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A Novel Percutaneous Surgical Approach Using Silicone Sheets for Lower Eyelid Lengthening: A Descriptive Case Series

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Background: Lower eyelid lengthening is essential to correct eyelid retraction and preserve ocular surface integrity. We evaluated the efficacy of a novel percutaneous surgical technique that utilizes a silicone sheet to elongate the lower eyelids to minimize ocular surface inflammation and corneal damage.

Methods: This case series included 15 patients (22 eyelids) with lower eyelid retraction who underwent a novel silicone-sheet-based lower eyelid elongation surgery by the same surgeon and completed at least 3 months of follow-up that involved consistent methods (ie, slit-lamp examination) between November 2014 and November 2023. Corneal epithelial damage and changes in the margin reflex distance-2 were measured preoperatively and postoperatively. Ocular surface discharge and foreign body sensation were assessed in patient interviews within the first postoperative week.

Results: During a mean postoperative follow-up of 31.9 months, the mean margin reflex distance-2 decreased from 7.17 to 5.89 mm. No recurrence or complications were observed. In all cases, superficial punctate keratopathy diminished within the first postoperative week and resolved within 1 month. Ocular discharge and foreign body sensation significantly decreased within a few days after surgery.

Conclusions: A novel surgical technique using silicone-sheet spacers for lower eyelid elongation showed promising results in reducing ocular surface damage and improving patient outcomes. Despite its potential benefits over traditional methods, further large-scale, multicenter studies, including clinical trials, with diverse study populations are needed to generate robust data to validate and expand the applicability of this technique for managing lower eyelid retraction, particularly when involving eyelash contact with the ocular surface. *(Plast Reconstr Surg Glob Open 2025;13:e6629; doi: 10.1097/GOX.0000000000006629; Published online 17 March 2025.)*

INTRODUCTION

The typical position of the lower eyelid margin is near the lower limbus.[1] Lower eyelid retraction is diagnosed when the lower eyelid margin shifts and exposes the inferior bulbar conjunctiva in the primary eye position,[1] and frequently results in eyelash contact with the ocular surface that potentially causes corneal and conjunctival damage,[1–3] exacerbates ocular complications, and necessitates treatment.[4] Among the various causes of lower eyelid retraction, the relative deficiency of the posterior lamella compared with the anterior lamella is a concerning issue.[2] This anatomical imbalance leads to complications such as dry eye, corneal epithelial disorders, and corneal ulcers.[1,2] Although conservative treatments (eg, artificial tear drops) may suffice for mild ocular complications, surgical intervention is necessary in severe cases.[1]

Surgical lower eyelid lengthening, which traditionally involved a transconjunctival approach for horizontal

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incisions of the palpebral conjunctiva and replacement of the deficient posterior lamella with a spacer,[5] is frequently associated with challenges in fully restoring the structural and epithelial integrity of the affected area.[6,7] Issues pertaining to early postoperative patient satisfaction often limit the perceived treatment success of traditional methods.[5,8] To address these limitations, we introduced a novel percutaneous surgical technique that preserves the palpebral conjunctiva and ensures clinical effectiveness and patient satisfaction. This innovative method was developed with the objective to maintain ocular surface homeostasis and promote a conducive environment for recovery, and thereby effectively address the gaps in the current surgical treatments.

In this study, we aimed to assess the efficacy and safety of this novel percutaneous surgical technique for lower eyelid lengthening, with a particular focus on its ability to minimize ocular surface inflammation and improve corneal health.

Takeaways

Question: Can we overcome the limitations of traditional methods for lower eyelid retraction using a novel percutaneous surgical technique involving using silicone sheets?

Findings: The new technique demonstrated substantial improvement in ocular surface health and corneal condition in a case series of 22 eyelids. Superficial punctate keratopathy improved in all cases within 1 week and resolved by 1 month. Lower eyelid position improved as confirmed by margin reflex distance-2 measurements.

Meaning: The percutaneous approach using silicone sheets showed promising outcomes and high patient satisfaction for lower eyelid retraction treatment. Further studies are needed to confirm these findings.

PATIENTS AND METHODS

This descriptive case series included 22 eyelids of 15 patients with lower eyelid retraction, which was characterized by eyelash contact with the cornea and was conducted at the MIE Eye Clinic in Yokkaichi, Japan, in accordance with the Declaration of Helsinki. This study was approved by the institutional review board of the MIE Eye Clinic, and written informed consent was obtained from all participants. (**See table, Supplemental Digital Content 1**, which shows the adherence of this case series to the PROCESS guideline, **http://links.lww.com/PRSGO/D924**.)

Study Design and Participants

In this descriptive case series, we assessed the clinical outcomes of our novel surgical technique in patients with lower eyelid retraction.

The inclusion criteria were as follows: lower eyelid retraction characterized by eyelash contact with the cornea, need for surgical intervention, and provision of informed consent with willingness to participate in follow-up assessments.

The exclusion criteria were as follows: a history of eyelid surgery that involved manipulation of the palpebral conjunctiva, which could affect the outcomes of the current procedure; severe systemic diseases that could interfere with surgical outcomes; pregnancy; lactation; or a known allergy to silicone.

Data Collection and Analysis

Data collection, analysis, and interpretation were conducted collaboratively by all the co-authors, including the lead author. Data on patient demographics (age and sex), clinical history, surgical details, and postoperative outcomes were obtained from electronic medical records. Experienced ophthalmologists performed follow-up assessments using a slit-lamp microscope.

Corneal epithelial damage was quantified using the area classification specified in AD grading system by Miyata et al[9] that was applied to a superficial punctate keratopathy grading system with fluorescein staining with the following scores: 0 points, absence of punctate fluorescein staining; 1 point, punctate fluorescein staining covering less than one-third of the entire corneal area; 2 points, staining covering one- to two-thirds of the corneal area; and 3 points, staining covering more than two-thirds of the corneal area. These evaluations were performed at 1 week, 1 month, and 3 months postoperatively to provide a detailed measure of corneal health over time.

Ocular discharge and foreign body sensations were assessed postoperatively and differentiated between secretions and residual eye ointment. Changes in the margin reflex distance-2 (MRD2) were assessed by measuring the corneal diameter and MRD2 in the primary eye position using digital photographs captured preoperatively and postoperatively. These measurements were subsequently normalized to the average corneal diameter of Japanese individuals (12.0 mm).[10,11] In cases where the lower eyelid margin was obscured by the skin, photographs were taken with the lower eyelid skin retracted downward to ensure minimal interference with the measurement of the lower eyelid margin.

Surgical Technique

Using local anesthesia (lidocaine 2% solution with adrenaline 1:80,000; xylocaine with adrenaline; AstraZeneca, London, United Kingdom) and a surgical microscope (OPMI PROergo; Carl Zeiss, Oberkochen, Germany) at 4× magnification, the surgical procedures were performed by a single surgeon (S.K.). A horizontal incision was delineated on the eyelid margin and positioned approximately 3 mm below the eyelashes using a surgical marker. After instilling topical anesthetic eye drops, local anesthesia was administered to the conjunctival side and thereafter to the skin side. Following skin incision, the anterior layer of the lower eyelid retractors (LERs)[12] was excised from the tarsal plate to expose the anterior surface. Next, the palpebral conjunctiva and posterior layer of the LERs[12] were meticulously dissected from the lower edge of the tarsal plate. To achieve complete detachment and separation of the posterior layer of the LERs from the palpebral conjunctivae, dissection was

performed within the confines of the eyelid clamps, which were subsequently removed. After hemostasis, the orbital septum was incised, and the anterior layer of the LERs was expanded. A 1-mm-thick silicone sheet was trimmed to match the dimensions of the peeled palpebral conjunctiva and inserted to achieve adequate vertical elongation of the dissected conjunctiva. (**See figure, Supplemental Digital Content 2,** which shows the silicone sheet used in the procedures and includes photographs of the silicone sheets, showing their original form [left] and a demonstration of their pliability [right], **http://links.lww.com/PRSGO/D925**.) To ensure sufficient lengthening of the posterior lamella and assess the alignment of the lower eyelid, the patient was positioned upright in a seated posture. Lower eyelid eversion or the presence of a noticeable separation between the lower eyelid and the ocular surface indicated an oversized silicone sheet, and this necessitated incremental trimming and reassessment of the alignment in the seated position after each adjustment. Proper alignment of the lower eyelid to the globe, without eversion or separation, signified sufficient lengthening of the posterior lamella with an appropriately sized silicone sheet. Next, the silicone sheet and the posterior layer of LERs were secured with sutures using 6-0 PROLENE (product no. EP8805H; Ethicon, Somerville, NJ), the wound encompassing the silicone sheet was irrigated with 50 mL physiological saline, and the silicone sheet was sutured firmly to the lower edge of the tarsal plate. Using 7-0 polyglycolic acid (product no. 2091; MANI, Tochigi, Japan) sutures, the anterior layer of the LERs was fixed to the anterior surface of the tarsal plate adjacent to its lower edge, and the absence of entropion was confirmed by asking the patient to blink in a sitting position. Subsequently, the orbicularis oculi muscle on the eyelash side and anterior layer of the LERs were fixed using 7-0 polyglycolic acid sutures. Epidermal closure was performed using an 8-0 nylon thread (product no. 2056; MANI). An ofloxacin ophthalmic ointment Tarivid ophthalmic ointment; Santen Pharmaceutical, Osaka, Japan) was applied, followed by a compression eye patch that was removed the following day. Patients were instructed to apply the ointment to the incision 3 times daily for the first postoperative week until suture removal. An algorithm of the procedural steps is shown in Figure 1, with a schematic in Figure 2. (**See Video 1 [online],** which demonstrates the dissection of the palpebral conjunctiva and posterior LER layer from the lower edge of the tarsal plate, followed by orbital septum incision and anterior LER expansion.) (**See Video 2 [online]**, which demonstrates the process in which the silicone sheet is fully covered by the LERs.)

Outcome Assessment

The primary outcomes of this study included MRD2-based quantitative improvement in the lower eyelid position, fluorescein staining-based quantitative assessments (using a grading scale) of corneal epithelial damage, and patient satisfaction (patient-reported outcomes) to evaluate the effectiveness of the surgical technique in treating lower eyelid retraction and maintaining ocular surface integrity.

Statistical Analysis

A paired *t* test was used to compare the preoperative and postoperative MRD2 values, with significance set at a *P* value less than 0.05. Analyses were performed using R software (version 4.3.0; R Core Team, Vienna, Austria), which provided a robust statistical evaluation and graphical representation.

Although a formal sample size calculation was not performed for this exploratory case series, the sample size of 22 eyelids aligns with the interquartile range (12–35 eyelids)[5] reported in previous studies, and supports the adequacy of the preliminary insights. Complete case analysis was performed for missing data, after excluding incomplete datasets, and this approach ensured that only cases with completeness of data were included in the analysis. This statistical approach supported the observational data with robust evidence to enhancing the validity of the results.

RESULTS

In this cohort of 15 patients (6 men and 9 women; age, mean ± SD, 51.9 ± 26.7 [range 16–85] y), the etiologies of lower eyelid retraction included inflammation-induced contracture (6 patients, 8 eyelids), congenital causes (3 patients, 5 eyelids),[1,2] prostaglandin-associated periorbitopathy (2 patients, 3 eyelids),[13] postoperative lower blepharoplasty (2 patients, 2 eyelids),[14] and thyroid ophthalmopathy (2 patients, 4 eyelids). Notably, no patient showed symptoms of pemphigoid. The average postoperative follow-up duration was 31.9 ± 26.9 months, and no hematoma, silicone sheet prolapse, or surgical site infection occurred. No eyelash contact with the ocular surface was noted during follow-up. The mean MRD2 decreased significantly from 7.17 ± 0.85 mm (preoperative) to 5.89 ± 0.58 mm (postoperative; $t[21] = 6.50$, $P < 0.001$). Mean lower eyelid elevation was 1.29 ± 0.92 mm. (**See figure, Supplemental Digital Content 3**, which shows the box plot comparing preoperative and postoperative MRD2 scores, which demonstrates a significant reduction [$P < 0.05$] with outliers, **http://links.lww.com/PRSGO/D926**.) Preoperative punctate superficial keratopathy had an average fluorescein staining score of 1.59 ± 0.50, which improved by 1 point or more in all cases at the week 1 postoperative assessment and 14 and 8 eyes had fluorescein staining scores of 0 and 1, respectively. One month postoperatively, punctate superficial keratopathy resolved in all cases and did not recur during the 3-month follow-up. Two eyes experienced discharge and foreign body sensations on the day after surgery, with the symptoms resolving by the second day. There was no objective discharge or ocular discomfort after the first postoperative week. (**See table, Supplemental Digital Content 4**, which shows the individual measurements [prostaglandin-associated periorbitopathy], **http://links.lww.com/PRSGO/D927**.) Representative cases are shown in Figures 3–5 and Supplemental Digital Content 5 and 6. (**See figure, Supplemental Digital Content 5**, which shows the preoperative and postoperative images of case 14 and demonstrates improved lower eyelid retraction and

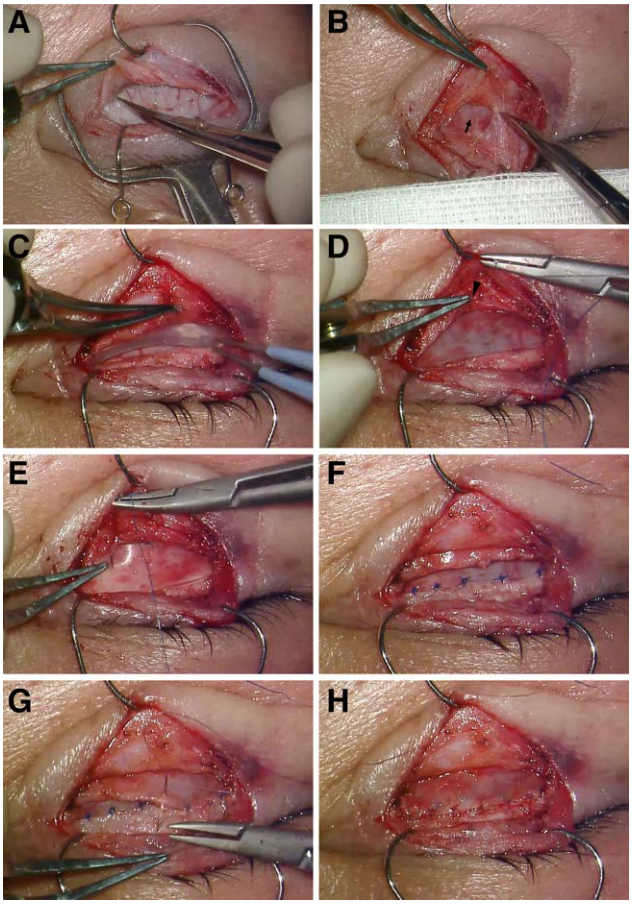

Fig. 1. Intraoperative photographs showing the key steps of the surgical procedure. A, Detachment of the posterior layer of the LERs from the palpebral conjunctiva. B, The anterior layer of the LERs exposed by incising the orbital septum (arrow). C, Silicone sheet (product no. 0412; KOKEN, Tokyo, Japan) inserted between the palpebral conjunctiva and the posterior layer of the LERs. D, The tips of the forceps gripping the posterior layer of the LERs (arrowhead). E, The silicone sheet and posterior layer of the LERs sutured together. F, Silicone sheet firmly attached to the lower edge of the tarsal plate. G, The anterior layer of the LERs is sutured to the anterior tarsal plate. H, Silicone sheet completely covered by the anterior layer of the LERs after suturing.

eyelash position at 3 mo, **http://links.lww.com/PRSGO/D928**.) (**See figure, Supplemental Digital Content 6**, which shows the preoperative and postoperative images of case 15 and demonstrates improved congenital lower eyelid retraction at 4 mo, **http://links.lww.com/PRSGO/D929**.)

DISCUSSION

In this case series–based study, we assessed the effectiveness of a novel percutaneous surgical technique for improving lower eyelid retraction, enhancing patient satisfaction and maintaining ocular surface integrity. This technique constitutes a significant advance in the treatment of lower eyelid retraction without persistent ocular surface-related complications and marks a notable improvement over traditional techniques. Unlike the conventional transconjunctival approach, which has been associated with complications on the ocular surface,[5] our innovative technique utilizes a silicone spacer that is strategically placed between the tarsal plate and posterior layer of the LERs to preserve the palpebral conjunctiva. This spacer is secured with sutures, and the anterior layer of the LERs is sutured to the tarsal plate to ensure anatomical continuity and specifically target the elongation of the palpebral conjunctiva while preserving its integrity. In our case series, significant improvement was noted in 21 (95.5%) of 22 eyes. Notably, in 1 (4.55%) case wherein lower eyelid retraction persisted, no evidence of eyelash contact with the ocular surface was noted, with improvement in corneal epithelial disorder, and the procedure yielded satisfactory functional outcomes. This highlights the effectiveness of the novel technique in providing substantial clinical improvement. Previous studies employing the transconjunctival approach alone reported an average decrease in MRD2 (0.5–1.3 mm) without incorporating additional surgical modalities, such as midface lift or lateral tarsal strip.[5] Our approach achieved an average reduction of 1.29 ± 0.92 mm in MRD2, which closely matched and exceeded the reported outcomes, and demonstrates its efficacy in managing lower eyelid retraction accompanied by eyelash contact with the ocular surface.

The hard palatal mucosa is frequently used as a spacer in lower eyelid lengthening procedures using the transconjunctival approach.[6] Distinguished by its keratinized, stratified squamous epithelium, the hard palatal mucosa differs from other nonkeratinized oral mucosal surfaces.[15] Postoperatively, the stratum corneum of the hard palatal mucosa continues to accumulate, and this causes patients to experience sensations of secretions or foreign bodies on the ocular surface[15] and could provoke inflammation on the ocular surface and lead to corneal epithelial disorders.[16] Although it has been suggested that the transplanted hard palate mucosa eventually transforms into nonkeratinized mucosa over a longer postoperative course, symptoms stemming from keratinization of the hard palatal mucosa may persist.[15] Indeed, even 6 months after surgery, transformation to nonkeratinized mucosa may remain incomplete.[15] With the novel surgical approach, which conserves and elongates the palpebral conjunctiva in contact with the ocular surface, patients typically do not experience ocular surface secretions or foreign body sensation from the second postoperative day. Consequently, our novel technique offers higher patient satisfaction levels compared with conventional lower eyelid lengthening via the transconjunctival approach. Moreover, no discernible surgery-related issues pertaining to the ocular surface were observed objectively. Therefore, this technique is less invasive to the ocular surface than the transconjunctival approach.

In traditional transconjunctival approaches for lower eyelid lengthening surgery, the type and size of the spacer are crucial.[5] The spacer should be biocompatible, accessible, and have specific physical properties to ensure optimal outcomes.[17] An ideal spacer should have a low shrinkage rate and sufficient hardness to maintain eyelid structural integrity postoperatively while facilitating tissue integration with minimal inflammation.[17] This underscores the

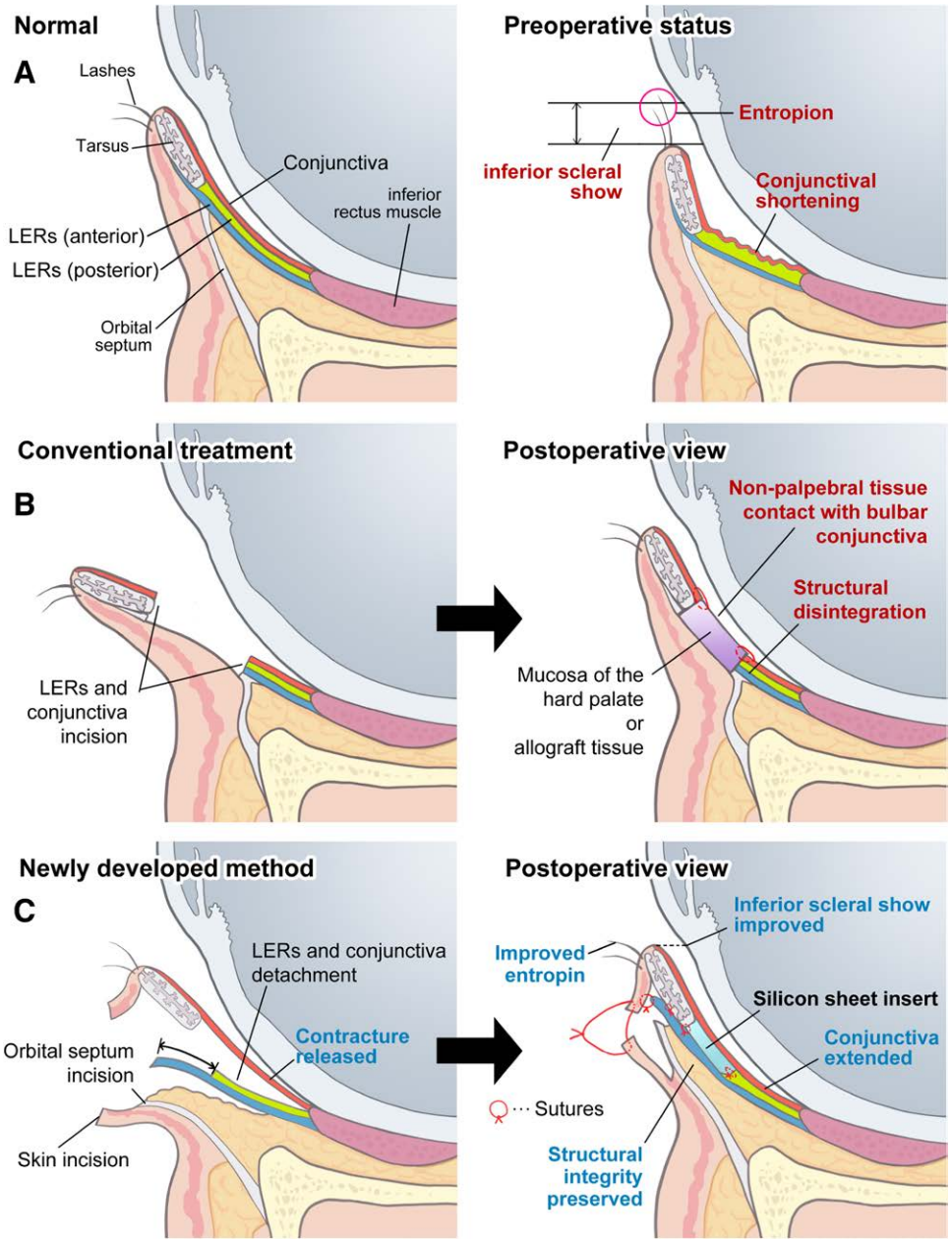

Fig. 2. Schematic diagrams illustrating the surgical procedure for lower eyelid retraction. A, Schematic showing lower eyelid retraction where the normal lower eyelid and eyelashes are in contact with the cornea and bulbar conjunctiva. B, In conventional lower eyelid lengthening, the palpebral conjunctiva is incised, and tissue is transplanted, causing secretion and foreign body sensation. C, Schematic of a new surgical method involving insertion of a silicone spacer between the tarsal plate and posterior LERs, preserving the palpebral conjunctiva and ensuring anatomical continuity.

preference for autologous or allogeneic tissues, despite their tendency to undergo posttransplant shrinkage, which complicates postoperative eyelid position maintenance.[2,3,5] Given these challenges, our study explored the use of artificial materials in a percutaneous surgery approach. This method circumvents the issues associated with tissue shrinkage and mucosalization observed with autologous or allogeneic grafts, thereby ensuring more predictable and stable results. Unlike the traditional transconjunctival approach, which is associated with tissue integration variability, using artificial spacers in a percutaneous method provides a reliable approach to maintain eyelid position without tissue contraction risks.[18,19] This approach not only addresses the limitations of traditional spacers but also enhances patient satisfaction and clinical outcomes. Artificial spacers offer a reliable solution for patients with lower eyelid retraction by minimizing ocular surface invasiveness and allowing precise intraoperative adjustments.

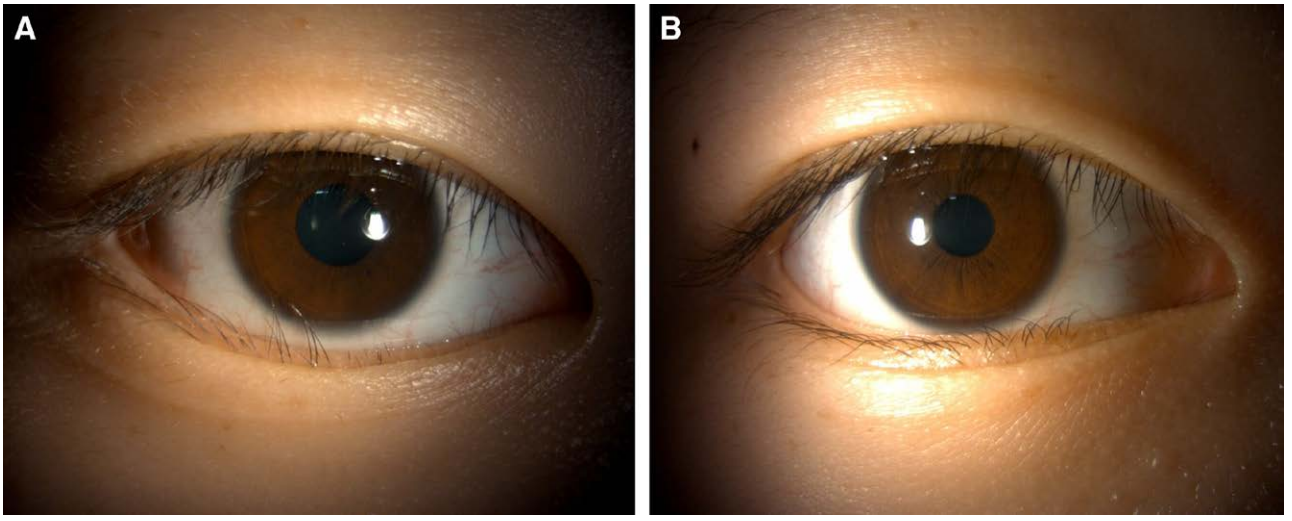

Fig. 3. Preoperative and postoperative: case 8 (right lower eyelid). A, Before surgery, lower eyelid retraction stemming from thyroid disease is evident. B, Postoperatively, at the 7-month follow-up, observations reveal improvement in lower eyelid retraction and no contact between the eyelashes and the ocular surface.

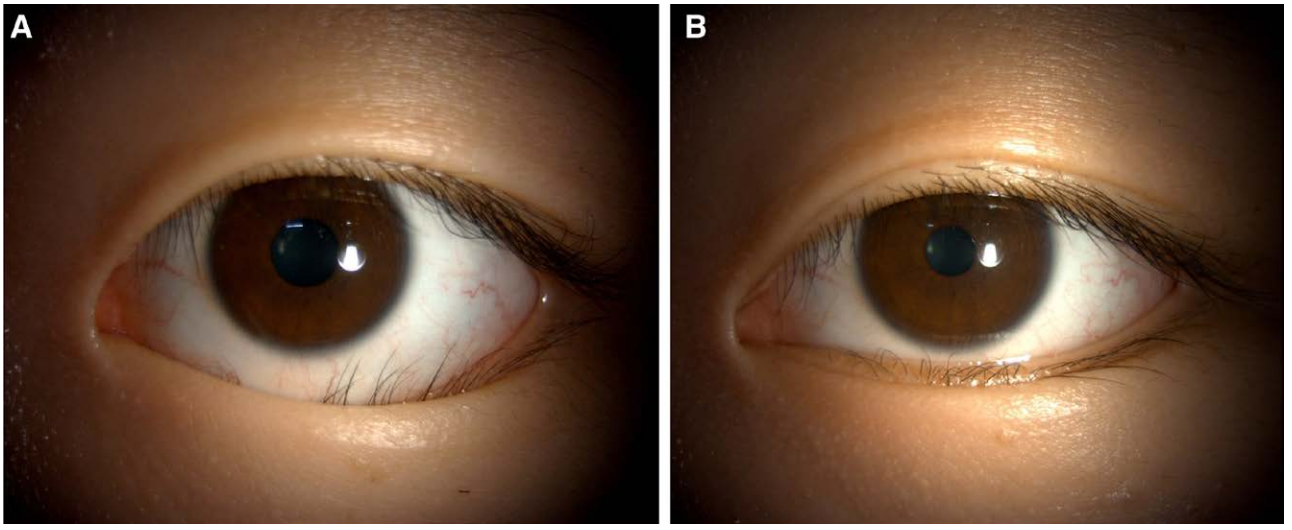

Fig. 4. Preoperative and postoperative images: case 8 (left lower eyelid). A, Before surgery, the left lower eyelid shows more severe retraction than the right lower eyelid, as shown in Figure 3. B, Postoperatively, at the 7-month follow-up, there is a slight residual retraction of the left lower eyelid; however, the eyelashes do not contact the ocular surface.

During follow-up, no silicone sheet prolapse or infections were observed, owing to meticulous posterior layer completion of the LERs, tear-free peeling of the palpebral conjunctiva, and internal fixation of the silicone sheet to prevent movement. Moreover, the silicone sheet was entirely enveloped by the eyelid subcutaneous tissue and supported by robust blood flow, further reducing the risk of complications. We excluded cases with prior surgical scarring of the palpebral conjunctiva owing to its potential impact on the absence of prolapse or infection. However, postoperative care is crucial because excessive eye rubbing can lead to implant displacement or prolapse. To mitigate this risk, patients should avoid excessive eye rubbing. Regular follow-up visits are essential to monitor implant position and ensure proper healing. Postimplantation, the smooth surface of silicone typically resists blood vessel and fibrous tissue infiltration.[20] However, myofibroblasts may form a pseudocapsule around the silicone sheet, which offers benefits such as reinforcement in orbital floor fractures.[20] With our surgical method, a capsule is expected to gradually envelop the silicone sheet, and thereby reinforce its periphery to prevent prolapse. In the event of a prolapse, the capsule may sustain an elongation effect and, thus, reduce the risk of recurrence after removal.

In lower eyelid lengthening surgery, Chang et al[21] introduced a technique that preserves the palpebral conjunctiva using a small lateral incision to release the subcutaneous scar tissue and insert a spacer for minimal trauma. However, this method lacks vertical fixation, which leads to

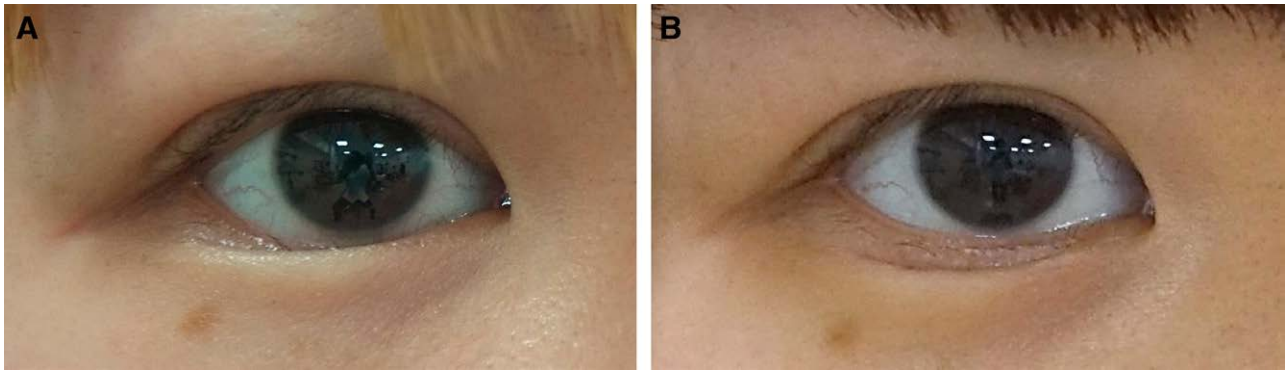

Fig. 5. Preoperative and postoperative images: case 15. A, Before the surgery, the patient presented with lower eyelid retraction attributed to scarring on the palpebral conjunctival side, which occurred after prolonged episodes of conjunctivitis. The possibility of thyroid-related etiologies was dismissed after evaluation by an internist. B, Following the surgical intervention, observations made at the 5-month postoperative mark reveal a notable amelioration in lower eyelid retraction, with improved contact between the eyelashes and the ocular surface.

alignment-related uncertainties. In contrast, Kakizaki et al[8] detached the LERs more aggressively, using auricular cartilage as a spacer for better structural support but did not focus on elongating the palpebral conjunctiva alone. In our approach, we used a 1-mm-thick artificial silicone sheet, tailored to fit precisely, and focused on elongating the palpebral conjunctiva, ensuring both horizontal and vertical fixation for improved alignment and stability. This technique represents an advancement in lower eyelid surgery that prioritizes safety, precision, and patient satisfaction, thereby addressing a significant gap in surgical options for eyelid retraction.

This study has some limitations that are inherent to its retrospective case series design, which confers a potential for selection bias and limits the generalizability of the results. Owing to the selective nature of the case inclusion, particularly regarding lower eyelid retraction, the relatively small sample size (22 eyelids) aligns with the findings of previous studies. However, this restricted the statistical power and general applicability of this study. Only 4 eyelids with thyroid eye disease were included in this study, suggesting that these results might not fully represent the outcomes for this subgroup. As the study was conducted at a single center, the findings may not be replicable across different settings. Further research with larger and more diverse populations is necessary to validate and expand the application of this novel surgical technique.

CONCLUSIONS

This study demonstrates that our novel percutaneous surgical technique offers promising results in the treatment of lower eyelid retraction, particularly in patients whose eyelashes are in contact with the ocular surface. However, further studies are needed to confirm the effectiveness of this technique compared with traditional methods and to explore its clinical applications. In addition, the limited representation of eyelids with thyroid disease warrants further research. Future studies should include more diverse patient groups and use a multicenter approach to ensure robust data for validating and expanding the applicability of this technique.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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