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Case report

Hydrogel sealant to prevent recurrent epithelial ingrowth in the setting of a LASIK flap buttonhole

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ABSTRACT

Purpose: To report the first case of hydrogel sealant to prevent the recurrence of epithelial ingrowth in a LASIK flap buttonhole.

Observations: A 67-year-old female presented ten years after undergoing bilateral LASIK with diffuse lamellar keratitis and flap dislodgement after blunt trauma to the right eye. She was found to have epithelial ingrowth with diffuse debris and striae, so her flap was lifted and the epithelial ingrowth was removed. However, a central buttonhole was noted intraoperatively. Once all the epithelium was removed, the flap was repositioned and hydrogel sealant (ReSure, Ocular Therapeutix, Bedford, MA) was used to fill the buttonhole as well as seal down the edges of the flap. Sixteen months postoperatively, the patient's uncorrected visual acuity was 20/50-2 and there was no recurrence of the epithelial ingrowth at the edges of the buttonhole.

Conclusions and importance: Preventing the recurrence of epithelial ingrowth is a challenging situation, especially in the setting of a LASIK flap buttonhole. The use of hydrogel sealant in the buttonhole and around the edges of the flap may offer an elegant and effective solution.

1. Introduction

One potential complication of LASIK flap creation is buttonhole formation, where an irregular lamellar cut results in a connection between the plane of the flap and the corneal surface. The incidence of buttonhole formation has been reported to range from 0.07% to 1.74% with mechanical microkeratomes and has become even less common with the use of femtosecond laser flap creation.[1–8] Nevertheless, it is a feared complication as it can result in epithelial ingrowth, which can lead to irregular astigmatism, flap melt, and loss of visual acuity. If an ablation is performed despite buttonhole formation, the patient is at higher risk of epithelial ingrowth, scarring, and loss of visual acuity given the mismatch between the contour of the stromal bed and flap.

Prior reports have described the successful use of fibrin glue (Tisseel, Baxter International, Deerfield, IL) in buttonhole defects and around the edges of flaps to prevent the recurrence of epithelial ingrowth.[9–11] More recently, a hydrogel sealant (ReSure, Ocular Therapeutix, Bedford, MA) was granted FDA approval for sealing clear corneal wounds in cataract surgery, and reports have already documented its use sealing the periphery of LASIK flaps after removing epithelial ingrowth to prevent it from recurring.[12,13] However, we present the first case of hydrogel sealant successfully preventing the recurrence of epithelial ingrowth through a LASIK flap buttonhole.

1.1. Case report

A 67-year-old female presented with diffuse lamellar keratitis associated with an epithelial defect and flap dislodgement after blunt trauma to the right eye. She had undergone bilateral monovision LASIK ten years prior with her right eye targeted for distance and her left eye targeted for near.

On examination, her uncorrected distance visual acuity (UDVA) in the affected right eye was count fingers at one foot. On slit lamp exam, she was found to have confluent diffuse lamellar keratitis in the central cornea with debris under the flap. Topography demonstrated 2.09 D of irregular astigmatism. She was treated with difluprednate 0.05% every hour while awake and ofloxacin 0.3% four times a day in her right eye.

Over the following two weeks, the diffuse lamellar keratitis resolved and she was tapered off of difluprednate, and ofloxacin was discontinued. However, significant epithelial ingrowth with diffuse debris, striae, and scalloping of the flap edge was noted in the affected eye. It was recommended she undergo flap lift with removal of the epithelial ingrowth, but the patient left the country for over a month against medical advice. When she returned, her uncorrected distance visual acuity was 20/80 in the affected eye with 2.19 D of irregular astigmatism on topography (Fig. 1). Aberrometry readings (iDesign, Abbott Medical Optics, Inc.) were −1.59 + 3.13 × 048 with a higher order

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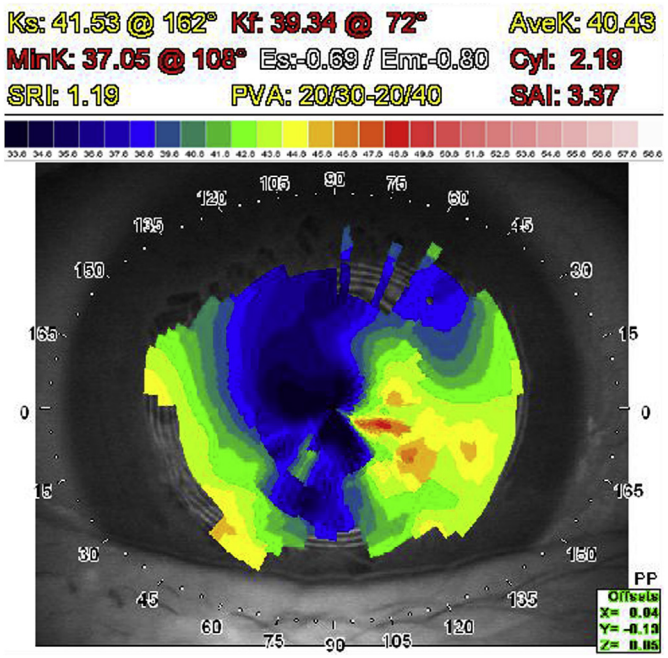

Fig. 1. Preoperative topography of the right eye demonstrating relatively flat Ks, consistent with prior LASIK, and significant irregular astigmatism.

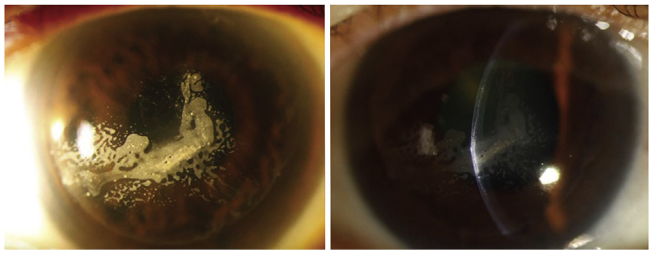

Fig. 2. Preoperative slit lamp photos demonstrating significant central epithelial ingrowth with elevation and scalloping of the flap edge.

root mean square error of 1.47 μm. There was now significant epithelial ingrowth with elevation and debris under the flap with scalloping of the flap edge (Fig. 2). The procedure was planned shortly after but the patient cancelled on two separate occasions before finally undergoing flap lift, epithelial ingrowth removal, and placement of hydrogel sealant almost two months after the procedure was first recommended.

The patient was taken to the excimer laser operative suite for LASIK flap lift and mechanical debridement. Under topical anesthesia, the cornea was marked and then the flap was carefully lifted with a LASIK hook. At this time, a central buttonhole in the LASIK flap was noted. The epithelial ingrowth was carefully removed from the stromal bed as well as from the posterior surface of the flap using a photorefractive keratectomy spatula and dry cellulose sponges. Once all of the epithelium was removed, the flap was repositioned and the interface was irrigated with balanced salt solution. The flap was smoothed out until the striae dissipated. ReSure hydrogel sealant was used to fill the buttonhole as well as seal down the edges of the flap. After the sealant dried, a bandage contact lens was placed (Video 1).

Supplementary video related to this article can be found at https://doi.org/10.1016/j.ajoc.2019.100518.

The patient tolerated the procedure well and was started on topical moxifloxacin 0.5% four times a day and difluprednate 0.05% four times a day in the operative eye. On postoperative day one, the hydrogel sealant was in place with an overlying bandage contact lens (Fig. 3). The hydrogel sealant remained in place for the following three days under the bandage contact lens and dissolved by postoperative day ten,

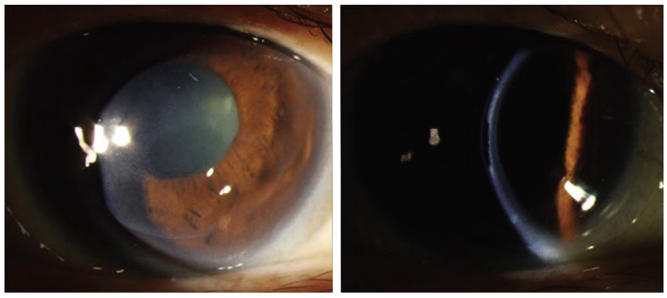

Fig. 3. Postoperative day one slit lamp photos demonstrating the central buttonhole with hydrogel sealant in the defect and at the edges of the LASIK flap and a bandage contact lens in place.

at which time the bandage contact lens was removed and the moxifloxacin and difluprednate were decreased to twice a day. One week later, the moxifloxacin and difluprednate were discontinued.

By postoperative month one, her UDVA was 20/100, pinholing to 20/30 with no evidence of epithelial ingrowth. At postoperative month two, her UDVA was 20/60. A manifest refraction of plano +5.75 × 075 resulted in a visual acuity of 20/50 + 2. Aberrometry readings were −2.37 + 5.79 × 092 with a higher order root mean square error of 2.89 μm. The central buttonhole did not demonstrate any evidence of epithelial ingrowth and there was a small area of epithelial ingrowth inferiorly that advanced less than 0.9 mm centrally from the flap edge (Fig. 4).

By postoperative month sixteen, her UDVA was 20/50-2. A manifest refraction of −0.50 + 2.50 × 068 was unable to improve her visual acuity better than 20/50-2. Topography demonstrated significant improvement from her preoperative measurements with 1.72 D of oblique astigmatism with a mildly asymmetric bowtie pattern (Fig. 5). Aberrometry readings were −0.42 + 1.77 × 084 with a higher order root mean square error of 1.04 μm. The central buttonhole did not demonstrate any recurrence of the epithelial ingrowth and the small area of peripheral epithelial ingrowth inferiorly remained stable (Fig. 6).

2. Discussion

Buttonhole formation is an uncommon but feared complication of LASIK surgery as it can result in epithelial ingrowth, irregular astigmatism, and decreased visual acuity. If it is noted during flap creation with a microkeratome, the flap is carefully repositioned and the laser ablation aborted. If it occurs during femtosecond laser creation of the flap, the treatment is stopped as soon as the defect is noted, ideally before the side cut incisions are made. In that case, the flap is not manipulated and the rest of the procedure is aborted. If the side cuts were completed, the flap is carefully repositioned as with microkeratome flap creation, and a bandage contact lens can be placed to help the flap adhere in the intended position.

Although same day ablation treatment has been described, it is not

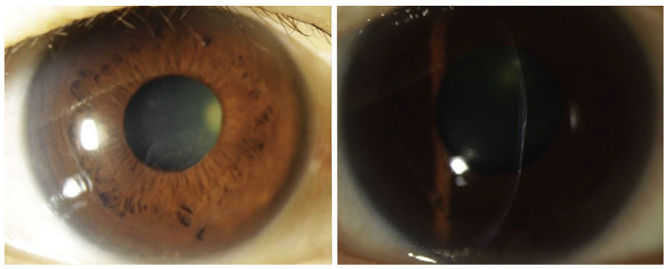

Fig. 4. Postoperative month two slit lamp photos demonstrating the central buttonhole with no evidence of recurrent epithelial ingrowth and a small area of non-progressive epithelial ingrowth inferiorly.

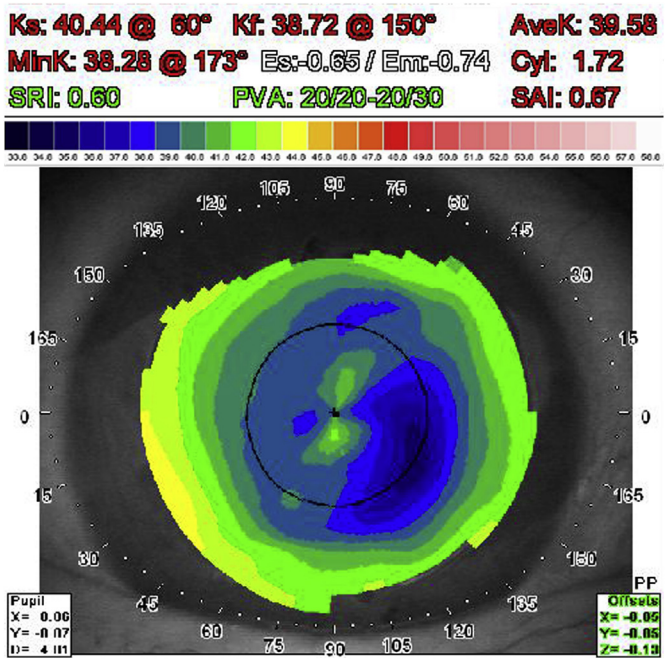

Fig. 5. Postoperative month sixteen topography demonstrating significantly improved regularity compared to her preoperative imaging, now with 1.72 D of oblique astigmatism with a mildly asymmetric bowtie pattern.

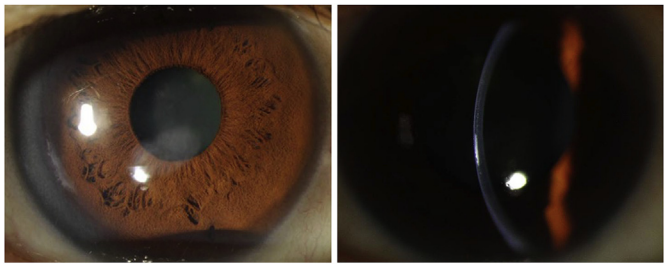

Fig. 6. On the left, postoperative month ten, and on the right, postoperative month sixteen slit lamp photos demonstrating the central buttonhole with no evidence of recurrent epithelial ingrowth and the same area of non-progressive epithelial ingrowth inferiorly.

recommended after buttonhole formation. Stulting et al. performed a prospective observational study of 1062 eyes undergoing LASIK and found that there was a trend toward loss of best corrected vision when same-day ablation was performed on eyes with flap complications such as buttonholes.[3] Most surgeons recommend waiting a period of time and then either making a deeper flap cut for LASIK or, more commonly, changing to a surface ablation approach. For example, some have described protocols involving photorefractive keratectomy (PRK) with mitomycin C, some preceded by phototherapeutic keratectomy (PTK) and others preceded by epithelial treatment with alcohol.[5,8,14,15] Some advocate for early surface ablation before haze, scarring, or epithelial ingrowth are significant, while others advise waiting several months to allow the refraction to stabilize.[2,16–19] In severe cases of epithelial ingrowth, flap amputation can be considered, especially if melting occurs.[20–22]

Here, we describe a unique situation where a buttonhole was created by overlying flap melt in the setting of severe epithelial ingrowth, rather than flap creation during initial LASIK surgery. Therefore, the refractive ablation had already taken place ten years prior and manipulation of the flap was necessary to remove the epithelial ingrowth before lying the flap back in place. Although flap amputation was an option, the decision was made to attempt a more conservative approach first, since flap amputation could be performed at a later date if needed.

Regardless of the presence of a buttonhole, the management of epithelial ingrowth after LASIK can be challenging. After mechanical scraping of the epithelial cells out of the LASIK flap interface, the next step is preventing recurrence. Flaps may be sutured with 10-0 nylon and/or glued to promote flap edge adhesion and prevent the recurrence of epithelial ingrowth.[23–26] Although suturing the flap is the gold standard, this is not an option around the edges of a buttonhole as it would induce unacceptable amounts of astigmatism and scarring. Fibrin tissue glue offers a more elegant solution, eliminating the need for later suture removal and likely inducing less astigmatism. The fibrin sealant works by mimicking the final steps of the coagulation cascade, combining two sets of human proteins to create a fibrin clot that can be used to achieve hemostasis or adhere one tissue to another. It can be applied to the flap edges, any buttonholes or breaks, or over the entire flap, and dissolves after about two weeks.[9,11] The cases reported have had excellent success with regards to visual outcome, prevention of recurrence, and safety profile.

More recently, hydrogel sealant has emerged as a potential alternative to sutures for closing corneal incisions. It is composed of a synthetic polyethylene glycol hydrogel, which is applied in a liquid form, which then polymerizes to form a soft gel within 20 seconds. It was FDA approved for sealing clear corneal incisions in cataract surgery but has also been reported to seal other types of corneal wounds as well. For example, it has been used to seal down the edges of a LASIK flap after removing epithelial ingrowth, successfully preventing recurrence.[13] Similarly, it has been reported to seal the wound in small incision lenticule extraction (SMILE) after epithelial ingrowth removal, preventing recurrence.[27] It has also been used to close corneal wounds after intrastromal corneal ring segment implantation with no subsequent wound complications.[28] Lastly, it has been used to adhere amniotic membrane grafts to corneal and conjunctival defects after pterygium surgery.[28,29] Hydrogel sealant may offer an attractive alternative to fibrin glue since it is FDA approved for use on the cornea and is even easier to apply than fibrin glue.

In our case, hydrogel sealant was successfully used to prevent the recurrence of epithelial ingrowth through a LASIK flap buttonhole. Some advantages of hydrogel sealant include its easy application, quick drying time, and lack of postoperative suture removal. It, along with fibrin glue, offers a great solution for sealing the edges of LASIK flap buttonholes or other flap defects.

3. Conclusion

Here, we report the first case of hydrogel sealant successfully used in a LASIK flap buttonhole to prevent the recurrence of epithelial ingrowth after removal. Hydrogel sealant appears to be a safe, effective, and elegant option for achieving tissue adherence. Although a LASIK flap buttonhole is always a challenging situation, the addition of hydrogel sealant to the refractive surgeon's armamentarium is a valuable one and may increase the chances of a successful outcome.

Patient consent: Consent to publish the case report was not obtained. This report does not contain any personal information that could lead to the identification of the patient.

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Conflicts of interest

Edward E. Manche:

Equity in Seros Medical, LLC., RxSight

Consultant for Allergan, Avedro, Carl Zeiss Meditec, J & J Vision, Shire.

Sponsored Research for Alcon, Allergan, Avedro, Carl Zeiss Meditec,

J & J Vision, Ocular Therapeautix, Presbia

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