Buttonholes During LASIK: Etiology and Outcome

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ABSTRACT

PURPOSE: To report the clinical features and outcome of eyes with flap buttonhole during LASIK.

METHODS: A retrospective review was performed to identify eyes that developed flap buttonhole during Hansatome microkeratome translation. Pre-, intra-, and postoperative data were obtained to identify factors predictive of buttonhole.

RESULTS: Five patients with buttonhole were identified from June 2001 through September 2002 (5 [0.06%] eyes of 7672 primary LASIK procedures). Mean patient age was 49.2 ± 11.3 years (range: 37 to 66 years). Mean preoperative spherical equivalent refraction was −4.92 ± 2.90 diopters (D) (range: −2.25 to −9.50 D). Mean keratometry was 45.59 ± 1.15 D (range: 43.90 to 47.60 D). All 5 flap buttonholes occurred in the second of 2 consecutively treated eyes (P = 0.03). Buttonhole occurred in 2 (0.26%) of 778 eyes where the 160-μm microkeratome plate was used, and 3 (0.06%) of 4350 eyes where the 180-μm plate was used (P = 0.16). Two eyes received laser ablation at the time of buttonhole formation. In the untreated cases, the buttonhole flap itself caused a myopic spherical change of −0.50 D and 0.70 D of astigmatism. One of 5 eyes lost 2 lines of best spectacle-corrected visual acuity; this eye received laser ablation immediately after buttonhole formation.

CONCLUSIONS: Buttonholes are significantly more likely to occur in the second of two consecutively treated eyes. A new blade for the second eye when the flap in the first eye appears to be thin should be considered. Caution should be exercised when considering laser ablation immediately following buttonhole formation. [J Refract Surg. 2007;23:472-476.]

Although LASIK is generally a safe procedure, intraoperative complications such as thin flaps, flap buttonholes, and incomplete flaps can result in a loss of best spectacle-corrected visual acuity (BSCVA). Buttonhole is most likely to be associated with loss of BSCVA if laser treatment is performed at the time the buttonhole is created. A retrospective analysis was conducted to identify factors associated with intraoperative buttonhole formation when using the Hansatome microkeratome (Bausch & Lomb, Rochester, NY).

PATIENTS AND METHODS

A retrospective review identified eyes that developed buttonhole in the LASIK flap during microkeratome translation at our institution.

Eyes with buttonhole flap defects were identified during the period from June 2001 to September 2002 (16 months), during which time a total of 7672 eyes underwent primary LASIK. All LASIK flaps were created with the Hansatome microkeratome throughout the entire study. The surgeon selected a session devoted only to creating a superiorly hinged flap. Bilateral, same-session surgery was performed with the right eye receiving the initial treatment. The same blade was used for microkeratome translation in both eyes of the same patient.

A 180-μm plate was used routinely, but a 160-μm plate was used when the surgeon thought the cornea was too thin. The particular microkeratome plate (160 or 180) used was documented only for 10 months within the 16-month period of analysis, between December 2001 and September 2002. To measure the effect of the microkeratome plates in producing a buttonhole, we estimated the number of cases where the
160- and 180-μm microkeratome plates were used during the entire 16-month period of analysis, based on the observed ratio of cases during the 10-month period where microkeratome plate use was documented. The variables that were tested for their influence on button-hole formation included age, sex, preoperative refraction, keratometry, pachymetry, right versus left eye, and the Hansatome plate (160- vs 180-μm). Statistical analysis of the results was performed using chi-square tests and Student t tests. A P value <.05 was considered statistically significant.

RESULTS

Of the 7672 primary LASIK procedures, 5 (0.06%) eyes of 5 patients with flap buttonholes were identified. Three of the affected patients in the study were men and two were women. Mean patient age was 49.2 ± 11.3 years (range: 37 to 66 years) (Table 1). Mean preoperative refractive keratometric and corneal thickness values are presented in Table 1. No statistically significant differences were observed between the right and left eyes of patients with buttonholes in terms of preoperative refraction, keratometry, and pachymetry (P > .05) (Table 1).

All 5 flap buttonholes occurred in the second of 2 consecutively treated eyes of the same patient (P = .03). Buttonholes occurred in 2 (0.26%) of 778 eyes in which the 160-μm microkeratome plate was used and in 3 (0.06%) of 4350 eyes in which the 180-μm plate was used (P = .16).

Two of the eyes (patient 3 and patient 5) received laser ablation at the time of buttonhole formation (Table 2). In these patients, extremely thin flaps were noted intraoperatively, and the surgeon decided to proceed with laser ablation. These flaps were actually partial thickness buttonholes (incomplete buttonhole) in which
the central corneal epithelium was left in the corneal flap. A few days postoperatively, a thin circular scar became evident in the center of the cornea. Patients 1, 2, and 4 had a total thickness (complete buttonhole) in which no corneal stroma and epithelium appeared in the center of the flap. In these three untreated cases, the buttonhole flap caused an average myopic spherical change of $-0.50 \text{ D (range: } -0.25 \text{ to } -0.75 \text{ D)}$ and an increase of $0.70 \text{ D of astigmatism (range: } 0 \text{ to } 1.00 \text{ D). One of the five eyes (patient 5) lost } >2 \text{ lines of BSCVA at 1 year, from } 20/16 \text{ preoperatively to } 20/32. Laser ablation was performed immediately after buttonhole formation. This eye had the densest corneal scar of the five eyes (Fig 1). Topography of the affected, left eye (“buttonhole eye”) of this patient 3 months postoperatively demonstrated small central steepening within an area of flattening (Fig 2); the fellow eye of this patient demonstrated central corneal flattening as expected after uneventful LASIK (Fig 3).

The other four eyes maintained BSCVA between 20/16 and 20/20 (Table 2). In all five fellow right eyes without a buttonhole, uncorrected visual acuity was 20/20 at 1 year after LASIK.

Figure 4 shows topography of the left eye of patient 2, in whom laser treatment was not performed at the time of buttonhole occurrence. Preoperative topography showed an asymmetric bowtie pattern (Fig 4A). Paracentral steepening developed 3 months after the buttonhole complication (Fig 4B).

**DISCUSSION**

Factors predisposing to buttonhole formation include steep corneas, small eyes, deep eye sockets where suction can be lost during flap creation, thinned epithelium from drying while the eye is exposed before microkeratome translation, previous eye surgery such as penetrating keratoplasty, and choice of microkeratome.²,⁶

Gimbel et al.⁷ suggested that steep corneas are predisposed to buttonhole formation during LASIK because the central cornea tends to buckle in a posterior direction during microkeratome translation. This buckling leads to a dimple in the central cornea, through which the blade of the microkeratome passes during translation. Leung et al.⁸ suggested that a malfunction of the
microkeratome itself leads to buttonhole formation, when an increase in the speed of translation of the microkeratome might cause the device to pass across the cornea faster than it can cut, thus skimming the blade over the corneal tissue; in their case, servicing of the keratome eliminated further buttonhole formation.

Our study demonstrated that the second eye was significantly more at risk for buttonhole formation than the first eye, which is consistent with previous reports that flaps are thinner in the second eye when the same microkeratome blade is used on both eyes of a patient having bilateral same-session LASIK. A trend toward increased risk of buttonhole formation was noted with the 160-μm plate compared with the 180-μm plate; however, this difference was not statistically significant and might be due to the small number of buttonhole cases. The preoperative refraction, corneal thickness, and keratometric power did not reach statistical significance (P>.05) as independent risk factors (Table 1).

We propose that buttonholes are essentially defects in the flap at or near the corneal apex where the flap has become “infinitely” thin. The fact that there was a trend toward increased risk of buttonhole formation with use of the 160-μm microkeratome plate compared with the 180-μm microkeratome plate further supports our proposed mechanism.

Buttonhole formation during microkeratome translation is a rare complication of LASIK, occurring at a reported rate of 0.03% to 2.6%. These studies used the Chiron Automated Corneal Shaper (ACS; Chiron, Claremont, Calif) and the Hansatome microkeratome. The Hansatome has been found to have a lower incidence of buttonhole formation when compared to the ACS. Walker and Wilson as well as Jacobs and Taravella compared the incidence of buttonhole formation between the Hansatome and the ACS; they found 0.17% compared to 1.1% and 0.03% compared to 1.8%, respectively. In our study, buttonhole occurred in 0.06% of eyes, which is a low rate. We believe part of the reason for this low rate was our consistent use of the Hansatome.

Our study supports the recommendations of Stulting et al that laser treatment should not be performed immediately after buttonhole formation. Alternatives for future treatment may include repeat LASIK, where another flap would be created, and surface laser ablation (laser epithelial keratomileusis or photorefractive keratectomy), perhaps with the use of topical healing modulators, such as mitomycin.

As partial thickness buttonhole may be underdiagnosed, and buttonhole itself is an undesirable complication, we offer several recommendations that might allow surgeons to reduce the likelihood of creating buttonholes. First, surgeons should become proficient at identifying a normal thickness flap in the first eye; the presence of a thinner than expected flap in the first eye should prompt the surgeon to ask for a new blade for use in the second eye, to obtain as thick a flap as is permitted with the particular microkeratome head used. Some surgeons elect to perform subtraction ultrasound pachometry to estimate achieved flap thickness in the
first eye more accurately to aid their decision-making regarding the request for a new blade.

There are two limitations to this study. First, the retrospective analysis may have failed to identify all cases of buttonhole formation during the study period. Second, the use of the 160- and 180-μm microkeratome heads was not documented for the entire study period. Our method of extrapolation to estimate use of the two keratome heads is not, however, likely to have a material effect on the conclusions of our study.

Buttonholes occur more frequently in the second eye of bilateral simultaneous LASIK surgeries when the same blade is used for both eyes. This may be a reflection of the fact that the same blade cuts thinner flaps when used a second time, 9,12,14,17 supporting our postulated mechanism that buttonholes are, in effect, infinitely thin flaps. Gimbel et al 17 further advise that steep corneas are additionally at risk for buttonholes. Laser ablation should never take place at the same time that buttonhole formation occurs; favorable outcomes are possible when laser treatment is delayed, either with surface laser treatment or a repeat attempt at flap creation with the LASIK procedure. 1,5,15-18

REFERENCES