Eyelid Reconstruction Techniques: An Overview

Maya Hada
Oculoplasty and Ocular Oncology Services, Sawai Man Singh Hospital, Jaipur, India

Abstract

Eyelid and periocular reconstructions are often required for the defects due to trauma or following excision of neoplasms. Reconstruction of the eyelids poses a significant challenge to the budding ophthalmoplastic surgeons. A variety of techniques have been described for the repair of these defects. This comprehensive review outlines the basic principles of eyelid reconstruction and the range of surgical techniques available.

Introduction

Eyelids are complex structures and play an important role in protecting the globe and maintaining the integrity of tear film with their dynamic movement. eyelid defects are caused by trauma, tumor excision and congenital colobomas. Reconstruction techniques have evolved over time and excellent results can now be achieved with a combination of ingenious flaps and grafts. An injudicious selection of a technique may be harmful for the eye and may necessitate further surgical correction. This review article discusses various surgical techniques commonly used for periocular reconstruction with their advantages and disadvantages, with an emphasis on different flaps.

The goals of eyelid reconstruction:
1. Anatomic integrity - An adequate lid reconstruction must restore the anatomic structures of the eyelid and must allow the eyelid to protect the ocular surface by apposing a mucosal surface to it. It must also have a stable eyelid margin that prevents stratified squamous epithelium, lashes, or hairs from abrading the cornea.
2. Physiologic functioning - The eyelid must be mobile, so it can wipe the cornea and refresh the tear film and clear the visual axis.
3. Cosmesis - As the eyelids form one of the most significant landmarks of the human face; there should be an acceptable cosmetic appearance in relation to the other eye, with regards to symmetry of eyelid height, contour, tarsal show, and skin fold. The realistic outcome of the reconstruction must be well understood by the patient.

Principles of Lid Reconstruction

“Reconstruction of an eyelid or even a part of it requires a minimum of three elements: an outer layer of skin; an inner layer of mucosa; and a semirigid skeleton interposed between them” as described by Mustarde. The eyelid is divided into two lamellae with an anterior lamella consisting of skin and orbicularis muscle and a posterior lamella consisting of mucosa. In the tarsal region this posterior lamella also contains the tarsus. For the defect of the anterior lamella, if limited to the eyelid alone, a full thickness skin graft is recommended. The upper eyelid skin is both the thinnest skin of the body and is hairless. It is therefore essential to try and match “like-for-like” when reconstructing the anterior lamella. One must adhere to the basic principles relating to the viability of flaps and grafts. These dictate that a graft can be laid on a flap, and vice versa, and a flap can be laid on a flap, but a graft cannot be laid on another graft because of the lack of a secure blood supply.

Assessment of the Defect

Thorough assessment of the defect is essential for effective eyelid reconstruction. The horizontal and vertical extent of the lesion should be measured and photographed. The amount of tissue required for reconstruction is then determined by placing the medial and lateral wound edges under gentle tension to demonstrate the reduced defect size. Methods of reconstruction for full thickness eyelid defects are:

1. Small defects
   • Direct closure
   • Direct closure with lateral cantholysis
2. Moderate size defects
   • Lateral semicircular rotation flap (Tenzel’s)
   • Tarsocconjunctival flap – Horizontal tarsocconjunctival transposition flap (Hewes)
   • Tarsocconjunctival advancement flap (Hughes)
   • Marginal pedicle rotation flap (Mustarde’s flap)
   • Composite lid graft (Callahan’s)
3. Large size defects
   • Bridged advancement flap (Cutler–Beard)
   • Mustarde’s cheek rotation flap
   • Rhomboid cheek flap
   • Free tarsocconjunctival graft and myocutaneous advancement flap
   • Tarsocconjunctival advancement flap
   • Lid switch flap (Mustarde)
   • Temporal forehead transposition flap (Fricke)
   • Median forehead flap

a. Direct closure

Small defects can be reconstructed by direct closure. The defect is converted into a pentagon by making a perpendicular cut up to the upper border of the tarsus. Closure is done in layers with extra care for the marginal sutures. This method is useful for the correction of congenital simple coloboma of the upper eyelid. If there is some tension, a cantholysis of the upper crux of the lateral canthal tendon can be done. Up to 25% defect of the upper eyelid can be closed in younger individuals.
and up to 40% in older individuals.

b. Lateral semicircular flap (Tenzel flap)
For the central defects in the lower eyelid, which cannot be closed directly, a superiority based semicircular flap can be fashioned from the lateral canthal area (Figure 1, a-c). The flap is elevated in a suborbicularis plane up to the orbital rim and subcutaneously beyond this so as to avoid the zygomatic branches of the facial nerve. If further translation of the flap is required, the flap can be further extended and a back-cut can be utilized.7 The flap is raised up to the peristeum and moved medially. The conjunctiva in the lateral fornix is dissected and advanced to suture to the margin. The central defect can be closed in layers. The lateral lid would be devoid of cilia.

For similar defects in the upper eyelid, the inverted semicircular flap is fashioned, that follows the downward curve of the lateral eyelid towards the orbital rim and then gently curves upward (Figure 1, d-i). Once the wound edges can be apposed with minimal tension, the flap is secured by its deep tissues to the peristeum of the lateral orbital rim. This important step prevents the flap from sagging under its own weight, exacerbated by the temporary loss of muscle tone. The primary full-thickness eyelid defect is then closed directly, and the lateral canthus is reformed with a buried absorbable suture. The marginal edge of the flap need not be sutured to the mobilized conjunctiva.

c. Composite Grafts
Composite free graft containing the conjunctiva, tarsus, and eyelid margin skin may also be used to repair a medium sized full-thickness defect of the upper eyelid. Full thickness composite eyelid grafting was first described by Callahan and Fox, but resulted in poor tissue viability because neither the anterior nor posterior lamellae had sufficient vascularity.13,14 A viable alternative was later proposed in the form of the tarsomarginal graft which contained the lid margin and adjacent tarsus only, and which required a vascularized anterior lamella.15,16 It is recommended that tarsomarginal grafts be used for defects only up to a maximum of one-half of the relaxed eyelid length to ensure direct closure of the donor site.7 Tarsomarginal grafts may also be harvested from the lower eyelids, particularly where there is significant lower eyelid laxity.18

d. Hughes’ tarsoconjunctival flap
Hughes’ tarsoconjunctival flap is a useful method for reconstruction of large eyelid defects.9 A tarsoconjunctival flap is developed 4 mm above the lid margin from the upper eyelid. This is needed for the stability of the lid margin. The levator aponeurosis is dissected off the flap. Muller’s muscle is included but divided at the time of the division of the flap. The width of the flap should be less than the size of the defect. The flap is sutured to the inferior edge of the defect to the conjunctiva and to the tarsal plates on the side with absorbable sutures. The anterior lamella is reconstructed by the advancement flap from the cheek (Figure 2 g-i), if the skin is lax, or a full thickness skin graft (Figure 2a-f). The division of the flap is done preferably after 6 weeks to allow stretching of tissues. Extra conjunctiva should be retained in the newly reconstructed lid to form the conjunctival lining of the margin.

e. Cutler–Beard reconstruction
The Cutler-Beard flap (“bridge flap”) was first described in 1955.12 The principle is to bring full-thickness lower eyelid tissue, harvested from 4 mm below the lower eyelid margin, underneath this remaining “bridge” of tissue and over the cornea to fill the upper eyelid defect (Figure 3a-d). The full-thickness flap is divided 4-8 weeks after surgery at the level of the newly reconstructed upper eyelid margin. The Cutler-Beard

Figure 1 (a-i): a) Lower lid defect post tumor excision (<50%); b) Tenzel’s semicircular flap raised at lateral canthal region; c) Flap is rotated medially and defect is closed in layers; d) Upper eyelid recurrent sebaceous gland carcinoma; e) Marking for tumor excision in a pentagon shape; f) Eversion of the lid to delineate posterior extent; g) Tumor excision and marking of semicircular flap; h) Semicircular flap advanced to close the defect; i) Post operative photograph at 2 weeks.

Figure 2 (a-i): a) Incision marked around lower lid basal cell carcinoma; b) after tumor excision (Large defect (>75%) of the lower lid after tumor excision; c) Tarsoconjunctival flap advanced from upper lid for posterior lamella; d) Full thickness skin graft placed for anterior lamellar reconstruction; e) Retroauricular donor site; f) Healthy and well apposed graft at 4 weeks follow up; g) Lower lid large size defect post tumor excision; h) Anterior lamella formed with advancement of local myocutaneous flap, over the tarsoconjunctival flap; i) Post separation of flap, at 6 weeks.
flap does provide good donor–recipient skin match, but has few limitations, including prolonged occlusion of one eye, persistent lower eyelid instability and upper eyelid entropion.\textsuperscript{19,20}

Various modifications have been made to the original Cutler-Beard procedure to address such problems, including the implantation of a stiffener such as donor sclera,\textsuperscript{20,22} ear cartilage,\textsuperscript{13} and Achilles tendon\textsuperscript{23} between the skin-muscle layer and the conjunctival layer of the lower eyelid. An alternative approach has been to raise flaps of only anterior or posterior lamellae from the lower eyelid and to use a free graft to reconstruct the other lamella. Tarsocconjunctival flaps can be raised from the lower eyelid as a reverse of the upper eyelid modified Hughes procedure\textsuperscript{23,24}

f. Glabellar flap
Defects in the medial canthal areas may involve the skin alone or MCT and/or the lacrimal drainage system. For the skin defect alone, the laissez Faire method which is spontaneous healing of the area is sometimes recommended.\textsuperscript{25} The glabellar flap is a transposition flap raised from the glabellar region. The surrounding area is undermined to allow for the direct closure of the donor area and help in transposing the flap into the defect. The donor area is closed like an inverted “Y”. It brings the medial ends of the eyebrow together. The MCT and lacrimal drainage system need not be repaired primarily in defects due to malignant lesions.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure3.png}
\caption{Figure 3 (a-d): a) Squamous cell carcinoma of the right upper eyelid; b) Upper eyelid defect with large horizontal and shorter vertical extent; c) Bridge flap advanced from lower lid and sutured with two lamella; d) Clinical photograph after separation of bridge flap, acceptable cosmesis with cilialess lid margin.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure4.png}
\caption{Figure 4 (a-f): a) Circular defect in the medial canthal region post tumor excision; b) Bilobed flap marked and rotated into the defect laterally; c) Post operative photograph; d) Recurrent basal cell carcinoma of medial canthal region; e) Median forehead flap fashioned post tumor excision; f) Flap rotated and placed over the posterior lamellar graft, with direct closure of forehead defect.}
\end{figure}

g. Median forehead flap
The median forehead flap is a versatile flap for reconstructing upper, lower, or both eyelids and the medial canthal areas. The flap is thick and the dog-ear in the pedicle needs to be trimmed later. The flap is raised from the center of the forehead depending on the width needed. The donor area is closed directly (Figure 4d-f).

h. Mustarde’s cheek rotation flap
This flap is particularly useful for reconstruction in larger defects of the lower lid especially in long vertical defects. The flap is marked lateral to the defect extending to the lateral canthal area. It should curve upward and carried down in front of the ear. The entire flap is undermined in the subcutaneous layer. It is transposed over the defect. The medial end of the defect should be vertical and should be anchored to the medial wall of the orbit. Laterally, it is anchored to the lateral wall. Posterior lamellar reconstruction can be done with tarsocconjunctiva,\textsuperscript{26,27} or by hard palate mucosa.\textsuperscript{29,30}

i. Mustarde’s lid switch flap
The Mustarde “lid switch” procedure is based on a medial or lateral pedicle.\textsuperscript{29,30} It is a transposition flap as opposed to an advancement flap. The pedicle of the flap is placed on the same side as any residual upper eyelid tissue. The flap is secured in the upper eyelid by bilamellar direct closure, leaving the pedicle connected. The flap is usually divided after 2 to 4 weeks, and the lower eyelid defect is then repaired by a secondary reconstructive procedure.

This is useful for upper eyelid defects with differing lamellar defects or to preserve additional posterior lamella and eyelid margin in the lower eyelid. Bipedicled lower eyelid anterior lamellar (Tripier) flaps have also been reported with buccal mucous membrane lining.\textsuperscript{24} However, the lack of tissue to replace tarsus results in a lack of rigidity in the reconstructed upper eyelid, making it prone to entropion.

j. Non-bridging, Non-occlusive Techniques
To avoid occluding the eye with a bridge flap, vascularized tissue must be recruited from the periocular region to support both lamellae. This may be in the form of an anterior lamellar flap in conjunction with a posterior lamellar graft or bi-lamellar grafts supported by orbicularis mobilization (“sandwich flap”).\textsuperscript{30} Autologous grafts for upper eyelid posterior lamellar reconstruction include tarsocconjunctiva,\textsuperscript{26,27} and hard palate chondromucosa.\textsuperscript{29,30} Buccal mucous membrane is another alternative, although this lacks rigidity.\textsuperscript{34}

k. Reconstruction of defects of both eyelids
The reconstruction of full thickness defects in both eyelids is a challenge to the creativity of the plastic surgeon. One of the common causes we see in our country is the loss of eyelids due to burns, especially post-acid injuries. To protect the cornea, total tarsorrhaphy by
suturing the mobilized conjunctiva from both fornices and covering the anterior surface with a split graft is advised. This is called as the Masquerade procedure.

**Conclusion**

Eyelid defects form one of the challenging areas of reconstruction because of the highly specialized anatomy. The reconstruction of full-thickness eyelid defects is best approached using an algorithm of techniques based on defect size. This requires careful assessment of the defect, including horizontal measurement under gentle tension. Combination of several techniques may be needed in the repair of complex eyelid reconstructions. The availability of tissues, technical expertise, and the specific needs of the patient have to be kept in mind before choosing a particular method. The procedure which produces functional improvement and best cosmetic result and is most convenient for the surgeon, should be the procedure of choice.

**References**

1. McCord CD: Eyelid surgery. Principles and techniques. Lipincott-Raven publishers 1995; 252-311.
2. Mustarde JC: Repair And Reconstruction in the Orbital Region. 2nd ed. Philadelphia: Churchill Livingstone; 1991.
3. Doxanas MT. Orbicularis muscle mobilisation in eyelid reconstruction. *Arch Ophthalmol* 1986; 104:910-4
4. Codner MA, McCord CD, Mejia JD, Lalonde D. Upper and lower eyelid reconstructions. *Plast Reconstr Surg* 2010; 126:231e-45e.
5. J.R.O. Collin, Manual of systematic eyelid surgery, 3rd edition. Churchill Livingstone, 1983,76-95
6. Irvine F, McNab AA. A technique for reconstruction of upper lid marginal defects. *Br J Ophthalmol* 2003; 87:279-81.
7. Tenzel RR, Stewart WB. Eyelid reconstruction by the semicircle flap technique. *Ophthalmology* 1978; 85:1164-9.
8. Hewes EH, Sullivan JH, Beard C. Lower eyelid reconstruction by tarsal transposition. *Am J Ophthalmol* 1976; 81:512-4.
9. Hughes WL. A new method for rebuilding a lower lid: Report of a case. *Arch Ophthalmol* 1937; 17:1008-1017.
10. Mustarde JC. Major reconstruction of the eyelids: functional and aesthetic considerations. *Clin Plast Surg* 1981; 8:227-31.
11. Callahan A. The free composite lid graft. *Arch Ophthalmo* 1954; 45:539-45.
12. Cutler ML, Beard C. A method for partial and total upper lid reconstruction. *Am J Ophthalmo* 1955; 39:1-7.
13. Wilsek G, Leatherbarrow B, Halliwell M, Francis I. The ‘RITE’ use of the Frick flap in periorbital reconstruction. *Eye (Lond)* 2005; 19:854-60.
14. Fox SA. Autogenous free full-thickness eyelid grafts. *Am J Ophthal* 1969; 67:941-5.
15. Hubner H. [Closure of eyelid defects by transplantation of lid margin and tarsus (author’s transl)]. *Klin Monbl Augenheilkd* 1976; 168:677-82.
16. Putterman AM. Viable composite grafting in eyelid reconstruction. *Am J Ophthalmo* 1978;85(2):237-41
17. Daggregorio G, Huguiel V, Darsnoval V. Reconstruction of seventeen full-thickness defects of the eyelids with twentytwo Hubner tarsomarginal grafts. *Br J Plast Surg* 2005; 58:361-5.
18. Hoyama E, Limawararu VT, Malhota R, et al. Tarsomarginal graft in upper eyelid coloboma repair. *J AAPOS* 2007; 11:499-501.
19. Carroll RP. Entropion following the Cutler-Beard procedure. *Ophthalmology* 1983; 90:1052-5
20. Wesley RE, McCord CD. Transplantation of eyebank sclera in the Cutler-Beard method of eyelid reconstruction. *Ophthalmology* 1980; 87:1022-8
21. Kadou C, Hayasaka S, Kato T, et al. The Cutler-Beard bridge flap technique with use of donor sclera for upper eyelid reconstruction. *Ophthalmologica* 2000; 214:140-2
22. Holloman EL, Carter KD. Modification of the Cutler-Beard procedure using donor achilles tendon for upper eyelid reconstruction. *Ophthal Plast Reconstr Surg* 2005; 21:267-70.
23. Leone CRJ. Tarsal-conjunctival advancement flaps for upper eyelid reconstruction. *Arch Ophthalmo* 1983; 101:945-8.
24. Mauriello JA, Antonacci R. Single tarsocconjunctival flap (lower eyelid) for upper eyelid reconstruction (“reverse” modified Hughes procedure). *Ophthalmic Surg* 1994; 25:374-8.
25. Zitelli JA. Secondary intention healing: an alternative to surgical repair. *Clin Dermatol* 1984; 2:92-106.
26. Hawes MJ. Free autogenous grafts in eyelid tarsocconjunctival reconstruction. *Ophthalmic Surg* 1987; 18:37-41.
27. Stephenson CM, Brown BZ. The use of tarsus as a free autograft in eyelid surgery. *Ophthal Plast Reconstr Surg* 1985; 1:43-50.
28. Cohen MS, Shorr N. Eyelid reconstruction with hard palate mucosa grafts. *Ophthal Plast Reconstr Surg* 1992; 8:183-95.
29. Siegel RJ. Palatal grafts for eyelid reconstruction. *Plast Reconstr Surg* 1985; 76:411-4.
30. Stafanous SN. The switch flap in eyelid reconstruction. *Orbit* 2007; 26:255-62.
31. Van der Meulen JC. The use of mucosa-lined flaps in eyelid reconstruction: a new approach. *Plast Reconstr Surg* 1982; 70:139.
32. Naugle TC, Levine MR, Carroll GS. Free graft enhancement using orbicularis muscle mobilisation. *Ophthalmo* 1995; 102:493-500.
33. Paridaens D, van den Bosch WA. Orbicularis muscle advancement flap combined with free posterior and anterior lamellar grafts, a 1-stage sandwich technique for eyelid reconstruction. *Ophthalmo* 2008; 115:189-94.
34. Moschella F, Cordova A. Upper eyelid reconstruction with mucosa-lined bipedicled myocutaneous flaps. *Br J Plast Surg* 1995; 48:294-9.
35. Subramanian N. Reconstructions of eyelid defects. *Indian J Plast Surg* 2011; 44:5-13.