Principles of Management of Eyelid Trauma: A Review

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ABSTRACT

Background: Eyelid trauma is a common day to day ophthalmic emergency, presenting to both general emergency room physicians as well as ophthalmology emergency sections. Often, these cases are inadequately managed due to lack of requisite understanding of eyelid anatomy, inadequate surgical skills by the primary attending physician and the presence of more severe life-threatening injuries which could cause delay in prompt ophthalmic intervention. The consequence therefore is a heightened risk of eyelid, ocular, visual, and aesthetic complications, which if not adequately managed could negatively impact the quality of life (QoL) of the injured.

Purpose: This review article, with focus on mechanical eyelid trauma, aims to present a simplified guide on the principles of management of eyelid trauma with the hope of providing an algorithm to facilitate decision making on eyelid trauma reconstruction.

Conclusion: Requisite knowledge and skills, adoption of basic principles and early referral where necessary, together with prompt multidisciplinary intervention, would ensure anatomical and functional restoration of the eyelid, as well as minimize post traumatic complications.

Keywords: *Eyelid trauma, eyelid laceration, eyelid injury, canalicular laceration, canthal injuries.*

INTRODUCTION

The eyelids are thin movable folds of skin overlying the anterior surface of the eyeball. The eyelid is a multi-layered structure composed from outwards inwards of skin, muscle, vascular, fibrous, connective, glandular and palpebral conjunctiva; and by virtue of being anteriorly placed over the eyeball plays important anatomical and physiological roles in globe protection and ocular surface wetting. The blink action of the eyelids aids in protection against any approaching foreign body and washing away of particulate matter that could be injurious to the cornea with possible potential threat to vision. Eyelid trauma represents a leading ophthalmological emergency and could present as blunt injury or penetrating lacerations. Eyelid lacerations refer to partial - or full-thickness defects in the eyelid[1]. These injuries may occur in isolation and are often also accompanied by other ocular injuries including corneal abrasions, disruption of the lacrimal drainage system, foreign bodies, open globe injuries, or orbital fractures[1]. Threat to vision may result from the primary injury or post - traumatic complications such as exposure keratopathy, eyelid retraction, ectropion and entropion,

corneal scarring, and complicated cataract. Visual loss has been documented in 9.9% of cases with eyelid trauma[2]. Earlier studies have reported cicatricial ectropion and entropion following eyelid trauma, occurring in 67.9% of cases, as the most common types of ectropion and entropion[3]. This is in contrast to western countries where involutional changes were more commonly responsible for the development of ectropion and entropion[4,5]

A prevalence of 22.2% was also reported for post-operative ectropion following repair of eyelid injury with canalicular laceration[6] . Injuries involving the lacrimal drainage pathway may also occur in association with eyelid trauma and have been documented to be present in 15.4% – 66.7% of eyelid injuries [7]. This may be complicated by epiphora if not detected and managed appropriately. Canthal injuries when present, could result in damage to the medial and lateral canthal ligaments - major contributors to eyelid support, as well as the lacrimal sac located at the antero-medial wall of the orbit. Canthal injuries can result in loss of eyelid support while lacrimal sac or nasolacrimal duct injuries can cause epiphora. Prompt diagnosis and appropriate management is crucial in the restoration of function, aesthetic appearance and the quality of life (QoL) of the injured persons. The attending emergency physician and the 1st year ophthalmic resident doctor who are often the first contact with the patient are not adequately prepared to manage eyelid injury. They aim for rapid suturing to achieve wound closure and maintain haemostasis only to have the eyelid injured patient present later to the oculoplastics unit with malpositioned eyelids, cosmetically unacceptable appearance and some degree of loss of eyelid function. It is important therefore that the attending emergency physician and the general ophthalmologist should be equipped with the requisite basic principles of eyelid trauma management which is the goal of this review article. Pearls for surgical successes will also be described.

METHODS

Literature search was conducted on Google Scholar, Google, PubMed, Medline, and Medscape. Key search terms were eyelid trauma, eyelid injury, eyelid laceration, eyelid wound, canalicular laceration, canthal injuries and eyelid scar management.

Selection and Eligibility Criteria for Articles: Articles most appropriate were selected and relevant information and data extracted. For the purpose of this review, publications highlighting current eyelid trauma and scar management techniques and principles were referenced.

FINDINGS

Epidemiology: Reviewed articles clearly showed that all age groups are susceptible to eyelid injury including neonates during birth[8]. Males (86.4%) are however more susceptible than females to eyelid trauma[9]. In a nine-year review eyelid injuries were reported to occur following various reasons such as RTA (27.3%), sports/recreational activities (18.4%), and fight/ assault injuries (21.2 %)[10]. Conversely females and children have been reported to have higher prevalence in domestic injuries and falls. Mechanical injuries have been found to constitute between 12.7% and 20.5% of eyelid injuries[11, 12.] Mechanical injuries occur either as blunt or penetrating injuries and the leading causes of these injuries include road traffic accidents (20%), and assault (23.3%), with accidental falls (36.7%) as the commonest aetiological factors[13] .

Anatomical Considerations: A good knowledge of the anatomy of the eyelid and lacrimal drainage passage[14], [15] is important to aid repair the of eyelid lacerations. The eyelid consists of seven layers comprising of skin, subcutaneous areola layer, striated muscle layer (orbicularis oculi muscle) and submuscular areolar tissue together making up the anterior

lamella; and fibrous layer (tarsal plate), and palpebral conjunctiva as the posterior lamella. The upper eyelid margin lies 2mm below the superior limbus, while the lower lid margin lies at the level of the lower limbus. Maximum mobility of both upper and lower eyelids and proper eyelid closure at sleep are very essential to protect against exposure keratopathy. Important anterior - posterior anatomical landmarks along the eyelid margin are the lash lines, the meibomian orifices and the grey line where sutures must be placed to achieve proper eyelid margin apposition and function as well as aesthetically acceptable outcome in the event of marginal laceration. The extraordinarily rich vascular supply from branches of the ophthalmic artery ensures rapid healing of the traumatized eyelid. The levator palpebral superioris muscle is the major elevator of the eyelid, supplied by the superior division of the oculomotor nerve. Trauma to the muscle or its nerve supply will cause variable degrees of ptosis and visual obscuration. Muller's muscle with sympathetic innervation contributes minimally to upper eyelid elevation. However, traumatic sympathetic denervation in the cervical region or direct trauma to Muller's muscle would result in mild ptosis. Orbicularis oculi muscle damage would present with poor eyelid closure, lagophthalmos and risk of exposure keratopathy. Surgical repair must therefore aim to restore structure and function following trauma.

Presentation and Management

Eyelid trauma could present clinically in a variety of ways. The basic pathological response to eyelid trauma includes pain, redness, swelling and loss of function. With healing, tissue fibrosis and cicatrization develop and in severe and poorly managed cases may result in malposition of the eyelids and vision threatening complications. The aims of management include adequate evaluation, requisite laboratory investigations, imaging, and appropriate treatment.

(a.) Clinical Evaluation

The patient could present with blunt or penetrating injury. Type of injury could range from mild abrasion to severe eyelid tissue loss and associated ocular and periocular involvement. Clinical evaluation involves detailed history taking with emphasis on demographics, mechanism of injury[16], activity at time of injury, offending agents, and the pre-morbid visual status. Examine for deficiency in eyelid closure, corneal exposure, and orbicularis oculi muscle involvement. The presence of fat in the wound will be indicative of breach of the orbital septum, the possibility of retained intra-orbital or intraocular foreign body and the risk of orbital cellulitis should be considered, in addition to the possibility of trauma to the muscle belly of the levator palpebral superioris which could result in ptosis. Gentle and careful wound cleansing is overly critical in ensuring adequate wound exposure and prevention of wound infection.

It is important to characterize the injury based on anatomical location, presence and severity of tissue loss and complexity of associated injuries. The anatomical location would be assessed and classified as - eyelid margin involving or non-marginal involving, laceration parallel or perpendicular to the eyelid margin, canalicular or proximal lacrimal drainage channel involvement, and canthal injuries. The presence and severity of eyelid tissue loss must be documented. This is generally classified into thirds and managed accordingly based on ease and availability of tissue for direct wound closure; need for an initial tissue mobilization prior to direct closure or use of a graft or a flap to fill the defect. The role of clinical photographs taken after informed consent from the patient or care giver is vital and they serve as useful documentary material. These photographs aid careful pre-operative planning of surgical repair, patient counselling, follow - up and outcome assessment post-operatively.

Furthermore, careful wound assessment is especially important using penlight and carrying out careful slit lamp examination with focus on detecting eyelid lacerations, eyelid tissue loss, tissue incarceration, associated complications such as corneal abrasion, cornea, and/or sclera laceration, uveal prolapse, hyphaema, traumatic iris tear, iridodialysis, iridodonesis, lens subluxation/dislocation, traumatic cataract, ruptured lens, vitreous haemorrhage, retinal detachment, as well as periocular and periorbital trauma[17]. It is important to pay attention to likely entry point which could be easily missed on cursory look, particularly for high velocity foreign bodies, pellets, and metal chips that may penetrate the globe or orbit unnoticed.

Meticulous wound cleaning is especially important to aid adequate visualization of the extent of tissue damage, detect foreign bodies[18], prevent wound infection, and thus facilitate wound healing. Vital eyelid tissues though traumatized should be preserved.

(b.) Laboratory investigations and imaging:
Basic pre-operative haematological and biochemical work-up as required, and gentle ocular ultrasound scan is necessary when associated ocular pathologies such as lens dislocation, vitreous haemorrhage, and retinal detachment is suspected. Computerized tomographic scan (CT scan) of the orbit is indicated when orbital wall fracture is suspected. CT scan also helps in diagnosis of globe injury[19] , especially when the globe cannot be accessed easily. CT scan is the imaging technique of choice in detecting orbital and ocular foreign bodies[20]. MRI would be required in suspected optic nerve injury, intra-orbital non – metallic foreign body and glass. Simple lacerations may however be treated without need for these imaging techniques.

(c.) Medical management:
This is often undertaken in blunt eyelid injury (Fig. 1a & 1b). This involves frequent application of cold compress, use of broad-spectrum systemic antibiotics when indicated, anti-inflammatory agents, tetanus toxoid and anti-tetanus toxoid serum as applicable in cases with open wounds. Mild ocular surface trauma resulting in traumatic conjunctivitis and corneal abrasion should be managed with prophylactic or definitive topical broad-spectrum antibiotics and anti-inflammatory agents.

Fig. 1a: Traumatic ptosis from blunt trauma

Fig. 1b: Ptosis resolution 3 months post - trauma

(d.) Surgical management:
The goal is to restore the anatomy, physiological functions, ensure adequate globe (eyeball) protection and improved aesthetics of the injured eyelid. It is advised that these injuries be repaired as soon as possible – within 72 hours except in the presence of life-threatening injuries in which case patient requires prior stabilization of all vital signs. Cases with other co-morbidities such as diabetes also require prompt surgery as delay might predispose to wound infection[21]. Most eyelid injuries could be repaired under local anaesthesia. Injuries in children and non-cooperative adults as well as moderate to severe injuries will however require general anaesthesia.

Surgical techniques will be dictated by the location, extent of injury and the presence/ severity of eyelid tissue loss. Eyelid injuries are classified as adopted by previous authors[22]

(i.) Margin involving injury - are injuries in which the eyelid margin is breached with consequent misalignment and aesthetically unacceptable cosmesis (Fig. 2a & 2b). It is important to ensure good apposition of the wound margin. The prevalence of eyelid margin involvement among patients with eyelid trauma has been reported to be 24% [23]. Another study reported that

Fig. 2a: Marginal laceration upper eyelid

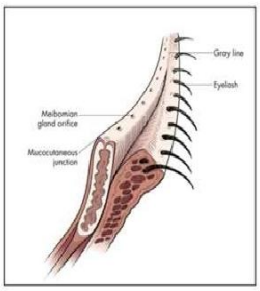
Fig. 2b: Repair by direct wound closure

significant proportion of patients (66.7%) had full thickness injury as compared with 33% with partial thickness[13]. Laceration involving more than 2mm of the margin is an indication for surgical repair.

Surgical pearls for repairing injuries of lid margin:

- Meticulous layer-by-layer wound apposition is important to restore anatomy, promote wound healing and minimize scarring.
- The tarsal plate must be included in the wound repair to ensure the framework of the eyelid is preserved.
- The use of 5-0 vicryl suture provides adequate tensile strength to the marginal wound.
- Tent up the eyelid margin while suturing to prevent notching: The tented margin would eventually even out to a flattened surface upon healing thus preventing notching[24] from wound contracture.
- Avoid suture penetration of the palpebral conjunctiva. This is to prevent suture abrasion of the corneal surface and the risk of developing complications such as corneal ulcer, corneal abscess, endophthalmitis and even blindness. Marginal sutures should be passed vertically through the eyelid margin 1-2 mm from margin of the wound directed perpendicular to the lid margin to a depth of 1-2 mm from the margin to emerge at the same level of the opposing wound and eyelid margin (Fig. 3).

(ii.) Non – margin involving injury: These injuries are also repaired in layers, making sure that eyelid shortening, entropion or ectropion are not induced as this may lead to undesirable ocular



Anatomical landmarks of the eyelid margin

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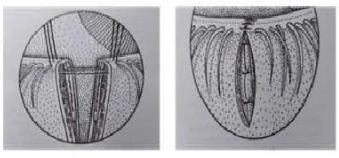

Fig. 3: Eyelid marginal laceration and posterior lamella repair. Anterior lamella is sutured in a similar approach

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surface damage and reduced vision. Large partial thickness tissue loss would require full thickness skin graft.

(iii.) Injury with tissue loss: A variable amount of eyelid tissue loss could occur with potential risk of exposure keratopathy, corneal ulceration, corneal abscess, endophthalmitis or even globe perforation with subsequent impairment of vision. Injury with tissue loss less than 30% marginal loss – would require direct wound closure (Fig. 2a & 2b) and adequate undermining of tissues where needed. More than 30% but less than 60% tissue loss will require tissue mobilization achievable by lateral canthotomy and cantholysis followed by the primary wound closure (Fig. 4a & 4b). Tenzel

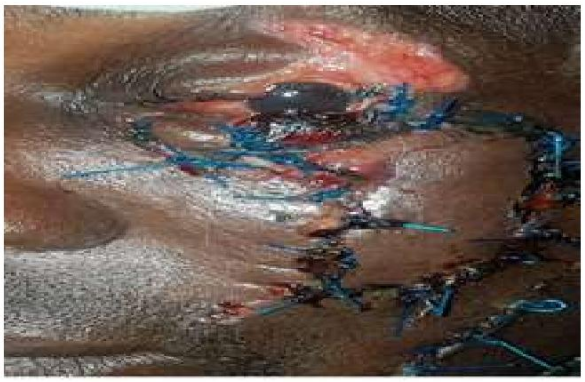

Fig. 4a: Eyelid tissue loss, multiple facial laceration

Fig. 4b: Repair: lateral canthotomy/cantholysis

semi-circular flap (Fig. 5a & 5b) is also a surgical option for large tissue loss and involves raising a semicircular flap from the temporal aspect of the mid-face. More extensive tissue loss of

Fig. 5a: Eyelid full thickness marginal tissue loss

Fig. 5b: Repair by Tenzel semicircular flap

greater than 60% marginal defect will require advancement flaps using Cutler- Beard I and II (upper lid loss) procedures (Fig. 6a & 6b) and Hughes tarso-conjunctival flaps (lower lid marginal loss), and Mustarde flaps as applicable.

Fig. 6a: Upper eyelid tissue loss

Fig. 6b: Repair by Cutler Beard - I procedure. To be followed by eyelid division 6-8 weeks later by Cutler beard II procedure.

(iv.) Injury with canalicular laceration (Fig. 7a & 7b):- Injury to the medial canthal area from direct or indirect impact often results in accompanying canalicular and/or medial canthal tendon tear. The canaliculus is in the medial aspect of the eyelid where there is absent tarsal structure and thus more susceptible to damage from avulsion injury[25]. The frequency of lacrimal outflow passage trauma is variable as reported in various studies with cases of canalicular laceration co-existing with eyelid laceration ranging between 50% - 66.7% for involvement of the lower canaliculus[7, 26, 27, 28] which is most often involved. Upper canaliculus was less commonly involved in 23% -33.3% of cases[26, 27, 28] and the common canaliculus involvement had even lesser prevalence (4% - 13.3%) [7, 26, 27, 28]. Isolated canaliculus injury has been reported to occur with a frequency of 16% to 54% by other authors [23, 29] . The lacrimal sac and nasolacrimal duct may also be involved, with risk of epiphora as a complication if not promptly treated. In lacrimal passage injury, 70% of trauma to canaliculi and 30% involvement of lacrimal sac and nasolacrimal duct trauma have been reported[30]. Epiphora would cause visual blur, ocular irritation, ocular infection, maceration of the lower eyelid and malar area, with subsequent dacryocystitis, and mucocele of the lacrimal sac in untreated cases. Early canalicular anastomosis and stenting with mono - or bi-canalicular stent is the treatment of choice. Studies have supported early repair within 24 hours of injury as this allows for easy tissue identification and stenting prior to development of considerable oedema. The occurrence of stent extrusion was reported to be 44.4% compared with 14.3% in cases operated before and after 24 hours of injury respectively [7]. Similar studies have also reported surgical and functional successes even in cases operated later than 24 hours[31, 32]. Successful anastomosis is facilitated by ensuring adequate lighting and magnification provided by the operating microscope, accurate identification of the cut ends of the canaliculus by various available methods such as saline irrigation of the wound and looking to identify the white fibrous ring of the lacerated canaliculus ('Calamari ring'). Viscoelastic[33], air bubble, fluorescein dye, trypan blue, Kenalog or a blunt tipped pig tail probe[34] are also helpful in identification. Successes

Fig. 7a: Lower eyelid avulsion injury/lower canalicular laceration

Fig. 7b: post-operative appearance

ranging from 61.1 - 100% have been reported following meticulous repair and stenting for canalicular injury[35, 36, 37, 28, 33, 38] . The use of monocanalicular stents for both upper and lower canalicular lacerations has been documented to have anatomical success rate of 86.7% and a functional success rate of 76.7% and this has been associated with surgeon's skill[39], early surgery, mechanism of injury and timing of surgery[7]

More recently, advances in Minimonoka designs which enable better stability and much less chances of extrusion support the use of self-retaining monocular stents [40] as against use of bi-canalicular stents even in cases of bi-canalicular lacerations[7]. These monocanalicular stents have been reported to be effective, less invasive, patient friendly and technically much easier to remove than the conventional bi-canalicular stents[7].

(v.) Injury with canthal involvement: The medial and lateral canthal ligaments are at risk of laceration or dis-insertion from their bony attachments depending on the severity of injury. The consequence of such injury is canalicular laceration and the potential for epiphora, loss of eyelid support and eyelid laxity. The torn or disinserted medial canthal tendon should be restored to its anatomical position with the posterior crus re-attached to the posterior lacrimal crest with non – absorbable 5/0 prolene suture. Torn or detached lateral canthal ligament would be reattached to the periosteum of the inner rim of the lateral orbital wall, or by drilling a hole through the bone if no periosteum is available for anchorage.

(vi.) Injury involving globe (eyeball): The prevalence of globe trauma in association with eyelid injury has been reported to range between 25% and 44%[16,28]. Globe injuries could include subconjunctival haemorrhage, corneal/ scleral laceration, uveal prolapse, cataract, and retina detachment. Eyeball injury is an ocular emergency requiring urgent intervention to save vision. It is important to note that repair of the eyeball should precede eyelid repair to avoid pressure and further ocular damage. The exposed eyeball (Fig. 4a, 5a, 6a), though not primarily involved in the injury needs to be protected from exposure keratopathy by topical antibiotics application and early eyelid repair.

(vii.) Injury involving the orbit and periorbital region: Periorbital, orbital and eyelid trauma as commonly found in midface injuries following road traffic accidents and assaults could constitute a threat to vision and cosmesis. The high frequency of the association of eyelid injury with fronto-orbito-zygomatic injury in upper midface trauma has been reported[41]. About 23.8% of all facial lacerations due to eyelid and periorbital traumas were reported in a national data analysis[42]. It is important to critically examine these injuries as a periorbital trauma might have an undetected entry point wound with retained intraocular or intra-orbital foreign body. A high index of suspicion together with meticulous wound inspection is therefore advised.

Orbital wall fractures may also occur in cases presenting with eyelid trauma. A study reported that 16.7% cases of injury occurred in association with medial wall fracture and multiple orbital injuries [7]. Oftentimes this may be associated with high impact blunt trauma. Eyelid oedema and ecchymosis during the acute phase of trauma may mask orbital wall fractures. It is important to examine for diplopia, enophthalmos, crepitus, ipsilateral epistaxis, and infraorbital anaesthesia in suspected cases of orbital floor fracture. Orbital CT Scan imaging will confirm orbital wall fractures when present and such should be managed appropriately and when necessary, by a multidisciplinary approach in collaboration with the oculoplastic, maxillofacial and neurosurgeons.

Eyelid Scar Prevention and Management: Eyelid scarring occurs following healing of an injured eyelid. Scarring, hypertrophic scar, or the occasional keloid have constituted the major disfiguring factors contributing to functional

oculoplastic

and cosmetic impediments of an injured eyelid. Scarring therefore could result in commonly encountered vision threatening post - trauma complications such as entropion, trichiasis, ectropion, eyelid retraction, lagophthalmos, exposure keratopathy, and its secondary complications such as corneal ulcers/ abscess and even endophthalmitis and blindness.

Scar tissue management is therefore of critical importance. Studies have suggested various methods of scar minimization and prevention. Early and meticulous layer-by-layer wound closure is imperative and would reduce scarring and other possible complications.

Scar massage, the use of silicone-based cream, intralesional triamcinolone and or anti-fibrinolytics like 5-Fluorouracil (5-FU) have been employed with variable degrees of success[43,44].

DISCUSSION

The integrity of the eyelid is crucial to ocular and visual health of an individual. Pathological inflammatory response characterized by pain, redness, swelling, loss of function, followed by tissue healing with fibrosis, contracture, and cicatrization occur following eyelid injury. The severity of injury, wound contamination/ infection, presence of foreign body especially when undetected, delayed presentation, improper wound repair, inadequate surgical skills, and financial constraints are risk factors for poor outcome following eyelid trauma. Gender susceptibility to eyelid trauma has been noted. Males with prevalence between 63.0% and 73.1% have been reported to present more frequently with eyelid and associated ocular injury[14, 45]. The complications of eyelid trauma are undesirable and may be vision threatening as well as have negative impact on the QoL. About 40% of patients who had eyelid trauma were reported to be dissatisfied because of epiphora, scar formation, and ectropion despite surgical repair[14] while 9.4% who had notching of the lid post - operatively also reported dissatisfaction[12].

A bimodal pattern of age group of young and elderly due to sports injury and accidental falls respectively was also found in relation to eyelid injury [13, 14]. It is important to embrace definitive management principles to ensure the best functional, visual, and aesthetic outcome. It is also important to intervene promptly[46], ensure wound asepsis, and maintain layer - by – layer wound apposition. Injuries with tissue loss must be adequately and appropriately repaired by tissue mobilization and use of flaps. Graft and flap viability must be ensured. Management goals must aim at minimizing complications. The eyelid trauma patient requires adequate counselling, multidisciplinary care where necessary as well as follow - up visits to detect and manage post-operative complications. It is also important to educate the population on trauma prevention. Efforts should be made to minimize road traffic accidents, prevent injury during sporting activities, and educate on the need to embrace dialogue rather than assaults in controversies in order to reduce the prevalence of eyelid trauma and associated complications.

CONCLUSION

Eyelid injuries are a potential threat to vision, aesthetics, and quality of life. Ophthalmic and emergency room physicians should strive to obtain the requisite surgical skills and be alert to possible associated ocular and periorbital injuries. It is advised that the basic management principles elucidated be adhered to. Meticulous tissue apposition is crucial and multidisciplinary intervention need to be embraced where necessary.

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