Management of Midface Maxillofacial Trauma

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KEYWORDS

• Midface fractures • LeFort • Zygomaticomaxillary complex (ZMC) • Orbital • Nasal-orbital-ethmoid (NOE)
• Frontal sinus • Cranialization • Obliteration

KEY POINTS

- The maxilla, palate, zygomaticomaxillary complex, nasal bones, orbits, nasal-orbital-ethmoid complex, and frontal sinus may be affected by midface trauma.
- Forces directed onto the midfacial skeleton are absorbed and transmitted through vertical and horizontal buttresses.
- By reconstructing and stabilizing the vertical and horizontal buttresses of the midface, occlusal forces can be tolerated and facial height, width, and projection can be restored.
- Complications of midface trauma include bleeding, malunion/nonunion, neurologic complications, ocular complications, and complications involving the lacrimal system.
- Frontal sinus fractures can be followed with close observation or treated surgically with anterior table reconstruction alone or in combination with sinus obliteration or cranialization.
- The decision to treat a frontal sinus fracture is dependent on the amount of bony displacement, the involvement of the posterior table and intracranial contents, and the condition of the nasofrontal outflow tract.

Introduction

The management and surgical treatment of midface maxillofacial trauma can present one of the most challenging undertakings for the maxillofacial surgeon. The midfacial skeleton and its soft tissue attachments protect the brain and eyes from injury and are closely related to the senses of vision and smell. Speech, mastication, and facial appearance can all be affected by midfacial trauma. Accurate correction of the bony skeleton to the preinjury state is vital to the restoration of function and esthetics.

Initial assessment

The initial evaluation and management of midface trauma should be directed at stabilization of the patient. Motor vehicle collisions represent the most common cause of facial trauma. Other causes include assaults, falls, sporting injuries, and home and occupational accidents. The high-energy nature of these injuries often leads to multisystem involvement and, therefore, a thorough, systematic evaluation of the entire patient should precede the management of their facial injury. The most common concomitant injuries in patients with panfacial fractures include intracranial injury or hemorrhage, abdominal organ injury, pneumothorax, pulmonary contusion, spine fracture, rib or sternum fracture, extremity fracture, and pelvic fracture. Trauma centers are especially equipped to deal with the evaluation and management of these injuries. Specially designed teams directed by trauma surgeons and emergency room physicians lead the initial management of these patients. Oral and maxillofacial surgeons are most commonly consulted after the initial evaluation and management of the most life-threatening injuries.

Of particular concern in patients with midface trauma are:

- The cervical spine
- The airway
- Hemorrhage

Midface fractures are positive predictors of cervical spine fractures and dislocations. The cervical spine should be immobilized until cervical fractures have been ruled out by imaging or clinical examination. If an injury is identified, head and neck immobilization and positioning during the repair of

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the midface injury should be coordinated with the spinal surgeon.

Airway obstruction can lead to asphyxia and death after midfacial trauma. Bleeding, fractured teeth, oral secretions, vomitus, foreign bodies, and edema can affect airway patency. If the airway obstruction cannot be cleared or controlled, a definitive airway should be placed via endotracheal intubation or cricothyrotomy. Oral endotracheal intubation is successful in the hands of experienced emergency physicians using rapid sequence induction. In terms of midface facture repair, nasal intubation allows for the simplest establishment of the dental occlusion. However, the increased difficulty, decreased speed and possibility of a concomitant basilar skull injury with concern for cranial intubation deter most providers from attempting this in an emergency setting. If needed, nasal intubation is better performed as a non-emergent procedure in the operating room prior to fracture repair. When attempts at oral intubation are unsuccessful, a surgical airway via cricothyrotomy provides the fastest approach. Cricothyrotomy should then be converted to a tracheostomy, if necessary, in a controlled environment with less risk of losing airway control.

With a secure airway, uncontrolled bleeding can be addressed. The midface has a robust blood supply, with contributions from both the internal and other branches of the external carotid arteries. The sphenopalatine and other branches of the internal maxillary artery can be significantly damaged during midfacial trauma. Although rare, life-threatening hemorrhage can result. When severe epistaxis is encountered, direct pressure via anterior and posterior nasal packs can be used. Often, posterior bleeding is encountered with drainage into the nasopharynx. A 10-French Foley catheter can be inserted through each nare, inflated with sterile water, and then pulled anteriorly. This procedure tamponades off the posterior chamber and in combination with an anterior packing provides a simple way of nasal packing. Anterior nasal packs can be accomplished with the layering of ribbon gauze or with the use of expandable sponges such as Merocel (Medtronic, Inc, Mystic, CT, USA) or Rhino Rocket (Shippert Medical Technologies Corporation, Centennial, CO, USA). Bleeding from intraoral wounds can be controlled with gauze packing, suturing, or electrocautery. If the hemorrhage has caused significant volume loss, fluid should be replaced with lactated Ringer solution or normal saline to restore blood pressure until blood can be typed and crossmatched. Alternatively, the patient can be transfused with O-negative blood. Once the primary advanced trauma life support survey has been completed and the patient's airway and cardiopulmonary status have been stabilized, the secondary survey, including a more detailed facial examination, can be accomplished.

Clinical examination

The awake patient can be questioned about their occlusion, sensory changes, and pain. The patient's subjective assessment of their bite can be one of the most sensitive measures when evaluating for the presence of a maxillary or mandibular fracture. Edema within the temporomandibular joint may also cause changes in occlusion and should be taken into consideration. Paresthesia and numbness of the upper lip, side of the nose, and maxillary gingiva suggest a fracture involving the infraorbital nerve and are common with maxillary and orbital fractures. Pain is also a common finding in the region of a fracture.

The physical examination is best accomplished when performed systematically. We prefer a top-down/outside-in approach. The soft tissue is first inspected for lacerations, edema, and ecchymosis. Abnormalities and asymmetries in midfacial height, width, and projection are assessed. The intercanthal distance is measured, and epiphora and rhinorrhea are noted if present. A cranial nerve examination is performed, including a detailed assessment of visual acuity and extraocular movements. Bimanual palpation can then be undertaken to assess for bony steps, mobility, crepitus, and tenderness. Palpation begins with the frontal bones and supraorbital rims. It then extends to the lateral orbits, zygomatic arches, and zygomas. The infraorbital rims are next addressed, followed by the medial orbits and nasal bones. The maxilla is then palpated. In addition to palpation, the maxilla can be grasped around the anterior maxillary teeth, with the thumb inferior to the anterior nasal spine and the forefinger at the depth of the palatal vault to assess for mobility. An intraoral examination is accomplished. The intraoral soft tissues are inspected for lacerations and ecchymosis. The teeth should be examined for fractures, luxations, and avulsions. The alveolar bone is assessed for displacement and mobility. Maximum incisal opening, lateral excusive movements, and protrusive movements are recorded and the occlusion is assessed.

A radiographic examination should always accompany the clinical examination in the patient with facial trauma. Although plain films can be useful for identification of specific fracture elements, computed tomography (CT) has become the standard for evaluating midfacial injuries. CT scans provide information in 3 planes of space (axial, coronal, and sagittal), and can be used as a standalone radiographic modality. The CT data can also be reconstructed into a three-dimensional (3D) image, increasing its usefulness. At a minimum, we prefer to order a non-contrast maxillofacial CT with 1-mm to 2-mm axial slices and coronal, sagittal, and 3D reconstructions (Fig. 1).

Maxillary and LeFort fractures

Anatomy

The maxilla, palate, nasal bones, and zygomas comprise most of the midfacial skeleton. The ethmoids, greater wing of the sphenoid, and frontal bone comprise elements of the bony orbit and connect the anterior facial skeleton to the cranial base. Forces directed onto the midfacial skeleton are absorbed and transmitted through vertical and horizontal buttresses. These buttresses constitute areas of dense, thick bone that support the maxilla and are more resistant to deformation when forces are applied. They are not only important in protecting the vital structures of the midface but they are also essential landmarks used during reconstruction. The buttresses provide higher-quality bone for internal fixation and guide reconstruction of facial height, width, and projection.

The midface is more resistant to vertical forces than horizontal and shear forces. This resistance is because of the strength of the 4 vertical buttresses (Fig. 2):

- Nasomaxillary (medial)
- Zygomaticomaxillary (lateral)
- Pterygomaxillary (posterior)
- Ethmoid-vomerian or septal (midline)

The paired nasomaxillary buttresses extend from the frontal bone to the nasal bones and medial orbit, and along the pyriform apertures and end at the maxillary alveolus in the region of the maxillary canines. Laterally, the pterygomaxillary