Review of facial trauma management

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Submitted: October 8, 2019, Revised: November 20, 2019, Accepted: November 29, 2019, Published online: January 14, 2020.

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DOI: 10.1097/TA.0000000000002589

Facial trauma can incur significant physical and psychological costs. Approximately 25% of all injuries reported in the National Trauma Data Bank involve the face.[1] Facial trauma is associated with one of the highest case fatality rates in serious injury and has potential for concomitant injury to critical adjacent structures, such as the brain and the airway.[1] Moreover, facial injuries are conspicuous, and their inherent esthetical concerns aggravate psychological stress of trauma patients.[2,3]

Facial trauma management is often entrusted to the craniofacial surgeon. In an unfamiliar anatomical field, noncraniofacial trauma surgeons may be stifled on what may be evidence-based practice versus practice pattern. We aimed to provide the noncraniofacial trauma surgeon with a review of evidence-based management of common traumatic facial injuries and highlight areas needing further research.

PRINCIPLES OF WOUND MANAGEMENT

Several Oxford Centre for Evidence-based Medicine (CEBM) Level I and II evidence studies have explored the basic principles of wound management.[4] A Cochrane review of 11 randomized controlled trials (RCT) showed that compared with wound irrigation with tap water, normal saline did not significantly reduce infection rates.[5] Wound irrigation with 1% povidone-iodine solution has not shown superiority in reducing infection rates compared with normal saline in three RCTs, which included a high proportion of facial wounds.[6–8] Of note, the findings are not applicable to patients at high risk for wound infections, such as diabetics and those on steroid therapy, who were often excluded from aforementioned studies. Overall, minimizing infection rates for traumatic facial wounds does not appear to depend on the type of irrigant, but on the general recommendation for thorough irrigation.

A systematic review of four prospective studies, including three RCTs, did show that prophylactic antibiotics do not decrease infection rate for intraoral lacerations.[9] There is no high-level evidence on the role of prophylactic antibiotics for nonoral facial wounds.

Key points: Evidence suggests the following:

- Type of wound irrigant (tap water vs. normal saline vs. 1% povidone-iodine) is not important
- Prophylactic antibiotics: no role for intra-oral lacerations, lack of high-level evidence for other facial wounds

Mammalian Bites

Dog, cat, and human bites to the face raise two important questions: whether prophylactic antibiotics should be given, and whether wounds can be closed primarily.

Dog Bites

There is no high-level evidence on the efficacy of prophylactic antibiotics for dog bites. A previous Cochrane review of eight RCTs showed that antibiotics did not reduce infection rates for bites without clinical signs of infection.[10] However, the queried studies prescribed inadequate antibiotics; the efficacy of appropriate beta-lactam and beta-lactamase inhibitor antibiotics was not examined. A more recent RCT on 94 patients, with 27% of bites inflicted on the face, did show a 4% difference in wound infection rates between those who did and did not receive appropriate antibiotics (0% vs. 4%, respectively).[11] Unfortunately, no a priori sample size or post hoc power calculation was performed. A prospective multicenter observational study of 345 patients did suggest that puncture-type bite wounds—those invading the dermis, with depth greater than length—have high infection risk and should receive prophylactic antibiotics.[12]

Evidence suggests that facial dog bite wounds can be closed primarily. A meta-analysis of four RCTs—including studies with 41% and 100% facial/neck wounds—concluded that primary closure does not increase wound infection rates.[13–15] No patient in this meta-analysis received prophylactic antibiotics. A recent prospective RCT, including 25% of wounds in the head/neck, showed no difference in infection rates after primary closure versus no closure.[16] All patients in this study received antibiotics.

Cat Bites

There is no high-level evidence evaluating the belief that cat bites are more prone to infection than dog bites.[17] Similar to suggestions that puncture-type dog bites are more prone to infection,[12] an early prospective observational study (including 15% of bites to head/neck) identified wound depth as the most important predictive factor for infection after cat bites.[18]

Human Bites

Human bites are often incurred during altercations.[19] Antibiotics are universally prescribed for the most common "punch bite" to the enclosed fist,[20] but recommendations for facial bites are not as clear. A double-blind RCT of low-risk bites—excluding bites to the hands/feet/skin overlying joints/cartilaginous structures, or puncture wounds—reported no significant differences in infection rates with or without antibiotics.[21] Unfortunately, the study did not explicitly report the proportion of facial bites, and the remaining human facial bite literature is limited to small observational studies. A study of 30 patients with facial bites suggested that immediate primary closure with prophylactic antibiotic was "safe," but reported a 10% infection rate.[22] Another study on bites to the orofacial region reported a 10% infection rate after primary closure and prophylactic antibiotics.[23] A report on 37 patients with bite injuries to the lip with immediate closure and prophylactic antibiotics noted no infections.[24]

High-level evidence for mammalian facial bite management appears to support primary closure of dog bite wounds. Of note, the need for debridement was not consistently reported or controlled for, and should be performed per clinical judgment. Given the esthetic consequences of a facial wound infection, prophylactic antibiotics for mammalian facial bites—especially puncture wounds—may be prudent.

Key points: Evidence suggests the following:

- Prophylactic antibiotics: no consensus high-level evidence for dog, cat, or human bites
- Puncture type wounds may be at higher risk of infection
- Primary closure: safe for dog bites, lack of high-level evidence for cat or human bites

Facial Fractures

The fourteen different bones comprising the facial skeleton can fracture to violate the intracranial, intranasal, or intraoral cavities. We review the role for prophylactic antibiotics, key features of common fracture patterns, and highlight the importance of the ocular exam.

Prophylactic Antibiotics

A recent survey of 205 plastic surgeons, otolaryngologists, and oral and maxillofacial surgeons substantiated the lack of consensus on prophylactic antibiotics for facial fractures.[25] A systematic review of six early quasi-RCTs (1975–200) showed

that preoperative prophylactic antibiotics decrease infection rates in compound, noncondylar mandibular fractures.[26] The same study suggested that prophylactic antibiotics do not reduce infection rates for condylar mandibular, maxillary, or zygomatic fractures. A follow-up systematic review of 31 studies, including nine RCTs, cited poor quality of queried studies and found no conclusive evidence for improved outcome.[27] A systematic review of more recent studies corroborated earlier suggestions that prophylactic antibiotics reduce infection rates in mandibular fractures, but claimed insufficient high-level evidence to support use in nonmandibular facial fractures.[28] Retrospective studies reflect similar sentiments: a study on 289 patients with maxillary or orbital fractures managed nonoperatively showed no difference in infection rates regardless of antibiotic use,[29] and a review of 233 nonmandibular facial fracture patients who underwent operative management showed no utility of preoperative, perioperative, or postoperative antibiotics in reducing infections.[30]

Patients with facial fractures who do receive prophylactic antibiotics do not appear to benefit from a longer course. An early systematic review showed for that a 1-day course of antibiotics had same efficacy as a 7-day course for compound, noncondyle mandibular fractures.[26] Similarly, a recent analysis of 403 critically ill patients with facial fractures reported that, compared with patients who received prophylactic antibiotics for less than 1 day, those who received an extended course had significantly higher infection rates.[31] Of note, studies on prophylactic antibiotics for facial fractures had variable reporting, inclusion, or subgroup analysis of patients with open (to skin or oral cavity) fractures; we did not find consensus high-level evidence for these patients.

Common Fracture Patterns

Four paired vertical and four horizontal buttresses—areas of increased bone thickness—form conceptual pillars of the facial skeleton (Fig. 1).[32] A principle of facial fracture management is reduction to restore anatomic integrity of the buttresses, allowing transverse buttresses to uphold facial width and vertical buttresses to uphold facial height. We highlight key points from an excellent review of facial fractures by Fraioli et al.[33]

(1) Frontal sinus fractures

The anterior wall is formed by the frontal bone, a horizontal buttress that maintains the aesthetic contour of the forehead. The posterior wall separates the sinus from the cranial vault, and the floor forms the medial orbital roof and involves the ostium to the nasofrontal duct.

Fractures that may warrant operative interventions include displaced anterior wall fractures (cosmetic), comminuted or displaced posterior wall fractures (possible dural violation),[34] and nasofrontal duct disruption (possible development of mucocele, epidural, or subdural abscess).[35]

(2) Zygomaticomaxillary complex fractures

The zygoma articulates with the frontal bone superiorly, maxilla medially, temporal bone laterally, and the sphenoid posteriorly. It also contributes to the lateral and inferior orbital walls. The zygomatic body forms the prominent malar eminence, the anatomic restoration of which is one goal of zygomaticomaxillary complex (ZMC) fracture reduction. The ZMC fractures should prompt evaluation for lateral and inferior orbital wall disruption; this can increase the orbital volume and cause enophthalmos, which may require an operation intervention.[36]

(3) Nasal Fractures

The nasal bone articulates with the frontal bone superiorly, maxilla laterally, medial orbital wall laterally, and ethmoid posteriorly. With anatomic proximity, the nasal bone, medial orbital

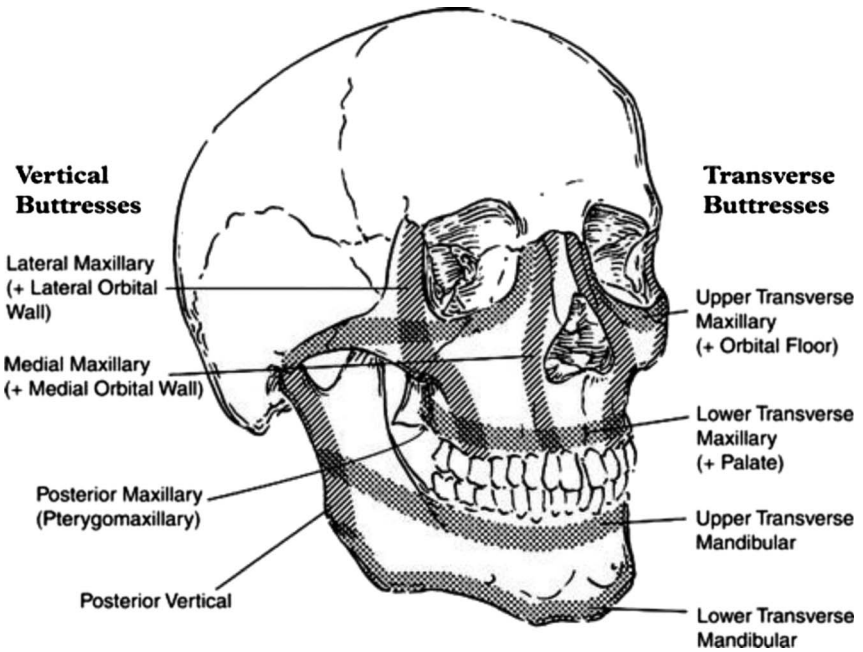

Figure 1. Vertical and transverse buttresses of the facial skeleton (Hopper et al).

wall, and ethmoid sinus (NOE) are often concomitantly injured. The central fragment of the medial orbital wall serves as the attachment point for the medial canthal tendon (MCT).[37] Displacement of the MCT or disruption of the anchoring medial orbital wall fragment can result in telecanthus and often requires operative management. Disruption of the nearby lacrimal drainage pathway can also result in epiphoria after NOE fractures.[38,39]

(4) Le Fort Fractures

The well-known Le Fort classification of midface fractures can be simplified by understanding the following relations: Le Fort I fractures cause the maxillary arch to move in relation to face and skull base, Le Fort II fractures cause the entire maxilla to move in relation to the skull base, and Le Fort III fractures cause the entire face to move in relation to the skull base. All Le Fort fractures involve bilateral pterygoid fractures. However, only Le Fort I fractures involve the lateral piriform aperture, only Le Fort II fractures involve the inferior orbital rim and zygomaticomaxillary suture line, and only Le Fort III fractures involve the zygomatic arch and the lateral orbital wall.[40]

Le Fort fractures disrupt the facial skeleton buttresses and cause both esthetic and functional deficits. A force strong enough to break these buttresses often results in other associated fractures. Specifically, concomitant fractures of the hard palate, maxillary dentoalveolar units, or mandible affect occlusion, and must be critically examined.

(5) Orbital fractures and the importance of the ocular examination

Periorbital ecchymoses and subconjunctival hemorrhage are readily recognized signs of orbital trauma.[41] However, orbital fractures may be both radiographically and visibly occult.[42,43] The term, white-eyed blowout fracture, refers to orbital fractures that lack external signs and risk delayed diagnosis unless an ocular examination is performed.[43] The trauma surgeon's ability to appreciate concerning symptoms signaling urgent intervention is crucial for timely diagnosis of ocular emergencies.

Limited ocular movement is a well-recognized sign of entrapment that should trigger immediate consultation of the ophthalmologist and/or craniofacial surgeon. Other concerning signs, such as diplopia, pain with directional gaze, and the oculocardiac reflex, must also be recognized as potential emergencies that require urgent consultation.[41] While the oculocardiac reflex most commonly manifests as bradycardia, persistence can decline into serious arrhythmias and even asystole. Of note, nausea and vomiting are less appreciated symptoms of urgent ocular injuries that may be attributed to concomitant intracranial injury, leading to delayed intervention.[44] All patients with facial trauma—especially those presenting with nausea and vomiting—should undergo focused evaluation for diplopia, painful gaze, limited ocular motility, and autonomic symptoms, with a high index of suspicion for underlying orbital fracture causing ocular injury.[45]

Key points: Evidence suggests the following:

- Prophylactic antibiotics should be provided for noncondylar mandibular fractures. There is lack of consensus high-evidence for use in other facial fractures or in open fractures
- There is no benefit, yet potentially harm, in extended course of prophylactic antibiotics for facial fractures.
- Frontal sinus fractures: evaluate for displaced anterior wall fractures, comminuted or displaced posterior wall fractures, and frontal duct disruption
- ZMC fractures: evaluate for lateral and inferior orbital wall disruption
- Nasal fractures: evaluate for MCT or lacrimal drainage pathway disruption
- Le Fort fractures: evaluate for concomitant hard palate/maxillary dentoalveolar unit/mandible fractures
- Perform focused ocular examination for all facial trauma patients to rule out inconspicuous ocular injuries

Airway Management

Securing the airway is the foremost task for any trauma patient, but may be especially arduous with facial trauma. Preoxygenation with bag-valve mask may be difficult with unstable facial fractures, and inserting nasopharyngeal/oropharyngeal tubes to minimize aspiration is generally contraindicated. Extensive collateralization between branches of both the internal and external carotid arteries may lead to extensive hemorrhage that can hinder airway visualization. There are many ways facial trauma can insidiously impede the airway: (1) posteriorly displaced maxillary fractures blocking the nasal airway; (2) loss of the tongue's anterior insertion point with a mandibular fracture blocking the oropharynx; (3) teeth and soft tissue fragments blocking the airway; (4) nasopharyngeal/oropharyngeal hemorrhage; (5) soft tissue swelling; and (6) associated laryngeal/tracheal trauma.[46]

The 2012 Eastern Association for the Surgery of Trauma review of emergency intubation can be consulted for facial trauma airway management.[47] Patients should be promptly assessed for difficulties with bag valve mask ventilation, laryngoscopy, or surgical airway using a structured tool, such as the LEMON (Look externally, Evalute the 3-3-2 rule, Mallampati, Obstruction, Neck Mobility) mnemonic[48]; more experienced airway personnel should be called for those stratified to have difficult airways. Orotracheal intubation with direct laryngoscopy and rapid sequence induction is the emergency intubation method of choice, but visualization of the vocal cords may be impaired with facial injuries. Video laryngoscopy is an appealing alternative, with reported higher intubation success rates by less experienced airway providers. Though the last choice of airway access in most cases, surgical cricothyroidotomy is the foremost choice for patients with extensive facial trauma. Of note, cricoid pressure is no longer a Level I recommendation for intubation in trauma; recent evidence has shown that it impairs visualization, reduces ventilation efficiency, and does not prevent aspiration.[49,50]

After securing the airway, continued airway management is a unique part of operative planning in facial trauma. Patients may undergo surgeries requiring repeated manipulation for occlusion or maxillomandibular fixation, precluding oral endotracheal intubation. Barak et al.[51] show one example of an algorithm used for deciding on the continued airway management method for facial trauma patients undergoing maxillofacial surgery (Fig. 2). Submental intubation can be performed for patients whose fractures or operative needs

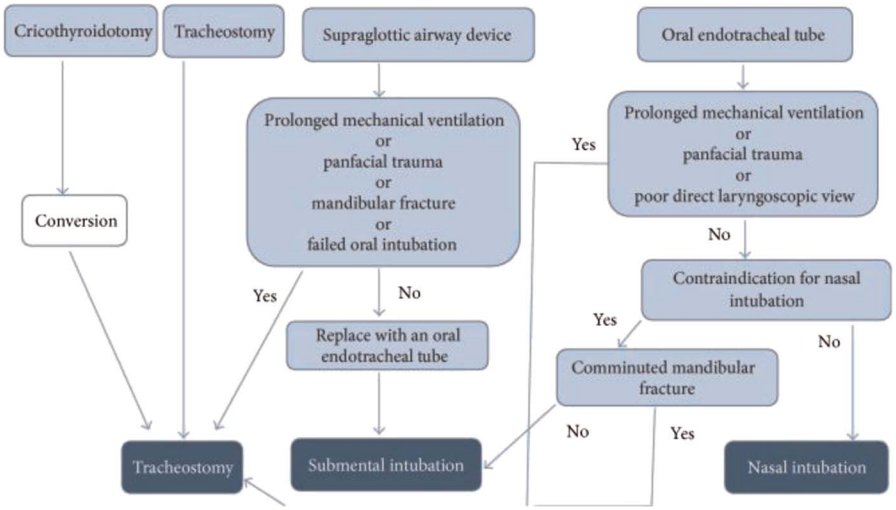

Figure 2. Algorithm for airway management in facial trauma (Barak et al).

preclude nasal or oral intubation; it is contraindicated in comminuted mandibular fractures.[51]

Facial trauma patients may have prolonged swelling; complications associated with prolonged intubation—such as ventilator associated pneumonia—must be kept in mind. The decision to extubate a patient with extensive facial trauma should anticipate challenging reintubation and encapsulate joint agreement between the craniofacial, trauma, critical care, and anesthesia teams.

Key points:

- The six potential ways facial trauma can compromise the airway should be remembered
  - posteriorly displaced maxillary fractures blocking the nasal airway
  - loss of the tongue's anterior insertion point with a mandibular fracture blocking the oropharynx
  - teeth and soft tissue fragments blocking the airway
  - nasopharyngeal/oropharyngeal hemorrhage
  - soft tissue swelling
  - associated laryngeal/tracheal trauma
- Patients with difficult airways should be triaged using structured assessment tools
- Orotracheal intubation with direct laryngoscopy is the intubation method of choice, but injury pattern may necessitate surgical cricothyroidotomy
- Airway management method should consider both the injury pattern and operative plan

Hemorrhage Control and Computed Tomographic Angiography

The incidence of severe hemorrhage from facial trauma is limited to reports from single-institution studies.[52–54] There is little high-level evidence for characterizing or managing hemorrhage from facial trauma; we review general management principles for the trauma surgeon.

Life-threatening hemorrhage from facial trauma is limited to those that obstruct the airway, most commonly from the anterior and/or posterior ethmoidal arteries. Severe oronasal hemorrhage can be managed with nasal or oral packing, with a vigilant balance between adequate pressure and avoidance of mucosal necrosis. Foley balloon or epistaxis catheter tamponade are alternative strategies. However, extensive facial fractures that disrupt facial buttresses may render tamponade-based hemostatic strategies ineffective. Fundamentally, the complexity of facial trauma hemorrhage control lies in the extensive collateral circulation between the external and internal carotid artery systems. Invasive hemorrhage control methods, such as external carotid artery ligation and angiographic embolization, may by ineffective and are associated with morbid complications, including brain infarction.

Bromberg et al. have highlighted the now well-known screening indications for blunt cerebrovascular injuries (BCVI), which include "epistaxis from a suspected arterial source" and "asymptomatic patients…[with] Le Fort II or III facial fractures."[55] Though digital subtraction arteriography is considered the gold standard for diagnosing BCVI, computed tomographic (CT) angiography has proven to be an effective screening modality.[56,57]

Key points:

- Life-threatening facial trauma hemorrhage is likely rare and limited to those that compromise the airway.
- Extensive collateral circulation between the internal and external carotid artery systems can complicate hemorrhage control
- CT angiography is effective for screening BCVI.

Nutritional Needs

Nutrition is critical for healing after traumatic injury. Mandibular and maxillary fractures may require extended dietary limitations, undermining adequate nutrition. Surprisingly, there is virtually no literature on evaluating or optimizing nutritional status after facial trauma. A singular retrospective review of 446 mandibular fracture patients showed that 82% of patients

lost weight over the course of their treatment, and that 9.2% of patients were malnourished at baseline.[58]

Further studies are needed to explore the impact of facial trauma on patients meeting adequate nutritional needs and how potential nutritional deficits can be optimized with various enteral access options.

Key points: Evidence suggests the following:

- There is much room for future research on evaluating and optimizing potential extended nutritional deficits of facial trauma patients

CONCLUSION

Though care is often consigned to the craniofacial surgeon, we hope this review provided a succinct summary of up-to-date evidence on managing facial trauma and elucidated the many areas that may benefit from future high-level evidence research.

AUTHORSHIP

J.C. contributed to the design, literature review, and writing of the article. H.P.L. contributed to the expert review, revision, and supervision of the article. D.A.S. contributed to the design, revision, and supervision of the article.

ACKNOWLEDGMENTS

J.C. would like to thank the Neil and Claudia Doerhoff Fund for support of his scholarly activities.

DISCLOSURE

The authors declare no fundings or conflicts of interest.

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