Interrelationship of Structure and Function in Maxillofacial Fractures

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Surgical fixation of maxillofacial fractures can be associated with a myriad of surgical complications. Specific complications correlate with the type of fracture. The authors present a case of multiple maxillofacial fractures, briefly review various types of fractures, and discuss the operative decision-making process. This case report serves as an important reminder that the operative decision-making process should take into account a patient's entire clinical condition.

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Documented treatment of maxillofacial injuries dates back to the fifth century BCE.[1] Approximately 5000 years ago, maxillofacial fractures were categorized as either simple fractures that could be repaired or more complex insults that were ultimately fatal.[2] The advent of wire osteosynthesis and internal wiring fixation improved outcomes in the mid-1900s.[3] In the modern day, it has been reported that as many as 5% of patients presenting to trauma centers have sustained maxillofacial fractures.[4] The majority of such injuries may result from traffic-related incidents; less common causes include interpersonal violence, falls, sports-related injuries, and work-related accidents.[5] Acting as a "crumple zone," the bony architecture of facial bones provides the necessary protection of organs such as the globe, optic nerve, carotid arteries, and cranial cavity.[6]

The tenets of osteopathic medicine describe the intimate and reciprocal relationship of structure and function.[7] Structural abnormalities of the face can lead to dysfunction and morbidity. For instance, accessory ligaments of the mandible have been implicated in the pathogenesis of temporomandibular joint disorders,[8] and treatment geared toward mobilizing these ligaments has been shown to improve patients' symptoms. In the case of maxillofacial fractures, primary treatment traditionally consists of surgical fixation. Although the initial diagnostic protocol for maxillofacial fractures is well established,[9,10] treatment decision-making can be challenging, owing to the complexity and variability of patients' clinical condition when presenting with maxillofacial injuries. Although a variety of philosophies, algorithms, and procedures are used, restoration of structure and function and prevention of complications are the primary goals of management of these injuries.

The current case describes a patient who sustained multiple traumatic maxillofacial fractures that were managed nonoperatively, ultimately saving the patient the morbidity of unnecessary invasive procedures. The authors review the literature on indications for surgery, surgical treatments, and complications of maxillofacial fracture repair.

Case Report

A 24-year-old male construction worker with an unremarkable medical history was transported to the emergency department of a tertiary care center after falling from a height of 40 feet and sustaining severe facial trauma. After initial resuscitation in the trauma bay, the patient was immediately taken to the radiology department for computed tomographic (CT) imaging. The scan revealed numerous fractures of the facial bones, including left Le Fort II and III, right Le Fort I and II, right lateral maxillary sinus fracture, right nasal bone fracture, bilateral frontal sinus fractures, bilateral orbital floor fractures, and bilateral zygoma fractures (*Figure*). Additionally, an epidural hematoma was identified. The patient was taken emergently to the operating room for hematoma evacuation by a neurosurgeon. No cerebrospinal fluid leak was identified.

While the otolaryngology service evaluated the patient for his maxillofacial fractures immediately after the hematoma evacuation, the patient re-

mained intubated and sedated per trauma team orders. The subjective visual field assessment was limited, but forced duction demonstrated no extraocular muscle entrapment. Palpation detected no obvious step-offs of the nasal bones, and there were no fractures of the teeth. It appeared that the patient had type I dental occlusion, but the examination was hindered by the endotracheal tube. No palpatory or structural abnormalities of the cervical spine, thoracic spine, or rib cage were found. It was decided that the patient was not an operative candidate for his facial fractures. As serial cognitive examinations continued to improve, the patient was eventually extubated, and type I dental occlusion was confirmed. The patient was subsequently discharged to a traumatic brain injury facility. He recovered and resumed normal activities.

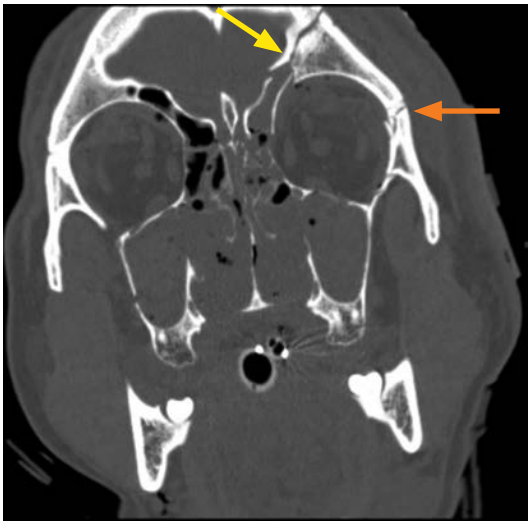

Figure.
Coronal computed tomographic image of a 24-year-old man after falling from a height of 40 feet. Orange arrow denotes left-sided Le Fort III fracture and yellow arrow denotes left frontal sinus fracture.

Discussion

Multiple classifications, indications, contraindications, and potential complications of surgical repair of maxillofacial fractures exist. We performed a literature search through the PubMed portal using keyword combinations such as *maxillofacial fractures*, *facial fractures*, and *operative management*. We systematically reviewed articles from 1990 through 2014 for surgical indications, treatments, and complications, and we summarized the data (*Table*).[11-22] Article citation preference was given to the most current literature found for each category. In general, indications for nonoperative management included the presence of minimally displaced fractures, minimal or absent symptoms, patient noncompliance, and patients who were medically unfit.[23] Complications that may develop after surgery for maxillofacial fractures are summarized in the *Table*. Of note, complications may also occur in the nonoperative setting, which may ultimately require surgical intervention. Complications of surgical repair include nerve disturbances, which are among the most common adverse sequelae of repair of midface fractures,[11] hardware infection, which can result from inadequate fixation during repair,[20] and cosmetic deformity.

In the case of maxillofacial fractures, the primary treatment was surgical fixation. As many as 75% of patients with multiple fractures have been reported to undergo surgical reduction and fixation.[24] Despite this reported frequency, studies have shown that there may be an increased risk for complications, concomitant iatrogenic injuries requiring further surgical treatment, and bothersome sequelae, including nerve disturbances and paresthesias.[22] Additionally, nonmedical factors such as religious, social, and economic issues may influence the wishes of the patient with regard to the treatment decision process. The decision between operative vs nonoperative management requires thoughtful consideration and discussion among surgeon, patient, and family.

We found a paucity of recent literature specifically discussing conservative management of maxillofacial fractures other than mandibular fractures. The trend of open reduction and internal fixation has become commonplace in Western medicine. Despite this trend, the rationale to treat the appropriate patient conservatively exists, even those patients with multiple maxillofacial fractures. Back et al[23] discussed conservative management of facial fractures using criteria including nondisplaced or

Table.
Characteristics and Management of Maxillofacial Fractures

Fracture Type	Classification	Indications for Surgery	Surgical Procedures	Potential Complications
Frontal sinus[11,12]	NA	Displacement of the anterior or posterior tables; compromise of the nasofrontal recess; CSF leak; comminution	Open reduction and internal fixation; cranialization or obliteration of the sinus	Mucocele; mucopyocele; sinusitis; meningitis; CSF leak; nerve disturbance; hardware infection; cosmetic deformity
Nasoorbital ethmoid[13-15]	Type 1: single segment involvement Type 2: comminuted fracture Type 3: comminuted fracture involving medial canthal tendon	Types 2 and 3 require surgery; Type 1 may be managed conservatively	Open reduction and internal fixation; transnasal wiring; other canthopexy	Shortened and retruded nose; shortened palpebral fissures; telecanthus ocular dystopia; nerve disturbance; hardware infection; cosmetic deformity
Zygomaticomaxillary complex[16,17]	Type A: isolated fractures Type B: noncomminuted tetrapod fractures Type C: comminuted fractures	Displacement present; complete fractures; involvement of orbital floor; involvement of orbital apex	Reduction and fixation of zygomaticomaxillary buttress, inferior orbital rim, lateral orbital rim, zygomatic arch, and lateral orbital wall	Alteration of orbital volume; retrobulbar hematoma; ocular muscle entrapment; enophthalmos; lid malposition; ectropion; nerve disturbance; hardware infection; cosmetic deformity
Maxillary[18-20]	Le Fort I: transverse fracture through maxilla passing above tooth roots with posterior extension through pterygoid plates Le Fort II: pyramidal fracture that crosses zygomaticomaxillary sutures bilaterally, resulting in separation of the nasal region from the cranium Le Fort III: courses transversely across the nasofrontal suture and medial and lateral orbital walls	Abnormal occlusion alternation in facial height alteration in facial projection	Reduction and fixation of zygomaticomaxillary buttress, inferior orbital rim, and lateral orbital rim	Malocclusion; neurologic deficits; infection; nonunion; ectropion; nerve disturbance; hardware infection; cosmetic deformity
Mandibular[21-23]	Anatomical location: symphysis/ parasymphysis, body, angle, or subcondylar	Malocclusion; instability	Load-sharing fixation; load-bearing fixation	Malocclusion; malunion; nonunion; nerve disturbance; hardware infection; cosmetic deformity

Abbreviations: CSF, cerebrospinal fluid; NA, not applicable.

minimally displaced fractures, minimal symptoms, or medical fitness for operative management. Of the 230 patients in their study, 83% were treated conservatively, with 3 requiring subsequent surgical intervention.[23] Timely follow-up of all patients with maxillofacial fracture is essential but markedly important when conservative management is used.

In the current case, after the thorough physical examination and careful review of the findings on CT imaging, no indication for surgical repair was observed. Although frontal sinus tables were fractured, they were not displaced, and no cerebrospinal fluid leak was found. The nasofrontal recess was uncompromised, maintaining a patent outflow and normal sinus drainage from the frontal sinus into the middle meatus. The forced duction testing showed normal range of motion; thus, the orbital floor fractures were not causing impingement of the inferior or medial rectus muscles. The lack of step-offs palpated on the nasal bones suggested a patent and unobstructed nasal airway allowing for laminar flow during nasal breathing. Furthermore, the patient had a type I dental occlusion, which optimized chances for recovery of normal speech and mastication. No alteration in facial height or projection was found. Overall, the structural integrity of the facial bones was not majorly compromised, which undoubtedly helped restore normal function during his recovery. The sole operative intervention that was performed was an emergent evacuation of an epidural hematoma by a neurosurgeon.

The first and second tenets of osteopathic medicine state that "the person is a unit of body, mind, and spirit" and that "the body is capable of self-regulation, self-healing, and health maintenance."[7] As modern medicine continues to advance via research, we must not forget or disregard the body's innate ability to heal itself. The patient discussed in the current case report is a formidable example of these abilities. However, patients sustaining multiple maxillofacial fractures may have a tedious recovery course. In addition to regular surgical follow-up visits, home health aides and rehabilitation services for tasks such as speaking and eating may be necessary on a long-term basis. Patients should also be counseled that whereas functioning should improve with ongoing treatment, there is a risk of cosmetic deformities sustained in both postoperative and nonoperative situations. The current patient had a positive outlook, was motivated to fully recuperate, followed all orders during his hospital stay, was compliant with postoperative rehabilitation appointments, and was eager to return to his job. Despite the seemingly catastrophic appearance of the maxillofacial fractures on CT imaging, he regained function. This outcome may reflect the power of the mind and spirit during recovery from trauma.

The third and fourth tenets of osteopathic medicine state that "structure and function are reciprocally interrelated" and that "rational treatment is based upon an understanding of the basic principles of body unity, self-regulation, and the interrelationship of structure and function."[7] Repair of maxillofacial fractures is an intervention with associated risks that must be weighed against the goals of reestablishing structure and function. Because of the possibility of inciting iatrogenic damage, caution should be taken in situations with no absolute indications for surgery.

Conclusion

The current case serves as an important reminder that conservative management may, at times, serve the best interest of the patient.

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