which the cap interface was separated first in 384 eyes (96%) and the lenticule interface was separated first in 16 eyes (4%). The Ridge sign was seen in 96% of cases where the cap interface was separated first and it was absent in 4% of cases. The absence of ridge sign



Figure 1 (a) Ridge Sign, (white arrow). (b) Ridge Sign, (white arrow) in an animated image.

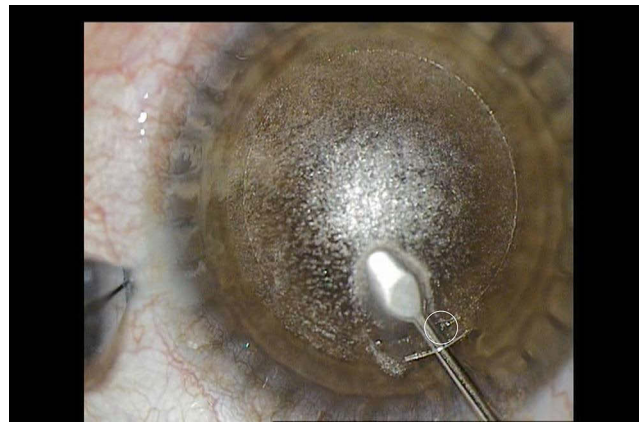


Figure 2 Ridge sign observed in a 2 mm cap side-cut incision.

indicated inadvertent initial entry into the posterior plane, with the lenticule attached to the cap. The entry into the posterior plane was terminated at the initial step itself. The anterior plane was dissected in the non-dissected part of the lenticule. Following similar confirmation of the ridge sign at the new junction of the dissected and non-dissected halves of both planes, the anterior plane dissection was carried out and the posterior plane was dissected through the posterior channel. Dissection was completed and lenticule was removed.

All surgeries were performed by one surgeon. The ability to recognize the presence or absence of the ridge sign was independent of the size of the side cut (Figure 2). Successful lenticule extraction was achieved in 100% of cases.

Discussion

In the early learning stages of the procedure, misdissection of the lenticule often arises as the predominant complication, characterized by the premature dissection of the posterior plane.

There are a few signs which help to identify appropriate dissection of the anterior and posterior planes. Shetty et al described the “shimmer sign”, observed as a distinct shining reflection around the instrument, which helps detect inadvertent posterior plane dissection only.³

Jacob et al described the “White Ring Sign”, which determines the plane of dissection based on the anteroposterior positioning of the dissecting instrument relative to the circular white light reflected from the lenticular side cut. A white ring appearing anterior to the instrument confirms posterior plane dissection, while a white ring obscured by the instrument’s shaft along its circumference signifies anterior plane dissection. The “white ring”, a visual guide for anterior and posterior plane dissection, cannot be appreciated when the opaque bubble layer (OBL) is insufficient or the lenticule is thin.⁴

Titiyal et al described the “Meniscus Sign”, characterized by a meniscus-shaped gap formed by pushing the lenticule away from the cap side-cut, indicating successful separation of the lenticule from the surrounding stroma. This creates a frilled appearance along the lenticule edge, making it more distinct and easier to identify. This technique proves particularly valuable for identifying the lenticule edge, a crucial step in preventing misdissection, especially for novice practitioners.⁵ However, appreciation of a transparent lenticule is challenging and requires skillful instrument maneuvering.

Sachdev et al described the “Stop Sign”, which distinguishes anterior and posterior planes through a resistance felt at the junction of the dissected and undissected halves of both planes.⁶

We present an easily identifiable “Ridge Sign” for confirming the correct dissection of the anterior and posterior lenticular planes prior to the final dissection of the anterior lenticular plane. Our sign is observed as a sloping and hanging ridge attached to the cap on one side and the stroma on the other side when the cap is gently lifted by the arm of the blunt dissector at the junction of the dissected and undissected halves of both planes. However, the Meniscus Sign is differently observed as a gap between the lenticular edge and the inner ring when the dissector enters the posterior plane. The Meniscus Sign is typically absent during anterior plane dissection and becomes prominent during posterior dissection.⁵ Furthermore, with initial inadvertent posterior

dissection, the Meniscus Sign is visible, while the Ridge Sign is absent, signaling that the anterior dissection has not yet been initiated, with the lenticule attached to the cap.

The absence of the Ridge Sign following repeated dissections indicates that surgery should be aborted to avoid inadvertent cap-lenticular adhesions. Its presence or absence guides the surgeon to continue, redissect, or abort. Our simple and user-friendly technique is useful in challenging situations. The Ridge Sign continues to be visible even after OBL disappearance and in the presence of liquid in the interface. Using this sign, a novice surgeon can easily identify the correct dissection plane.

Ridge Sign introduces a different approach to identifying correct plane dissection, specifically anterior plane dissection prior to posterior. The Stop Sign is the resistance felt during lateral movement at the junction between the dissected and undissected halves of both planes, whereas the Ridge Sign is a visualized slanting ridge stretching from the overlying cap to the underlying stroma at the same junction.

In conclusion, the “Ridge Sign” helps surgeons decide whether to continue or re-dissect the anterior and posterior lenticular planes before proceeding with the final cap and lenticule separation. It helps ascertain correct dissection, thereby making lenticule extraction safer.

Acknowledgment

1. Presented as a free paper at the American Society of Cataract and Refractive Surgery conference, 2023, San Diego.
2. Presented as a free paper at the Asia Pacific Association of Cataract and Refractive Surgery conference, 2023, Singapore.
3. Presented as an E-poster at the European Society of Cataract and Refractive Surgery conference, 2023, Vienna.

Ethics and Consent

The Ethics Committee of Dr. Om Parkash Eye Institute approved the study before its initiation. The patient’s written informed consent was obtained, and the tenets of the Declaration of Helsinki were followed.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Ganesh S, Brar S, Arra RR. Refractive lenticule extraction small incision lenticule extraction: a new refractive surgery paradigm. *Indian J Ophthalmol*. 2018;66(1):10–19. doi:10.4103/ijo.IJO_761_17
2. Sekundo W, Kunert KS, Blum M. Small incision corneal refractive surgery using small incision lenticule extraction (SMILE) procedure for the correction of myopia and myopic astigmatism: results of a 6-month prospective study. *Br J Ophthalmol*. 2011;95:335–9. doi:10.1136/bjo.2009.174284
3. Shetty R, Negalur N, Shroff R, Deshpande K, Jayadev C. Cap lenticular adhesion during small incision lenticular extraction surgery: causative factors and outcomes. *Asia Pac J Ophthalmol*. 2017;6(3):233–237.
4. Jacob S, Nariani A, Figus M, Agarwal A, Agarwal A. White ring sign for uneventful lenticule separation in small-incision lenticule extraction. *J Cataract Refract Surg*. 2016;42(9):1251–1254. doi:10.1016/j.jcrs.2016.07.018
5. Titiyal JS, Kaur M, Brar AS, Falera R. “Meniscus sign” to identify the lenticule edge in small-incision lenticule extraction. *Cornea*. 2018;37(6):799–801. doi:10.1097/ICO.0000000000001538
6. Sachdev GS, Ramamurthy S, Dandapani R. Stop sign for correct tissue plane identification in small incision lenticule extraction. *Indian J Ophthalmol*. 2020;68(5):895–896. doi:10.4103/ijo.IJO_1264_19

Clinical Ophthalmology

Dovepress

Publish your work in this journal

Clinical Ophthalmology is an international, peer-reviewed journal covering all subspecialties within ophthalmology. Key topics include: Optometry; Visual science; Pharmacology and drug therapy in eye diseases; Basic Sciences; Primary and Secondary eye care; Patient Safety and Quality of Care Improvements. This journal is indexed on PubMed Central and CAS, and is the official journal of The Society of Clinical Ophthalmology (SCO). The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/clinical-ophthalmology-journal>