Periosteal flaps allow for single stage reconstruction of larger full thickness eyelid defects: A retrospective study

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Abstract

Background

Full-thickness lower eyelid defects after Mohs micrographic surgery are frequently referred out to oculoplastic surgery for reconstruction. Reconstructive options include wedge closure with or without canthotomy/cantholysis and tarsoconjunctival sliding flaps. Defects >50% of the eyelid margin have traditionally required the two-stage Hughes flap, leaving the patient with monocular vision for 3-6 weeks until pedicle division.

Objective

To demonstrate single-stage periosteal flaps performed by dermatologic surgeons can result in safe, functional, and cosmetically acceptable repairs for large full thickness eyelid defects.

Materials and Methods

An institutional review board-approved retrospective study of repairs performed by two dermatologic surgeons between January 2017 and July 2021 at the University of Minnesota. Patient demographics, operative notes, and follow-up notes were reviewed. Defect and follow up photos were scored using a visual analogue scale to assess aesthetic results.

Results

Ten cases were included in the analysis. Six patients were male and the average age was 62 years old. 8/10 were basal cell carcinoma and 2/10 were melanoma. The mean defect was 9.5 cm2, with a range of 1 cm2 to 24 cm2. The median cosmetic score was 85.8 +/- 10.7. There were no serious complications reported.

Conclusion

Mohs micrographic surgeons can safely and successfully reconstruct large, full thickness eyelid defects by periosteal flap.

Background

Up to ten percent of skin cancers occur in the periorbital region[1], with basal cell accounting for the vast majority (87%) followed by squamous cell carcinoma (7%).[2] In a systematic review by Cook and Bartley, only two treatment modalities were found to have strong evidence supporting their use in the management of periocular BCC or SCC, Mohs Micrographic Surgery (MMS) and excision with frozen section or permanent section control.[1] MMS is particularly suited for cutaneous tumors of the periorbital area because it preserves healthy tissue and ensures complete margin evaluation.[3-4] Studies have shown that 29-69% of periocular defects are referred by Mohs surgeons to plastic surgery or oculoplastic surgery for repair.[5,6] However, there is growing evidence suggesting that Mohs surgeons can safely perform eyelid reconstruction.[5,6,7,8,9,10]

When postoperative defects are limited to the skin and orbicularis muscle, they are easily repaired with full-thickness skin grafts (FTSG) or local cutaneous flaps, however, full-thickness eyelid defects that include tarsal plate and mucosa present a more complex reconstructive challenge. Defects of the posterior lamella that involve 50-100% of the eyelid margin have traditionally required lid-sharing procedures such as the Cutler-Beard flap (upper lid) and the Hughes tarsoconjunctival flap (lower lid).[11] These interpolation flaps require the patient to tolerate monocular vision for up to three weeks prior to pedicle division. Such visual deficits for extended periods of time are universally difficult for patients and even dangerous and/or disabling in certain patient populations.

In 2021, Mori, et al. published a retrospective review of patients who underwent successful reconstruction by lateral canthotomy with inferior cantholysis by Mohs surgeons.[10] Herein, we expand on this work to demonstrate the use of the periosteal flap technique to reconstruct larger, full-thickness eyelid defects. We propose that this single-stage procedure can be performed safely by Mohs surgeons with significant benefit to the patient, including a reduction in the number of office visits to multiple specialists, avoidance of complications of general anesthesia, potential cost savings to the healthcare system, and most importantly, preservation of binocular vision in the post-operative period.

Anatomy

A thorough understanding of eyelid anatomy is a prerequisite before attempting any repair. The upper and lower eyelids are divided into the anterior and posterior lamella. The anterior lamella consists of skin, connective tissue, and orbicularis muscle, while the posterior lamella consists of the tarsal plate and the palpebral conjunctiva. The upper and lower tarsal plates attach medially and laterally to their respective canthal tendons, together comprising the tarsoligamentous slings that support the eyelids. Addressing deficiencies of the anterior lamella, posterior lamella, and canthal tendons is critical to achieve an optimal aesthetic and functional outcome. Furthermore, it is important to utilize similar materials when reconstructing any of these components, for example, obliterated tarsal plate needs to be reconstructed with tissue that will provide a semi-rigid structure, oppose the globe, and provide a lining of nonkeratinizing mucosal epithelium so as not to abrade the cornea.

Surgical technique

For full-thickness lower lid defects that cannot be closed primarily, our approach is described as follows. We first attempt canthotomy with inferior cantholysis. If there is still too much tension on the wound, we extend the canthotomy incision as a Tenzel-style semicircular rotation flap. If there is still too much tension, a mucosal back cut can be made to release the full thickness lateral lid remnant to meet the residual medial lid; this leaves a deficit in lateral support and lining, and a periosteal flap can be elevated to replace the tarsal plate and support the repaired lid on the bony skeleton of the orbit (Video 1).

Prior to the procedure, proparacaine eye drops are administered and the patient is positioned and asked to look toward the unaffected side. This ensures that the pupil is at the maximum distance from the anesthesia needle. Tension is provided by retracting the lateral canthus and 0.25 to 0.5 cc of anesthesia is slowly injected with the needle oriented away from the globe at the interior aspect of the lateral orbital rim, providing anesthesia to the lateral aspect of the posterior lamella. The remainder of the surgical zone is anesthetized in standard fashion.

The authors use an internal eye shield to protect the globe during the procedure but recommend its removal prior to closure of the primary defect. After placement of the eye shield, the skin is prepared with povidone-iodine and draped in standard fashion. The primary Mohs defect should be converted into a pentagonal wedge shape, which will result in optimal positioning for closure.[12]

Mori et al. describes the technique for canthotomy with cantholysis. If closure cannot be achieved after following these steps, it can be due to restraint from the anterior lamella. In this case, a Tenzel semicircular rotation flap can be used for patients with 25-66% full-thickness lower lid defects.[13] The canthotomy incision is extended superiorly and laterally from the lateral canthus in a semicircular arc. The flap is dissected in the pre-septal plane, posterior to the orbicularis muscle, until it is sufficiently mobilized so that the wound can be closed without tension. The flap is then elevated and rotated into position; anchoring sutures tether the flap to the periosteum of the medial aspect of the lateral orbital rim. The pentagonal wedge is closed primarily, and the flap is sutured into place. The procedure to repair the upper lid is the identical mirror image to that for the lower lid.

If the lateral eyelid can still not be mobilized sufficiently to allow for a low-tension closure, it is because of restraint from the residual mucosa. We make a vertical back cut through the mucosa of the affected lid at the lateral canthus, allowing the lateral lid remnant to advance medially to meet the medial lid remnant. A single diagonal tarsal suture approximates the eyelid margin.[14] Medialization of the lateral lid remnant preserves native lashes, and results in lateralization of the eyelid defect.

Next, we use a laterally based periosteal flap to replace the posterior lamella thus providing support and lining in a single stage. Using the Tenzel incision for access, a strip of periosteum is incised at the inner aspect of the lateral orbital rim, approximately 5 mm in height and with a length corresponding to just greater than the distance needed to reach the tarsal plate remnant. The flap should be incised in the desired vector of the affected lid (**Figure 1**) and the superior aspect of the planned flap will determine the position of the lateral lid. The strip of periosteum is carefully elevated from lateral to medial around the curve of the orbital rim and hinged 180 degrees, maintaining its attachment point at the inner, lateral orbital rim. It is sutured to the remaining tarsal plate using 5-0 vicryl. Attention is then turned to the Tenzel flap, which is rotated into the defect and suspended with tacking sutures to the lateral orbital rim. Alternative options including skin grafts and other local flaps can be used to reconstruct the anterior lamella.

Methods

After institutional review board approval, patients with eyelid tumors who underwent MMS and reconstruction by the periosteal flap technique were identified. All cases were performed by two Mohs surgeons (authors I.A.M. and A.M.) at a single academic institution (University of Minnesota) between January 2017 and July 2022. Patient demographics (age, sex, comorbidities, smoking history, medications), surgical details (tumor type, size, anatomic location, number of Mohs stages, final defect size, location, extent of eyelid involvement, and repair type), and follow-up notes were reviewed including any complications and their subsequent management. We specifically sought to identify complications related to infection, hematoma, flap necrosis, epiphora, entropion or ectropion, lagophthalmos, and aberrant scar formation. Photographs of each Mohs defect and subsequent postoperative follow-up photos were extracted from patient charts and uploaded to a REDCap database. Two cosmetic dermatologists (authors L.A.F. and R.S.F.) reviewed the photos at random. They used a visual analogue scale to rate the final cosmetic outcomes from 1 to 100, with 1 being the worst possible cosmetic outcome and 100 being the best.

Results

Ten patients with eyelid tumors treated with MMS were identified according to the above criteria. All were included in the analysis (See Table 1**)**, however only nine had follow-up photos available for cosmetic evaluation. Six patients were male and four were female, with an average age of 62 at time of surgery. 8/10 tumors were basal cell carcinoma, 2/10 were melanoma. None of the patients were smokers or tobacco users, and no patients were taking anticoagulants, though one was taking aspirin 81 mg daily. The average defect had a horizontal component of 3.2 cm and an

average vertical component of 2.3 cm. Mean defect area was 9.5 cm^2 with a range of 1 cm^2 to 24 cm^2. For post-operative pain control, tramadol and oxycodone were prescribed for selected patients. The mean follow-up period was 5.4 months.

Table 1: Post-operative complications, subsequent treatment, and cosmetic score after periosteal flap for eyelid reconstruction.

Patient number	Age	Sex	Skin cancer type	Defect location, % of eyelid involvement	Defect area (cm^2)	Reconstruction	Complication	Treatment	Follow-up time to cosmetic evaluation	Mean cosmetic outcome (0-100)
001	54	M	BCC	Right lateral lower eyelid from lateral canthus, 35%	1.0	Tenzel flap + C/C + periosteal flap	None	N/a	4 weeks	86
002	33	F	BCC	Left lower eyelid from lateral canthus, 50%	1.5	Tenzel flap + C/C + periosteal flap	None	N/a	6 weeks	94
003	75	M	BCC	Right lateral lower eyelid from lateral canthus, 50%	2.1	Tenzel flap + C/C + periosteal flap	None reported at one week, then patient lost to follow up	N/a	18 months	96
004	47	M	BCC	Right central lower eyelid, 75%	3.0	Tenzel flap + C/C + periosteal flap	None	N/a	4 months	98.5
005	71	M	BCC	Medial central left lower eyelid, 66%	1.8	Tenzel flap + C/C + periosteal flap	None	N/a	3 months	95
006	65	F	BCC	Left lower eyelid, 100%	8.8	Periosteal flap + cheek advancement flap	Medial and lateral canthal webbing, slight scleral show	Opted for conservative measures	12 weeks	72.5
007	61	M	BCC	Left nasal root to the left lateral canthus with small remnant of upper and lower tarsal plate remaining attached to lateral canthus; 65% of left upper and lower eyelids, left supramedial and malar cheek	24.0	Upper and lower C/C, upper and lower laterally based periosteal flaps, upper and lower eyelid advancement with tacking of tarsal plate remnants to medially based periosteal flaps, cheek advancement and paramedian forehead flaps	Mild-moderate lagophthalmos Mild medial lower lid ectropion	Opted for conservative measures	1 year	61.5
008	75	F	Recurrent invasive melanoma	Left temple to lateral canthus with involvement of 50% of upper and lower eyelids and full-thickness involvement of lower lid. Extends superiorly to above the left brow and inferiorly onto the cheek	20.9	Periosteal flap + trilobed flap for anterior lamella + Burrow's FTSG for upper eyelid	Trichiatic lower lashes at lateral canthus and lateral canthal phimosis	Epiilation; fractional carbon dioxide (CO_2) laser and Z-plasty at lateral canthus to correct phimosis	3 months	84.5

009	64	M	Melanoma	Temple to lateral canthus onto the lateral upper and lower eyelids; full-thickness involvement of lower lid	22.0	Periosteal flap + bilobed flap for anterior lamella + Burrow's FTSG for upper eyelid	Minor webbing Restricted range of motion at lateral canthus	Treated twice with intralesional triamcinolone 40 mg/mL and two sessions with CO2 laser	3 months	85.5
010*	79	F	BCC	Left lower eyelid, 100%	10.0	Periosteal flap + cheek advancement flap	Healing appropriately at 4-week follow-up	N/a	N/a	N/a

C/C = canthotomy/cantholysis. * = deceased prior to long-term follow up photos further follow-up photos. FTSG = full-thickness skin graft

No serious complications occurred postoperatively. Mild to moderate complications were reported in 4/10 patients. Minor complications included foreign body sensation, slight scleral show, trichiatic lower eyelashes, and canthal webbing in two patients. Two patients with lateral canthal defects reconstructed with lobed flaps and upper eyelid full-thickness skin grafts reported lateral canthal phimosis/restricted range of motion at the lateral canthus. One of these two patients was treated with a Z-plasty and the other with intralesional triamcinolone 40 mg/mL and fractional carbon dioxide laser. One patient reported mild-moderate lagophthalmos and mild medial lower lid ectropion however, this patient was lost to follow up.

The mean cosmetic score was 85.8 +/- 10.7. Representative photos of the lowest-, median-, and highest-scoring cosmetic outcomes are included in Fig. 2.

Discussion

To our knowledge, this is the largest retrospective series in Mohs literature reviewing functional and cosmetic outcomes after implementing the periosteal flap technique. This further expands the breadth of reconstructive options available to Mohs surgeons that can be used for repair of full-thickness eyelid defects. Each of the ten cases resulted in adequate surgical and cosmetic outcomes, without any major complications. Minor to moderate complications including lagophthalmos, mild ectropion, scleral show, and canthal webbing, were generally managed conservatively according to patient preference, while the patient with trichiasis was treated with epilation. Lateral canthal phimosis was managed effectively in one of our patients with a lateral canthal Z-plasty and in another by intralesional triamcinolone and CO2 laser. Our complication rate of 40 percent is comparable to the rate of complications reported by Papadopoulos et al. (8%), Kakudo et al. (46%), Spinelli et al. (29%), and Saito et al. (42%) in larger case series of eyelid repairs performed by oculoplastic surgeons.[15-18] A correlation was observed between defect size and complication rates, as well as defect size and lower cosmetic scores. This observation is likely attributable to tension at the wound edges with larger defects which may be managed with common scar revision techniques. For best functional and cosmetic results, we recommend minimizing tension as much as possible.

When there is too much tension and not enough support on the lid even with the technique described above, alternative options used for reconstructing the posterior lamella include the Hughes and the Cutler-Beard tarsoconjunctival flaps. These two-stage procedures leave the patient with monocular vision for several weeks prior to pedicle division and may be less desirable in some instances. We prefer to use the periosteal flap technique whenever appropriate, however those who simply cannot tolerate periocular surgery due to anxiety or discomfort may still benefit from reconstruction in an operating room setting. It is always important to consider patient perspective, and it would be valuable to assess intraoperative and post-operative patient experience during reconstruction of eyelid defects with a survey tool.

Limitations of this study are its small sample size, retrospective nature, and the inherent selection bias as larger cases may have been referred to oculoplastic colleagues for reconstruction. Because all procedures were performed by one of two dermatologic surgeons at a single institution, generalizability to the broader field is limited. In addition, because this was a single institution study, the cosmetic dermatologists and dermatologic surgeons were from the same institution and therefore not blinded to the performing surgeon. Finally, defect heterogeneity (size, percent of eyelid involvement, location) among the ten cases was also a limiting factor, however greater numbers are required to stratify based on these characteristics.

In summary, we demonstrate the safe, effective utilization of the periosteal flap as a single-stage option for repair of large, full-thickness eyelid defects with adequate cosmetic results and complication rates comparable to oculoplastic surgeons. Eyelid reconstruction requires a thorough understanding of the anatomic structure and function of the eyelids and careful attention toward what is missing. While some Mohs surgeons may lack the interest or comfort in performing these procedures, our findings support that with proper training, Mohs surgeons can indeed execute the periosteal flap technique successfully. Advantages for patients include preservation of binocular vision, improved patient experience, and potential cost-savings.

Declarations

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Conflicts of interest and disclosures:

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Figures

Figure 1

Periosteal flap and Tenzel semicircular rotation flap. A) A full thickness defect of approximately 50% of the lateral lower eyelid with design of a Tenzel semicircular rotation flap. First, canthotomy with inferior cantholysis is attempted and if there is too much tension, the Tenzel flap is incised and dissected in the preseptal plan posterior to the orbiculares oculi muscle until it is sufficiently mobilized so that the wound can be closed without tension. B) If there is still too much tension on the wound, a strip of periosteum is incised at the inner aspect of the lateral orbital rim, approximately 5 mm in width. C) The length of the periosteal flap corresponds to just greater than is necessary to reach the tarsal plate remnant. The flap should be incised in the desired vector of the affected lid, and the superior aspect of the planned flap will determine position of the lateral lid. D) The pentagonal wedge is closed. E) The periosteal flap is reflected 180 degrees and sutured to meet the lateral aspect of the tarsal plate remnant. F) The Tenzel flap is sutured closed. G) Immediate post-operative result. H) Three-month follow-up.

Figure 2

Representative photographs of the lowest-, median-, and highest-scoring cosmetic outcomes, respectively labeled A, B, and C. Photos taken before closure (A1, B1, and C1) and at follow up (A2, B2, C2).

Supplementary Files

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