Complications of Midface Fractures

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Abstract

The midface relies on key vertical and horizontal buttresses for proper function and appearance. Trauma to the midface can lead to untoward complications involving critical structures of this area. Many reviews focus on operative management of midface fractures with little focus on complications of the injury and operative repair. We review the current literature on the most common initial and postoperative complications of midface trauma with a specific focus on zygomaticomaxillary complex (ZMC) and Le Fort fracture patterns. A thorough literature review was conducted using PubMed analyzing articles relevant to the subject matter. Various search terms were used to identify articles regarding midface fracture presentation, diagnosis, and management, as well as postoperative complications. Articles were examined by all authors and pertinent information was gleaned for the purpose of generating this review. Disruption of the midfacial buttress system can lead to a significant compromise in form and function. A wide variety of complications are seen in nasal bone fractures, orbital floor fractures, Le Fort, and ZMC fractures. Some fracture patterns can be managed conservatively without operative intervention; however, complications such as loss of facial width/projection, trismus, malocclusion, ocular entrapment, and significant enophthalmos should be managed with open repair. Timing and method of repair depend on patient-specific injury patterns and surgeon preference. Proper management depends on a detailed understanding of the anatomy and pathophysiology of each fracture pattern along with restoration of the patient's premorbid state. Complications of midface fractures result from disruption of the vertical and horizontal buttress support systems. Proper management and repair of midface complications requires a strong understanding of its anatomic basis and pathophysiology. Sequelae from these fractures can be serious and long lasting if not addresses appropriately. Astute diagnosis and timely management can prevent patients from suffering debilitating long-term sequelae.

Keywords
- midface fractures
- complications
- zygomatic complex

Maxillofacial trauma has been associated with 14 to 17% of all facial injuries.[1] Most statistical analyses of maxillary trauma are retrospective and patterns of etiology differ regionally.[2] However, Mast et al note the incidence of severe or complex maxillofacial trauma seems to be decreasing over the past 10 years.[3] The most common causes of midface trauma still are motor vehicle accidents and interpersonal violence.[4] Most studies involve the operative management of these fractures with little literature discussing the complications of midface fractures and how they present. A firm understanding of these concepts is critical to correctly diagnosing patients as well as selecting those who should undergo operative management.

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Operative techniques described in the literature strive to restore basic form and function of the midface while preventing the initial complications from becoming long-standing. In this article, we will focus on maxillary and zygomatic fractures, and their complications in the untreated and treated settings. As the focus will be on complications, a full description of operative management is beyond the scope of this article and the reader is advised to consult the literature for further discussion. We aim to present these complications in an effort to emphasize the importance of their pathophysiology in midface fracture management.

Anatomy

The midface is composed of several components including the maxilla, zygoma, soft tissue, and the nose. Buttresses that are oriented in the vertical and horizontal planes provide structural support and are essential in providing height, width, and projection to the midface. Cosmetic deformity that results from fractures is a direct result from disruption of this support system. Vertical supports are the strongest and are responsible for transmitting masticatory forces to skull base and include the nasomaxillary, zygomaticomaxillary (ZM), pterygomaxillary, and nasal septum. Horizontal supports reinforce the vertical ones and provide width and projection to the face.[5] These include the inferior orbital rims, maxillary alveolus and palate, zygomatic process, greater wing of sphenoid, medial and lateral pterygoid plates, and the mandible. The Le Fort classification scheme is classically taught and essential to understand force transmission patterns, but is often not fully representative of the fracture patterns seen clinically.[3] Often times, fracture patterns can be unpredictable and difficult to compartmentalize into a single category. Operative repair of midface fractures is based on restoring the buttress system to its premorbid state.

Presentation and Workup

Patients should first be evaluated using the Advanced Trauma Life Support guidelines, as concurrent injuries to the cranium and cervical spines are common. Airway management is paramount, as severe facial trauma can compromise the upper airway and jeopardize cardiopulmonary function. Following clearance of the cervical spine and assessment of the patient's neurologic status, a complete head and neck examination must be performed with specific attention to cranial nerves (CNs) and ocular findings. Asymmetries of the malar eminence (►**Fig. 1**) or bony orbit, bruises, lacerations, and swelling are important signs that may indicate the presence of midface fractures. If the physical exam findings support the presence of a fracture, it is important to obtain a dedicated maxillofacial computed tomography (CT) with thin cuts to fully evaluate the bony skeleton. At some institutions, three-dimensional reconstructions are available, which can increase visualization and aid surgical planning. If any ocular concerns arise, an ophthalmology consult should be obtained to evaluate vision and globe status.

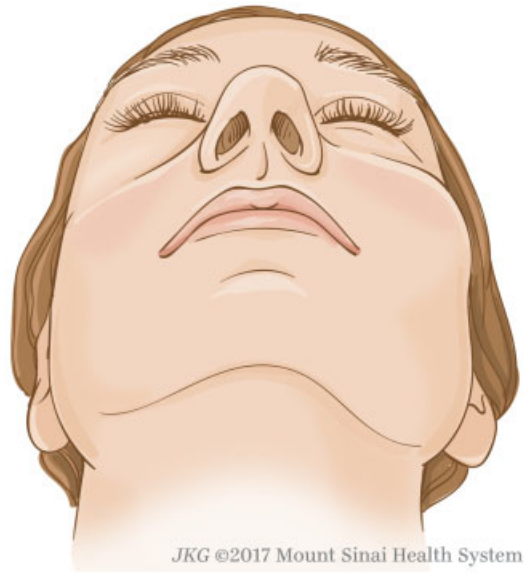

Fig. 1 Illustration of malar flattening in a patient with a right zygomatic complex fracture. (This image is provided courtesy of Jill Gregory, Senior Illustrator, at the Mount Sinai Health.)

Nasal Bone Fractures

Complications

Nasal bone fractures are the most common fracture of the midface.[6] Assault and battery are the most frequent cause of trauma. Sequelae of these fractures can range from minimal displacement requiring no intervention to displaced nasal deformity requiring initial reduction and possible future reconstructive surgery. Signs of nasal bone fracture include epistaxis, swelling, hematoma, and nasal obstruction. Nasal bone fractures can be associated with injury to other nearby structures including the overlying soft tissue and cartilage. Fractures of the septal cartilage can result in septal hematomas, which must be treated rapidly as the underlying cartilage can rapidly necrose resulting in a saddle-nose deformity. Epistaxis is common with nasal bone fractures as the rich arterial anastomotic network of blood vessels is frequently disrupted. Proper initial management is important as revision septorhinoplasty occurs at a rate between 9 and 50%.[7]

Management

Proper surgical correction requires an in depth understanding of the anatomic basis of deformity. Patients can have disruption of the bony–cartilaginous framework of the nose that can require a range of operative intervention from simple closed reduction or open septorhinoplasty in the operating room. Adults can have definitive treatment delayed up to 12 days, whereas children should have immediate treatment to avoid scar contracture.[8] Choosing which intervention each patient needs starts by determining which symptoms are most debilitating to the patient (deformity, nasal airway obstruction, etc.), and proper facial analysis. Operative management requires the surgeon to be familiar with current rhinoplasty techniques and have a strong understanding of the unique structural and aesthetic considerations of nasal surgery.[9]

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Postoperative Complications

The most common postoperative complications are residual nasal deformities and nasal airway obstruction. Postreduction nasal deformity has been reported as high as 40 to 62% regardless of surgeon experience after simple closed reduction.[8] Therefore, posttraumatic nasal deformity is one of the primary reasons patients seek septorhinoplasty with incidence of revision surgery in 14 to 50% of nasal trauma cases.[10] It is important to allow sufficient time to heal after initial repair even if the initial surgery yields suboptimal results. Time allows the inflammation and edema to subside and allows proper facial analysis before undertaking a revision procedure. DeFatta et al prospectively treated 40 nasoseptal injuries with either a closed or open approach. They found 60% of the closed reduction group having postoperative septal deviation where only 12.5% of the open group suffered the same result. This resulted in a statistically significant reduction in revision rhinoplasty required.[8]

Orbital Fractures

Complications

A full review of orbital fractures is beyond the scope of this article; however, the basics will be reviewed. Midface trauma commonly involves the bones of the orbit, as the medial wall and floor are weak points in the facial skeleton. The orbital floor is the weaker of the two and is more commonly injured. Injury results from increases in intraorbital pressure that results in fractures of the bone, occasionally with herniation of orbital contents. This article will focus on orbital fractures as a part of a ZM complex (ZMC) fracture pattern. Orbital or orbital blowout fractures will not be discussed. Signs and symptoms of orbital fractures include bruising, swelling, diplopia, enophthalmos, hypoglobus, and hypoesthesia of V2 branch of the trigeminal nerve. Entrapment of the inferior rectus muscle in the fracture line can limit extraocular movements but traumatic palsy of CN III can present similarly. A forced duction test is mandatory to rule out ocular entrapment.[11] Indications for repair includes hypoglobus, enophthalmos of 2 mm or more, oculocardiac reflex, diplopia from entrapment of inferior rectus muscle, and cosmetic deformity. Of these, oculocardiac reflex is the only true emergency, whereas the others can be dealt with in an urgent or elective fashion.

Management

The primary goal in orbital trauma is to restore orbital volume to its premorbid condition. This requires repair of the orbital rim as well as the zygomatic arch and nasoethmoid complex. Naso-orbitoethmoidal fracture management can be found in another section of this issue. Orbital floor fractures should be reduced and defects repaired with a variety of implant materials. As mentioned previously, a forced duction test can allow the surgeon to check for adequate resolution of muscle entrapment. True reconstruction of the orbital floor is done with autograft material including bone and cartilage or alloplastic material including titanium mesh, porous polyethylene, and resorbable sheeting.[12] This is best performed within 1 to 2 weeks of injury.[11] Access to the orbital floor includes the transconjunctival, subciliary, and direct approach through existing lacerations. Implant material is wide ranging and its selection and placement is beyond the scope of this article.[11]

Postoperative Complications

Souyris et al evaluated complications after repair of 1,393 ZMC fractures and found 7% reported infraorbital nerve dysfunction and 12% malposition of the zygoma resulting in diplopia, enophthalmos, or dystopia.[13] Enophthalmos is defined as recession of the globe within the orbit in an anterior–posterior dimension.[11] This results in a recessed globe clinically with possible hypoglobus. This asymmetry can be distressing for patients as even small millimeter differences between globe positions are perceptible to their eyes. Diplopia, which can be a presenting sign of orbital fractures, can continue to be present in the postoperative period especially if muscular release from entrapment is not adequately performed. Improper positioning of the zygoma and/or orbital floor/wall, which changes the orbital volume, typically causes enophthalmos. A comprehensive ophthalmologic exam and a fine cut CT scan are part of the workup before revision operation is attempted. Correct placement of the orbital rim, zygoma, naso-orbital ethmoid complex, and orbital walls will restore orbital volume and correct enophthalmos and hypoglobus. As with any procedure involving, long-term sequelae such as implant migration, extrusion, or infection are certainly possible and must be assessed in the postoperative period. Other complications include vertical dystopia: differing vertical position of the globes. This can be corrected with re-exploration and reconstruction of the orbital floor height.[9]

Zygomatic Complex and Le Fort Fractures

Complications of Zygomaticomaxillary Complex Fractures

ZMC fractures refer to disruption of the malar eminence at four buttresses: zygomaticomaxillary, frontozygomatic, zygomaticosphenoid, and zygomaticotemporal.[5] They are common as this area is the most lateral projection of the midface and thus susceptible to injuries from trauma, motor vehicles accidents, and sports injuries.[14] Loss of lateral projection is a common complication and is an indication for operative repair. Swelling at presentation may make the true extent of deformity difficult to assess and require a period of time to allow the swelling to subside.

Trismus is a common complication of ZMC fractures due to impingement of the depressed zygomatic arch on the coronoid process. This is also an indication for operative repair as osteogenesis and ankylosis of the mandible may result. Trismus may also result from direct compression of the temporalis by the zygomatic arch.[5] The orbital floor is almost always involved given the thin bone that makes up this part of the orbit; thus, a thorough eye exam is a mandatory step in every ZMC fracture assessment. Infraorbital nerve damage is common due to its proclivity of having the fracture traverse its canal.

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Complications of Le Fort Fractures

Le Fort I

This fracture pattern involves two vertical buttresses: the inferior medial maxillary at the pyriform aperture and inferior lateral maxillary buttress.[15] This results in a mobile palatomaxillary segment. Firm traction should result in anterior displacement of the maxillary teeth, confirming the diagnosis. There may be mucosal lacerations and palatal ecchymosis present. All Le Fort fractures dislocate the maxillary teeth and result in malocclusion. Commonly distal traction from the pterygoid muscles will cause early contact at the molars resulting in a frontal open bite.[6]

Le Fort II

This fracture pattern involves the upper transverse maxillary buttress (infraorbital rim) and lateral maxillary buttress, orbital floor, and nasofrontal junction. Unlike Le Fort I fractures, this includes the infraorbital rim and associated V2 branch of the maxillary nerve. Palpable bony stepoffs of the infraorbital rim are suggestive of Le Fort II fractures. The infraorbital nerve is commonly involved in the fracture line and its function should be assessed and documented. Nerve injury leads to reduced sensitivity in the frontal teeth, upper lip, cheek, and skin of the lateral nose.[6]

Le Fort III

This fracture is classically described as "craniofacial separation" with all bony attachments between the skull base and maxilla having been disrupted. This fracture pattern involves separation of midface at the zygomatic arch, along with frontozygomatic and sphenozygomatic sutures, orbital floor, and nasofrontal junction.[15] Importantly, the fracture line must traverse through the zygomatic arch, which neither Le Fort I nor II fracture patterns do. Symptoms include massive swelling, oral and nasal bleeding, malocclusion, palpable stepoffs, and orbital edema. Le Fort III fractures can include portions of the ethmoid bone possibly causing a cerebrospinal fluid (CSF) leak as well as trigeminal nerve damage indicating skull base involvement.[6]

Management

The topic of primary versus delayed repair of maxillofacial trauma has not been studied as thoroughly as in mandibular trauma. Timing is traditionally categorized as immediate (within 48 hours), early (< 2 weeks), and late.[3] Many authors suggest that repair should occur within 2 weeks of initial injury for optimal results. Delayed repair beyond 2 weeks is traditionally not advised as bone absorption and callus formation can lead to difficult repositioning.[3] In fact, Janus et al reviewed 34 midface fractures undergoing primary (< 6 days) versus delayed (> 6 days) repair and showed no difference in the rate of complications between the two groups.[16] Strong evidence for early versus late repair does not exist in the literature. Therefore, timing of operative intervention depends on many factors individual to each patient as well as interdisciplinary planning among emergency medicine, acute care surgery, neurosurgery, ophthalmology, and otolaryngology teams. Surgical approaches and operative techniques are beyond the scope of this article. However, the goal of midface surgery is proper anatomic fixation of fractured segments. This can be done with or without postoperative maxillary–mandibular fixation.

Postoperative Complications

Common complications from improperly repaired ZMC or Le Fort fractures include malocclusion, facial asymmetry (►**Fig. 2**), and poor aesthetics.[9] Early masticatory forces on the repaired maxillary bone can lead to bony nonunion. Other complications include sinusitis and soft tissue deformity including cheek ptosis. Workup options include fine cut imaging as well as dental models to aid in attaining correct intraoperative occlusion. Yang et al states that the goal of secondary maxillary reconstruction does not include re-establishment of premorbid occlusion but attaining a more ideal/functional maxillary–mandibular relationship.

Other Midface Fracture Complications

Bleeding

Epistaxis is a common symptom from direct facial trauma. Bleeding from nasal mucosa can be treated with cauterization or nasal packing. Bleeding from more posterior aspects of the nose indicates involvement of the external carotid system which may require posterior packing and/or endovascular intervention. Midface fractures are associated with aneurysms and late bleeding. Newman and Cillo described late vascular complications in 1 to 11% of blunt facial trauma

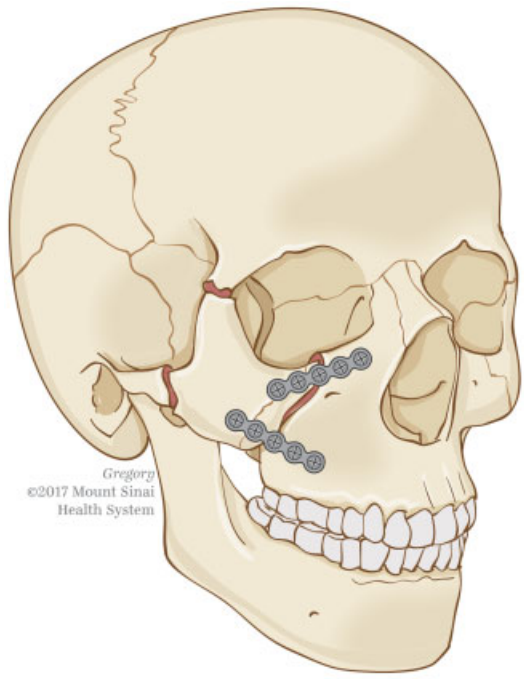

Fig. 2 Improperly reduced zygomatic complex fracture that will likely lead to continued facial asymmetry. (This image is provided courtesy of Jill Gregory, Senior Illustrator, at the Mount Sinai Health.)

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cases.[17] Therefore, severe epistaxis even years after severe facial trauma may be a sign of an aneurysm and should suggest further workup with contrast enhanced CT or magnetic resonance angiography.[18]

Cranial Nerve Injury

CN injury occurs mostly with skull base injuries. The most commonly affected nerves are V2 branch of the trigeminal nerve and the olfactory nerve. Following these, the facial nerve and intraocular CNs (II, IV, and VI) are next likely to be injured in facial/head trauma.[19] Olfactory dysfunction has been reported in 12.8% of craniocerebral injuries and likelihood increases if CSF leak is present.[20] Prognosis of hyposmia is good but anosmia is poor with only 11.3 and 2.3%, respectively, recovering their sense of smell.[21]

Summary

Midface trauma is associated with a wide variety of complications. Both cosmetic and functional deformities are a direct result of disruption of the vertical and horizontal buttress systems that provide support for the facial skeleton. Relatively nondisplaced midface trauma can be managed conservatively without operative intervention; however, complications such as loss of facial width/projection, trismus, malocclusion, ocular entrapment, and significant enophthalmos should be managed with open repair. A strong understanding of the natural history of midface complications will dictate which patients benefit from operative management. It must be emphasized that proper management of these injury patterns requires a multidisciplinary approach including emergency medicine, ophthalmology, neurosurgery, oral maxillofacial surgery, and otolaryngology. A review of complications from initial midface fracture and repair is missing from the literature. Although many articles discuss operative management, many only briefly touch on their initial presentation. These complications can be serious and misdiagnosing a patient could result in irreparable damage if left untreated. Most importantly, an understanding of the anatomy and function of each midface component is critical to correctly diagnose and ultimately treat fracture patterns.

Note

The author does not have any conflict of interest, financial, or otherwise. This article, or any part of it, has not been previously published, nor is it under consideration for publication elsewhere.

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