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Staged reconstruction of the lower eyelid following tri-lamellar injury: A case series and anatomic study

Jason Roostaeian, Emil Kohan, Neil Tanna, Christina J. Tabit, Henry K. Kawamoto, James P. Bradley*

David Geffen School of Medicine at University of California Los Angeles, Division of Plastic and Reconstructive Surgery, 200 Medical Plaza, Suite 465, Los Angeles, CA 90095-6960, United States

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Summary Purpose: Lower eyelid scarring and malposition following violation of all three lamellae pose a significant ophthalmologic reconstructive challenge. The purpose of our study was to document a staged approach for this problem using: 1) transconjunctival scar release followed by palatal graft below the tarsal plate and subciliary scar release followed by full-thickness skin graft superficial to the tarsal plate and 2) subsequent autologous fat grafting to the lower eyelid.

Methods: Cadaveric anatomic dissections were performed. Post-traumatic and post-surgical lower eyelid deformities requiring reconstruction were reviewed and outcome assessment was based on symptomatic improvement, perioperative complications, reoperations and long-term follow-up (> 1 year).

Results: Cadaver dissections demonstrated consistent lower eyelid tarsal plate and lamellar anatomy for the use of palatal graft and skin grafting. Clinically, 75% cases resulted from full thickness traumatic laceration of the lower eyelid or malar region and 25% of cases occurred after transconjunctival incisions were made for zygomatic maxillary repositioning following partial lower eyelid laceration.

Preoperative symptoms of: epiphora, tearing, redness, blurry vision and dryness improved in all patients and complete resolution was seen in 63% of patients. Thirty-seven percent of patients had complications: Redundancy of palatal graft, Partial FTSG loss, cellulitis after fat transfer.

Conclusions: We describe an approach for the scarred and displaced lower eyelid following injury to all three lamellae that provided symptomatic improvement after lower lid scar tissue release, lengthening of the contracted septum, support of the posterior lamellae with a palatal graft and a replacement of anterior lamella with full thickness skin graft.

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* Corresponding author. Tel.: +1 310 794 7616; fax: +1 310 794 7933.
E-mail address: Jbradley@mednet.ucla.edu (J.P. Bradley).

Introduction

Severe scarring and malposition of the lower eyelid following violation of all three lamellae pose a significant reconstructive challenge.¹ This problematic scarring and retraction may occur following full thickness traumatic laceration or injury to the lower eyelid or from trans-conjunctival access incision after partial thickness lower eyelid injury. When all three lamellar planes are violated from trauma and/or incisions, lower eyelid malposition with cicatricial entropion, ectropion, lower eyelid retraction/contracture and lid edema may result in close to 100 percent of cases.¹⁻³

Various surgical techniques have been described for the reconstruction of the lower eyelid following trauma with varying success. Previously reported reconstructive strategies include blepharotomy, the placement of rotation sutures, and hard palate mucous membrane grafts.^{2,4-8} These techniques focus on correction of cicatricial ectropion or entropion alone, with reconstruction aimed at either the anterior or posterior lamellar plane but not both. Management of the more severely scarred lower eyelid remains difficult due to unsatisfactory correction and/or continued scarring of the eyelid following reconstruction.⁹

For this difficult problem of severe cicatricial ectropion, entropion, and/or lower eyelid displacement, we describe a staged approach using: 1) a palatal graft below the tarsal plate after transconjunctival scar release and full-thickness skin graft superficial to the tarsal plate after subciliary scar release and 2) subsequent autologous fat grafting to the lower eyelid. To evaluate this new operative approach we performed cadaveric dissections of the lower eyelid and documented symptomatic improvement of patients with tri-laminar scarring.

Methods

Cadaver study

To better understand the anatomy of the lower eyelid, with particular focus on lamellar reconstruction, we performed 10 cadaveric anatomic dissections of the lower eyelid (n = 20). All cadavers were acquired through the willed body program at the University of California, Los Angeles. Lower eyelids were dissected based on the lamellar planes. Tarsal plate height was measured. A palatal graft was harvested, fashioned and used to replace the middle and posterior lamella below the tarsus. Various dimensions of palatal grafts were attempted in order to determine the average height that would support the lower lid margin at the level of the inferior limbus. In addition, a contralateral upper eyelid full-thickness skin graft was placed on the anterior tarsal plate.

Clinical study

All patients with post-traumatic and post-surgical lower eyelid deformities treated at University of California Los Angeles Medical Center between 1999 and 2008 were reviewed. Within this cohort we identified patients with

a severely scarred and malpositioned lower eyelid who underwent our described technique. Outcome assessment was based on 1) symptomatic improvement (epiphora, tearing, redness, blurry vision, dryness or other symptoms); 2) perioperative complications, 3) reoperations. Long-term follow-up was considered greater than 2 years from the surgery.

Operative technique

Following infiltration with .25% marcaine with epinephrine, a transconjunctival incision was made at least 6 mm below the margin, just below the tarsal plate. Scissors were then used to dissect the scar tissue and the preseptal plane was identified all the way down to the orbital rim. Subperiosteal dissection was performed and a backcut was necessary in the periosteum along the orbital rim to fully release the posterior lamella scar. Next, a subciliary incision was made and a skin muscle flap was raised to free the anterior lamella from scar (Figure 1).

A hard palate mucoperiosteal graft was harvested to the size of the posterior lamella defect (approximately 7 mm × 25 mm). Gelfoam soaked in marcaine with epinephrine was packed into the palatal defect. This palatal mucosal graft was then inset into the trans-conjunctival defect with interrupted 5-0 chromic sutures. Also, a FTSG was taken either from the contralateral upper eyelid from a blepharoplasty excision or the postauricular area based on a template for the anterior lamella defect. The FTSG was then sutured in with a running 5-0 plane gut suture. In 4 of the 8 cases, a lateral canthoplasty was also performed with full canthal and lateral septal release. A 3-0 nylon criss-cross (90°-90°) suture was placed through the canthus then through two superior orbital rim drill holes for

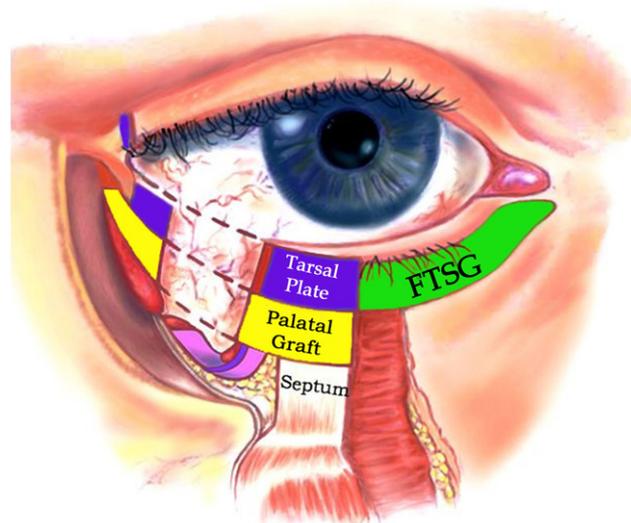


Figure 1 Illustration of lower eyelid anatomy, with key anatomic landmarks labeled (Tarsal plate (1), Septum (3), Orbicularis Oris muscle (4)). Cross-section demonstrates reconstruction posteriorly with palatal graft (2) and anteriorly with full-thickness skin graft (5 = FTSG).

repositioning. Finally, a frost suture was placed for 5 days for lower eyelid immobilization.

Three to six months following the scar release with palatal and skin grafting, autologous fat grafting to the lower eyelid was performed. (Fat grafting acted as a spacer and volume expander to the contracted, deficient lower eyelid and septum). The Coleman technique of a traumatic fat transfer was used, with 1) abdominal wall or flank fat harvest, 2) centrifugation for 3 minutes at 3000 rpms and 3) injections using a 1 cc syringe into different depths of the lower lid starting from superficial to the posterior lamella to the level of the orbicularis. A criss-cross pattern was utilized, with injection during withdrawal of the needle. The volume of fat injected per lid averaged 7cc and this amount was determined by the visible contour deficiency and amount needed to lengthen the space between the tarsal plate and arcus marginalis. Overcorrection of approximately 25% was the endpoint. At times repeat fat injects were deemed necessary at follow-up for further improvements.

Results

The cadaver studies demonstrated consistency in the anatomy of the lower eyelid and presence of all three lamellar planes as described in previous anatomic studies (Figure 2). It gave us further understanding of the proper planes of dissection as described in our operative technique above. Tarsal plate height ranged from 10–12 mms. The mean palatal graft height that supported the lower lid margin at the level of the inferior limbus was 6–7 mm. We further found that the palatal graft would provide the appropriate pliability and rigidity to both conform to the shape of the lower lid while also maintaining appropriate rigidity for lower eyelid support. We further verified the existence of fine smooth muscle attachments to the tarsal plate that extend along its anterior surface that would provide a suitable bed for skin grafting.



Figure 2 Cadaveric dissection demonstrated consistency in the tri-lamellar anatomy. Tarsal plate (labeled) height ranged from 10–12 mms. Optimal palatal graft (labeled) height for middle and posterior lamella reconstruction was 6–7 mm.

From 1999 to 2008, there were post-traumatic and post-surgical lower eyelid deformities with either entropion or ectropion that required reconstruction ($n = 52$). Of these patients, 10 patients (19%) were considered to have severely scarred and malpositioned lower eyelids (Table 1). These 10 cases were all treated with the above described techniques (Figure 3). Eight of these cases resulted from full thickness traumatic laceration of the lower eyelid or malar region and 2 cases occurred after transconjunctival incisions made for zygomatic maxillary repositioning following partial lower eyelid laceration. Seven of these traumatic cases were from motor vehicle accidents and 3 were from assault injuries. The lower eyelid reconstruction was performed at a mean of 9.1 months following the initial injury (range = 6–17 months). There was an average of 2.6 procedures performed per patient.

Preoperatively, all 10 patients complained of symptoms related to the lower eyelid scar including, epiphora (90%), tearing (100%), redness (100%), blurry vision (80%) and dryness (90%). There was some improvement in symptoms in all patients and complete resolution in 6 of the 10 patients (Figure 4). Three patients had complications. One patient underwent revision to the palatal graft with reduction for redundancy of graft at the time of fat transfer. One patient underwent repeat FTSG for partial loss. One patient had cellulitis after fat transfer treated with oral antibiotics. There were no other complications at a minimum of 2-year follow-up.

Discussion

Full-thickness traumatic injury of the lower eyelid and incisions used for accessing facial fractures can result in difficult-to-correct lower eyelid malposition. Malposition includes cicatricial entropion, ectropion, lower eyelid retraction/contracture and lid edema resulting from excessive scarring. Various surgical techniques including local flaps, scar releases, and tissue grafts have been advocated for correction of lower eyelid malposition, however no single method has proven to be ideal. Success rates have been variable in the literature among the various reported techniques for the correction of lower eyelid malposition and have ranged from 57% to around 90%.¹⁰

An understanding of lower eyelid anatomy is essential for deriving a suitable technique for the correction of malposition. Our cadaver dissections allowed us to further our understanding of the lower eyelid anatomy and access variability among specimens. The lower eyelid is described in 3 layers, or lamellae; the anterior, middle and posterior. The anterior lamella contains the skin, subcutaneous tissue and the orbicularis oculi muscle.¹¹ The middle lamella includes the orbital septum, sub-septal (or orbital) fat, and fibroadipose tissue posterior to the septum.^{12,13} The posterior lamella includes the anterior and posterior lower eyelid retractors, tarsal plate and conjunctiva.¹¹ Full-thickness injury of all three of these planes results in malposition in almost all cases. The lower eyelid retractors are believed to be composed of the aforementioned 2 layers (anterior and posterior).¹⁴ The posterior lower eyelid retractor, the thicker of the two, consists of smooth muscle

Table 1 Summary of lower eyelid trilamellar injury patient data.

Patient	Mechanism of Injury	Time to Reconstruction (months)	Time to Fat Grafting (months)	Resolution of Symptoms	Follow-up (months)	Complications
1	MVA	12.1	8.1	Partial	94	None
2	Assault	8.1	N/A	Complete	83	Palatal graft redundancy
3	MVA	7.2	5.2	Partial	77	None
4	MVA	6.8	5.8	Complete	74	None
5	MVA	9.5	6.6	Partial	65	FTSG loss
6	Assault	9.8	7.2	Complete	51	None
7	MVA	14.3	8.8	Complete	47	None
8	Assault	6.9	N/A	Partial	38	Cellulitis
9	MVA	8.8	5.2	Complete	28	None
10	MVA	7.4	6.8	Complete	24	None
Mean		9.1	6.7		58	

fibers from the globe and attaches to the posterior, inferior and anterior aspect of the tarsal plate. It serves to draw the lower eyelid in an inferior and posterior direction.¹⁵ It is likely these smooth muscle attachments and its associated vascularity that make the tarsal plate a suitable bed for full-thickness skin grafting as evidenced by the consistent graft take in our clinical series. The anterior lower eyelid retractor is composed of the capsulopalpebral fascia from Lockwood ligament, and facial tissue from the orbicularis oculi. The anterior lower eyelid retractor attaches to the subcutaneous tissue of the lower lid.¹⁶ When reconstructing the lower lid, the absence of structural lower lid support (i.e. due to scarring) provided by these retractors must be considered. The orbital septum, originating from the arcuate marginalis, joins the lower lid retractors and serves to keep contents within the orbit.^{17,18} Violation of the septum and the resulting scar tissue has also been responsible for post-operative cicatrix formation. Correction of full thickness defects resulting in lower eyelid malposition require consideration for each of the three layers of the lower lid with complete release of all scar tissue through each of these layers. Particular attention should then be paid to adequate structural support of the posterior lamellae and soft tissue coverage of the anterior lamellae.

In addressing reconstruction of the posterior lamellae, one technique that has been successful in the correction of cicatricial entropion for the lower eyelid is posterior buttress surgery. With this technique the eyelid margin is

repositioned and autologous tissue is added to support the new position of the margin.^{2,19–25} Various autologous tissue options are available for lower lid tissue replacement and include: nasochondral mucosa, buccal mucosa, ear cartilage, and hard palate mucous grafts. In addition to autologous options, acellular dermal matrix such as Allo-derm (Lifecell, Branchburg, NJ) has also been used for posterior lamellar support with some, but not complete success. However, in two comparative studies, Alloderm offered lower success rates with less lower eyelid elevation and higher post-operative contraction rates when compared to autologous tissue.^{26,27} Hard palate mucous grafts (HPMGs) are an attractive autologous option due to their composite nature with a mucosal epithelial surface along with a high collagen content that makes it both rigid for support yet relatively flexible. This combination of sufficient rigidity and flexibility was evident both clinically and in our cadaver dissection. The palatal graft was able to conform well to the convex shape of the eye and maintain that shape while supporting an elevated position of the lower lid following dissection. In addition, HPMGs allow for the harvest of large grafts with an inconspicuous scar, minimal donor site morbidity, and low complication rate. The most common complication is bleeding from the donor site with an incidence that ranges from 2.7 to 10%.^{21,28–30} One of the concerns with the use of HPMGs is the keratinized mucous membrane that can result in corneal irritation.²⁰ This however, did not occur in any of our patients



Figure 3 Patient with left lower eyelid scarring after removal of infected orbital floor implant for post-traumatic correction. A. After initial repair of displaced ZMC, orbital floor fractures and soft tissue, full-thickness lower eyelid laceration repair. B. Three months following initial injury with lower eyelid retraction and scar. C. Postoperative image, 6 months after lower eyelid reconstruction with cheek elevation, palatal graft, FTSG and fat grafting.



Figure 4 Patient sustained full-thickness left lower eyelid injury after motor cycle accident resulting in severe scarring, retracted left lower eyelid who underwent staged correction. A. Preoperative frontal image demonstrates retracted left lower eyelid with ectropion, chemosis and periorbital swelling. B. Postoperative image (after described staged procedure) showed improved protection of globe and improved lower eyelid position.

and was reported to only occur in 2.7% of patients in a recent large series.³¹ In this same series, including 107 patients for the repair of cicatricial entropion with HPMG, a 94% success rate with only 4% rate of revision was reported.

In order to address the anterior lamellae, after fully dissecting free all scar tissue, we placed a full thickness skin graft from the posterior auricular region over the tarsal plate. As noted above, the tarsal plate proved to be a suitable bed for graft take. Again, this may be related to its smooth muscle attachments along much of its surface, including its anterior surface where the graft was placed. Other options for addressing the anterior lamellar coverage could include local flap or more extensive cervicofacial flaps, or full thickness grafts from the contralateral lid or supraclavicular regions. We chose full thickness skin grafts as it supplies less extensive dissection with good color match, minimal donor site morbidity, and low rates of ectropion. The rate of ectropion following full thickness grafts range from 2.5 to 7%.^{2,32} In our series there was no ectropion or entropion noted on follow-up. It can be postulated that release of both the posterior and anterior lamellae and placement of grafts supply balancing forces in terms of contracture and thereby reduce the risk ectropion and entropion.

Following correction of the lower lid in terms of its position through our first stage procedure described above, we have successfully applied fat grafting techniques to correct volume deficiencies and skin texture of the lower lid. Injection of autologous adipose tissue, harvested and processed according to S. R Coleman's technique (lipostructure),^{33,34}

has become increasingly popular and its range of clinical application is widening.^{35,36} Fat grafting has been noted to improve skin texture, softness, and thickness.³⁷ Adipose contains stored cellular fat and mesenchymal stem cells. The adipose derived stem cells can divide indefinitely and are capable of replacing cells that are necessary for restoration of the skin's full mechanical and biologic properties. Fat grafting has been shown to be successful in the eyelid with good graft survival on histologic examination.³⁸ Moreover, fat grafting has also been noted in a case report to be successful in correcting lower lid ectropion.³⁹ We too have found utility in the use of fat grafting in a second stage to improve volume deficiencies and overall outcome in correction of lower lid malpositioning.

Although correction of ectropion or entropion may be difficult, the severely scarred lower eyelid from violation of all three lamellae is even more challenging to treat.¹⁻³ Previous publications focus on correction of cicatricial ectropion or entropion alone, with reconstruction aimed at either the anterior or posterior lamellar plane but not both. We describe a staged approach for reconstructing the scarred and displaced lower eyelid following injury to all three lamellae. In our approach we emphasize release of lower lid scar tissue and lengthening of the contracted septum, support of the posterior lamellae with a palatal graft and a replacement of anterior lamella with full thickness skin graft. After subsequent revisions with fat transfer we documented success in symptomatic improvement in a small series using this approach. In addition, we suggest caution against transconjunctival approach following partial lower eyelid cutaneous injury.

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