

An Algorithm for LASIK Buttonholes Based on the Stage of Progression

Classification of epithelial ingrowth helps direct the management approach.

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The LASIK buttonhole, resulting from an uncut portion of the corneal flap, may lead to irregular astigmatism and visual loss.¹ This intraoperative complication occurs when the microkeratome blade travels more superficially than intended, entering the epithelium or Bowman's layer complex.² Buttonholes can be either full or partial thickness, depending on whether the blade exits the overlying epithelium.¹

The incidence of LASIK buttonholes has been variably reported as 0.2% to 0.56%,³⁻⁵ with an incidence of 0.57% in our recent series.⁶ Although the advent of the femtosecond laser may have reduced the risk of LASIK buttonholes, vertical bubble breakthrough with the femtosecond laser has been recently published.⁷

INADEQUATE SUCTION

Several theories attempt to explain the occurrence of LASIK buttonholes due to microkeratome cuts. From all presumed etiologies, we suspected microsuction loss (undetected by the keratome safety mechanism) as the main reason behind flap buttonholes in our series. Inadequate suction may occur in cases of conjunctival incarceration in the suction port (ie, pseudosuction) or simply from an inadequately functioning vacuum unit.⁸

If a buttonhole is encountered, it is best to cancel the procedure; do not lift or reposition the flap (if it had to be lifted),⁹ and reschedule the laser treatment for a later date.¹ We also advise aborting the procedure in cases of near-buttonholes. Recutting a flap once a buttonhole has occurred is inadvisable due to the risk of double flaps, tissue loss, and subsequent irregular astigmatism.^{10,11}

Similarly, we avoid recutting the flap with the femtosecond laser due to the manipulation needed to lift the flap and the risk of margin disruption by cavitation bubbles.

The flap should be carefully inspected at the slit lamp to ensure good apposition of the buttonhole margins. In these cases, Bowman's layer is found uncut in the central or peripheral cornea and the epithelium remains grossly intact. Epithelial ingrowth may still occur and complicate the postoperative course.^{10,12,13}

The natural history of LASIK buttonholes suggests a system of classification to direct the management approach. Full- and partial-thickness buttonholes should be classified together, with classification broken into three stages. Stage 1 buttonholes have no epithelial ingrowth; stage 2 buttonholes have epithelial ingrowth; and stage 3 buttonholes have epithelial ingrowth and resultant stromal melting, scarring, or flap elevation.

CLASSIFICATION

We devised a treatment algorithm based on this classification. The infiltration of epithelial cells through the buttonhole determines what course of action is best. We have found this algorithm to be helpful in ensuring good visual outcomes.

Stage 1. Close observation is paramount. Epithelial disruption at the buttonhole's margins increases the risk of diffuse lamellar keratitis (DLK) and epithelial ingrowth through the edges of the hole. Hourly topical steroids applied for the first 2 to 3 days minimize the risk of DLK. It is crucial to prevent DLK from progressing beyond stage 2. If DLK is present and the flap is lifted to irrigate the inflam-

matory cells, the buttonhole edges are disrupted, and further difficulties may result.¹⁴ If the edges of the buttonhole stain with fluorescein, be suspicious of an epithelial fistula and consequent potential cellular infiltration.

It is best to wait at least 12 weeks before deciding on any further action⁹ to allow epithelial hyperplasia to smooth the corneal surface and ensure refractive stability. Our results confirm the benefit of a longer waiting period. If slit-lamp biomicroscopy reveals a smooth epithelial surface, a 50- μm phototherapeutic keratectomy (PTK) ablation, followed by the refractive treatment, is performed. In this situation, the epithelium acts as a masking agent during the ablation, allowing smoother stromal scars and irregularities.

If after 12 weeks the epithelial surface is deemed more irregular than the underlying buttonholed stroma, it may be best to remove it with 20% alcohol applied for 60 seconds. The alcohol time is crucial to avoid adherence of the epithelium to the edges of the hole, which may disrupt peeling. Care should be taken to prevent alcohol contact with the peripheral edges of the flap.

Although surface ablation on a LASIK flap has been reported to be associated with an elevated risk of corneal scarring,⁹ mitomycin C is an adjunctive antiscarring agent permitting more liberal use.¹⁵⁻¹⁷ We apply mitomycin C 0.02% for 60 seconds to prevent stromal haze formation.¹² We have not observed permanent haze in any of our patients; considerable haze would be difficult to scrape.

Stage 2. The presence of an epithelial ingrowth around the margins of a buttonhole or near-buttonhole indicate stage 2. A high index of suspicion should be maintained early postoperatively because stromal melting and irregular astigmatism may follow. If the ingrowth is small and unprogressive, it can be observed for 12 weeks and then treated similarly to a stage 1 buttonhole.

If the ingrowth appears to be progressive and/or there is threat of stromal melting, immediate intervention is warranted to avoid evolution to stage 3. In these instances, we recommend a staged approach. The first stage is therapeutic, intended to obliterate the infiltrated epithelial cells.¹⁸ An initial 6.5-mm PTK treatment is applied at the depth of 40 to 50 μm . If a residual epithelial ingrowth is noted on biomicroscopy, 10- μm PTK increments may then be applied with intermittent slit-lamp examination until the ingrowth is satisfactorily ablated. If the total amount of laser pulses applied in the first stage exceeds 50 μm , it may be best to delay the refractive treatment to a later stage, until a new stable refraction is obtained. Surface ablation may then be applied to correct the remaining refractive error, thus avoiding the risk of a hyperopic shift that would result if the full refractive treatment were applied in addition to a significant PTK ablation.

TAKE-HOME MESSAGE

- If a buttonhole or near-buttonhole is encountered, cancel or abort the procedure.
- If Bowman's layer is intact in the central or peripheral cornea and the epithelium is grossly intact, the buttonhole margins are well-apposed.
- Management should depend on the stage of epithelial ingrowth progression.

Stage 3. Stage 3 buttonholes occur if an epithelial ingrowth is significant enough to cause irregular astigmatism due to the elevated flap or stromal melting. These buttonholes are the most difficult to treat and may result in significant visual loss. A hard contact lens over refraction will differentiate between visual loss from an obstructing scar versus irregular astigmatism. Lifting the flap to clear any persistent epithelial ingrowth may result in flap tears if considerable edge scars have already formed. PTK or PRK may not successfully smooth the underlying stromal irregularity. A careful consideration of the benefits and risks of each approach and its timing should be individualized to the corresponding situation.

HYPEROPIC PATIENTS

LASIK buttonholes in hyperopic patients may have to be approached differently. Most of the ablation occurs in the periphery, which may not ablate the stromal scar. Surgical planning must consider the buttonhole scar's effect on vision. If the latter is considered significant, this may be best approached with a two-stage treatment: PTK to ablate the scar followed by PRK once refractive stability is achieved.

CONCLUSION

Because the cause of microkeratome-related LASIK buttonholes is still elusive, preventive measures are difficult to identify. The reported cases in our series show that most had average keratometry readings, were fashioned with a deeper keratome footplate, and showed no gross evidence of suction loss during surgery.⁶ By following the treatment algorithm described here, we have obtained good results in our patients with buttonholed flaps. ■

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