Midface Fractures II

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Abstract

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- palatal fractures

Facial fractures are a common source of emergency department consultations for the plastic surgeon. A working understanding of the evaluation, the assessment, the management, and the prevention of further injury when dealing with these fractures is vital. This second of a two-part series detailing the management of midfacial fractures serves as a guide for the appropriate workup and management of the wide variety of fracture patterns that are commonly encountered.

Epidemiology

Motor vehicle accidents (MVAs) and assaults account for the preponderance of facial fractures; falls, sports, occupational accidents, and gunshot wounds comprise a smaller percentage.^{1–3} The underlying insult is largely predictive of fracture pattern, with MVAs and gunshot wounds contributing to a higher portion of panfacial fractures, sports accidents leading to upper midface fractures, and assault most commonly leading to mandibular fractures. Males sustain proportionally more facial fractures than females, with a preponderance of injuries in the third decade.^{2,3} Advances in automotive safety have reduced the incidence of facial fractures,^{4,5} whereas the aging population has led to a higher proportion of facial fractures resulting from falls.^{4–6}

Initial Evaluation

As with any initial evaluation, the greatest priority is the primary survey, which consists of the ABCs (airway, breathing, and circulation). Once these are secured, a detailed history of the event should be ascertained from the patient, witnesses, or first responders.

Sample questions include

- Have you had any trouble with your vision?
- Have you had any problem hearing?
- Do you have difficulty breathing through either nostril?
- Do you have any facial numbness?
- Have you had any problems with your bite since the injury?
- Have you had bleeding or leakage from your ears, nose, or mouth?

If time does not permit a detailed history, the pertinent questions can be remembered with the mnemonic “AMPLE”: allergies, medications, past medical history, last meal, and events surrounding the injury.

Acute Management of Facial Fractures

Airway compromise is not uncommon in patients who have sustained an injury to the midface. Bleeding, swelling, and oral secretions may precipitously endanger the patient's airway. The judicious use of oropharyngeal suction is advised, and the airway should be secured. It is wise to have both oral intubation and cricothyrotomy kits available.

Large body cavities (abdomen, pelvis, thighs, chest) are usually considered first in the setting of profound hypotension and tachycardia after trauma. If these are ruled out and hypotension and tachycardia persist, a hemorrhage due to facial injury should be entertained. Although rare, a hemorrhage from facial injury may be life-threatening and deserves consideration. Bleeding can be controlled by the ligation of cutaneous vessels and aggressive nasopharyngeal packing. Reduction of the maxilla and intermaxillary fixation should ameliorate bleeding. Angiographic embolization may be required.⁷

Physical Examination of the Midface

Like any other portion of the physical examination, the examination of the midface must be systematic. First, the surgeon should inspect the patient's face and assess symmetry. This may require different vantage points and is often hindered by bleeding or significant ecchymosis. To

obtain the best physical examination of the face, it is important that any caked-on blood or debris be washed off to expose the full extent of the injury. Contusions and ecchymosis may suggest underlying bony involvement. A preinjury photograph (state-issued identification cards work well) is often helpful in comparing the patient's preinjury anatomy to postinjury appearance. On physical exam, LeFort fractures are often appreciated as facial distortion and elongation, maxillary mobility, midface instability, and malocclusion.

A bony examination should follow. When examining the maxilla, bilateral palpation is often helpful to help assess for step-offs. Both external and internal palpation of the maxilla is necessary. Assessing the stability of the upper jaw may be achieved by firmly pressing one hand against the patient's forehead and manipulating the maxilla with the other. If only the maxilla moves, it is likely to be a LeFort I fracture. If the nasal complex moves along with the maxilla, a LeFort II fracture is likely. Ecchymosis, facial edema, subcutaneous hematomas, and epistaxis are often seen in maxillary fractures.

The oral cavity should be assessed for mucosal lacerations, ecchymosis, and the presence of bone fragments. An injury to the mucosa may suggest either alveolar or palatal fractures. Each tooth should be assessed for mobility and documentation of broken and/or absent teeth is crucial. In the case of missing teeth, ask the patient if he or she remembers either losing the tooth, aspirating the tooth, or swallowing the tooth. In the case of neurologic impairment, this may be difficult to ascertain, and radiography of the chest is necessary to evaluate for either swallowed or aspirated teeth. To prevent the formation of lung abscesses, aspirated teeth should be endoscopically removed. If the tooth was swallowed and passed below the diaphragm, the patient is likely to pass the tooth without incident. In cases of acute respiratory failure in which the patient has sustained facial injuries, an aspirated tooth may be the underlying cause.⁸

The mobility test may be used to assess the stability of the tooth. The blunt ends of two instruments should be placed against the facial and lingual aspect of the base of the tooth. Alternating pressure should be applied to assess for mobility of the tooth. Apply downward pressure on the top of the tooth to assess for depression in the socket.

Examination of the patient's occlusion is vital and should be done in a neutral position. Ask the patient to open and close, and then clench the jaw and see if there is any sensation of the bite being "off." Even the smallest change in occlusion can be readily appreciated by the patient and is more sensitive than the examiner's assessment.

If any abnormalities are encountered on the exam that may suggest an underlying fracture, craniofacial computed tomography (CT) scans should be ordered and read by the surgeon.

Maxillary Buttresses

Maxillary buttresses are the supportive structures of the midface and are generally thicker than the surrounding, thin facial bones. There are both horizontal and vertical maxillary

buttresses. The vertical buttresses are composed of the lateral maxillary, the medial maxillary, and the posterior maxillary buttresses; the transverse buttresses are composed of the upper transverse maxillary and the lower transverse maxillary.

LeFort Classification

Fractures of the midface require considerable force and are often caused by MVAs and assaults. The anatomy of the maxillary and surrounding structures is such that energy is dissipated by fracturing the midface so as to reduce the inertial burden, thus protecting the globe and brain. Hence, midface fractures often occur in recognizable patterns.

First described in 1901 by Rene LeFort, LeFort fractures I through III are commonly encountered by the plastic surgeon, but rarely in the pure forms as described by LeFort. This is attributed to the change in injury mechanisms over the past 100 years. The initial classification was based on injury patterns caused by low-velocity and low-energy inciting events; however now, LeFort fractures are predominately caused by MVAs or other high-energy collisions. They can be unilateral or bilateral, symmetrical or asymmetrical, and are often concomitant with other facial fractures. Often, fractures extend through the maxillary sinus, as well as the medial and lateral buttresses.

LeFort I fractures are in the horizontal plane inferior to the maxillary sinus and inferior orbital rim, but superior to the teeth (► **Figs. 1** and **2**). Displacement of the maxilla is more likely to be encountered when the fracture extends beyond both the medial and lateral maxillary buttresses. LeFort II fractures extend from one lateral maxillary buttress through the maxilla into the infraorbital rim and nasofrontal junction and are aptly described as pyramidal fractures.

Fig. 1 A bilateral LeFort I fracture with a right zygomaticomaxillary complex fracture and a mandibular parasymphysis fracture.

Fig. 2 A sagittal view of a LeFort I fracture.

Ethmoidal involvement is common. LeFort III fractures cross the medial and lateral orbital walls, the nasofrontal region, and the zygomatic arches.

Part I of this series detailed the fractures commonly listed and described in a systematic fashion to avoid confusion and for conciseness. Lowest order fractures (LeFort I, II, and III, respectively) should be listed first. Specific considerations must be made when reporting LeFort fractures and other midface fractures. The LeFort level should be indicated as well as the laterality. Concomitant fractures (frontal sinus, NOE, and ZMC fractures) should be remarked upon. Similarly, the hard palate and dentoalveolar units are commonly involved in LeFort fractures and must be listed.⁹

Treatment of LeFort Fractures

The goals of surgical intervention of LeFort fractures include the restoration of occlusion, the restoration of the medial and lateral maxillary buttresses, the restoration of midface height and projection, the re-establishment of maxillary arch width, and the restoration of the integrity of the nose and orbit. The most important of these goals is the restoration of dental occlusion. If all other goals are achieved at the expense of dental occlusion, the reconstruction is considered a failure.

In treating maxillary fractures, special attention must be paid to securing the airway. As maxillary fractures tend to be inferiorly and posteriorly placed, the airway may be obstructed. This is compounded by soft tissue edema and swelling of the structures in the oral cavity. Nasotracheal intubation is preferred or oral–nasal endotracheal tube exchange. If there are cranial base or additional facial fractures that may require the patient to remain in intermaxillary fixation (IMF), tracheostomy may be required.

Intermaxillary Fixation

Once the airway is secured and the bleeding stopped, the next most important step is achieving dental occlusion. This is commonly achieved using IMF. Although IMF may achieve occlusion, it may not be an anatomical reduction and as such is often combined with open reduction and internal fixation (ORIF) to achieve both an anatomical and a functional reconstruction. There are a variety of methods for achieving IMF with Erich arch bars being the most common. The use of IMF with screws in patients without fracture involvement between teeth is becoming increasingly common and is preferred by some.¹⁰ Newer techniques include the use of hybrid arch bars, which combine the full functionality of Erich arch bars with the ease of use of IMF locking screws. If IMF is used alone, rigid fixation with wire loops is preferred. If IMF is used as an adjunct to ORIF or if the patient has had rigid IMF for a while, elastic IMF may be used.

Aggressive prophylactic antiemetic therapy is necessary for patients in IMF. Wire cutters should accompany the patient at all times in the case of imminent emesis. Patients with elastic IMF should be instructed on the proper removal and placement of the bands.

Rigid IMF should generally not be applied for greater than 3 to 4 weeks as the incidence of trismus or ankylosis is considerable beyond this period. This is even more evident in the pediatric and elderly population. If the fracture site is not adequately healed at this point, the patient should be transitioned to elastic IMF with a weekly decrease in number of bands used.

Open Reduction and Internal Fixation

After the application of IMF, exposure of the involved anatomical subunits can be achieved using a combination of a coronal approach (LeFort II and III), intraoral approach through either the sublabial or upper gingivobuccal sulcus (LeFort I and II), or periorbital approaches.

In the intervention of LeFort I fractures, the medial and lateral buttresses should first be aligned. Disimpaction and mobilization of the maxilla may be necessary. Rigid fixation is then achieved with at least two screws on either side of the fracture line for each buttress. Bone grafts should be used for gaps greater than 5 to 10 mm.

Concomitant frontal sinus fractures may necessitate a coronal exposure in the repair of LeFort II fractures. A periorbital incision can be used for access to the inferior orbital rim with subsequent reduction at the lateral maxillary buttress and the periorbital buttress. Once again, bone gaps greater than 5 to 10 mm require bone grafting.

LeFort III fractures may be more complex; as such, they require greater exposure with a combination of a coronal and intraoral approach. The nasofrontal area is fixated first, followed by zygoma fixation and maxillary buttress fixation as is achieved in LeFort I and II fractures.

Alveolar and Palatal Fractures

These fractures commonly accompany LeFort fractures and contribute to malocclusion and lower midface widening (►Fig. 3). Palatal fractures can be stabilized with miniplate

Fig. 3 A palatal fracture.

fixation after the elevation of a palatal flap and alveolar fractures may be fixed with an arch bar. Alveolar fractures should be addressed within 3 hours to prevent pulp necrosis (► **Figs. 4–6**).¹¹ Stabilization may be achieved using either a resin splint or an arch bar for 3 to 4 weeks. The patient should be given prophylactic antibiotics and appropriate instructions on diet and oral hygiene.¹²

Complications

Significant complications include malunion, malocclusion, and nasolacrimal duct injury. The most common cause of malunion is misdiagnosis or poor reduction. If malocclusion persists or develops, elastic traction may be used. However, if the fracture has healed, elastic traction may only lead to loosening and subsequent extrusion of the teeth. A secondary osteotomy may be required and should be in a LeFort I pattern. Nasolacrimal duct injuries are more likely to be encountered in LeFort I and LeFort III fractures. Proper realignment of the medial fragment pieces is helpful in preventing nasolacrimal duct obstruction.

Postoperative Care

Postoperatively, a decision must be made as to whether the patient can be safely extubated or if he requires tracheostomy. The patient should be given instruction on the care for IMF hardware and proper oral hygiene and placed on a full liquid, followed by a soft diet until IMF is removed. Rigid IMF is to be removed within 3 to 4 weeks and transitioned to elastic IMF. The occlusion must be assessed at each follow-up appointment. After 6 weeks, IMF may be removed, provided preinjury occlusion is achieved.

Postoperative infection is rare in maxillary fractures compared with mandibular fractures. Infections are more likely to occur in the setting of maxillary sinus obstruction and pre-existing sinus disease. A nasal-antral window may be used if the maxillary sinuses are obstructed. Prophylactic antibiotics should be used as indicated.¹² Otherwise, routine postoperative antibiotics are not recommended.

Fig. 4 A maxillary alveolar ridge fracture.

Fig. 5 An axial view of a maxillary alveolar ridge fracture.

Fig. 6 A maxillary alveolar ridge fracture.

Dental Fractures

Given the limited formal training in regards to dental trauma, the treatment of patients with dental injuries is often confusing for emergency department providers and plastic surgeons alike. However, emergency room visits for dental trauma are very common with an estimated 199,061 visits between the years of 2008 and 2010 with the most common cause being falls and MVAs.¹³ When evaluating a patient with dental trauma, it is important to obtain a relevant dental history such as the presence of crowns, bridges, and fillings. Like any other injury, it is important to understand the mechanism of injury. Physical exam tips are outlined above.

A useful classification for dental trauma is the Ellis system.

- Class I: Only the enamel is involved—the patient may be evaluated by a dentist as an outpatient.
- Class II: The yellow dentin is exposed. A dressing composed of calcium hydroxide and wrapped with dental foil should be given to the patient with instructions not to eat solid food until following up with a dentist.
- Class III: The dental pulp is exposed—the patient should be evaluated by a dentist within 48 hours.

Tooth avulsions should be treated within 2 hours. Some studies have found that the best results are achieved if the tooth is reimplanted within 1 hour of injury; reimplantation 3 hours or more after injury yields worse inflammation and bone resorption.^{14,15} Before the patient reaches the hospital, there are a few safe methods for transporting the tooth. If the patient is reliable, the tooth can be immediately washed (with no manipulation of the dental pulp) and placed directly into the socket. A “click” should be heard upon placing the tooth back in the socket. Otherwise, the tooth may be washed and placed within the oral cavity with care so as not to swallow it. If all else fails, store the tooth in milk until the patient can receive medical and dental attention.

In the case of partially avulsed, extruded, or laterally luxated teeth, the tooth should not be removed, but rather reimplanted. If a single tooth needs stabilization, it can be splinted to the surrounding teeth. One method is to use an Erich arch bar, which spans the width of the injured tooth and two teeth on either side. The tooth is stabilized to the arch bar with a 28-gauge wire with the lingual wire above the apex of the crown so that a direct perpendicular force secures the tooth in the socket. This appliance is kept in place for 1 week after which the patient is referred to a dentist for further management.¹⁶

Less pressing injuries include extrusion, lateral luxation, and root fractures and can wait up to 5 hours. These may be referred to an outpatient dentist. Injuries that do not require attention for up to 24 hours include intrusion, concussion, subluxation, and crown fracture.

Postoperative Care

Postoperatively, patients should be instructed to follow a soft diet for 6 weeks. Direct occlusion on the injured tooth should be avoided for 6 weeks. Strict oral hygiene is necessary to prevent infection. Chlorhexidine washes should be used and

antibiotics prescribed as necessary. The patient should have regular follow-ups with a dentist.

Conclusion

Midface fractures are commonly encountered in the emergency department by the plastic surgeon. A secure airway and control of bleeding is vital before initiating further examination and workup. LeFort fractures rarely abide by the original classification scheme and are often asymmetric with varying degrees of comminution. The primary goal of reconstruction of the midface is dental occlusion that can be accomplished with intermaxillary fixation while anatomical fixation can be achieved with open reduction and internal fixation. Dental trauma is commonly encountered and is often a nexus of confusion for providers; as such, basic knowledge of tooth implantation and splinting are useful in navigating these injuries.

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