The Imaging of Maxillofacial Trauma 2017

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KEYWORDS

• Maxillofacial trauma • Surgery • Imaging

INTRODUCTION

Epidemiology

Facial fractures account for a large proportion of emergency room visits and 2% of all hospital admissions.[1] Significant facial injuries are clinically occult in more than half of intubated multitrauma patients.[2] Mechanisms include motor vehicle collisions, assaults, falls, sports injuries, and civilian warfare. Together, motor vehicle collisions and assaults account for more than 80% of all injuries and commonly involve young adult men and alcohol use.[3]

By understanding common fracture patterns and the implications for clinical management, radiologists can better construct clinically relevant radiology reports and thus facilitate improved communication with referring clinicians to best serve victims of maxillofacial injuries.

Clinical Issues

The face protects the brain from frontal injury; supports the sensory organs of sight, smell, taste, and hearing; and serves as the point of entry for oxygen, water, and nutrients.

Initial management of any trauma patient begins with life preservation aimed at airway, breathing, and circulation maintenance. In acute facial injury, the presence of fracture fragments, teeth and airway foreign bodies, pharyngeal hemorrhage, and loss of hyomandibular support with posterior displacement of the tongue can all compromise the airway. Stridor and hoarseness are clues to laryngeal injury that may be occult, initially leading to subsequent precipitous airway compromise.

Branches of the external and internal carotid arteries supply circulation to the face. Injuries to these vessels are common and may result in a rapidly expanding hematoma or profuse arterial bleeding. In closed injuries, bleeding is controlled by packing or balloon tamponade using a Foley catheter. When packing fails, angioembolization is necessary to control hemorrhage, often targeting the maxillary and palatine arteries associated with midface fractures and in cases of penetrating arterial injury.

Once patients are stabilized, clinical attention in the setting of facial trauma is directed to restoration of form and function, with attention to facial injury patterns and their impact on sight, smell, taste, speech, and cosmetic deformity.

Biomechanics and Associated Life-threatening Injuries

Injury pattern and severity of maxillofacial fractures are determined by the direction and magnitude of the impacting force and the underlying facial architecture. For example, the prominent positions of the nose, zygoma, and mandible are typically injured in assault with a relatively small amount of energy transfer. Motor vehicle collisions, falls, and other high-velocity injuries result in more complex, midfacial fractures.

A study of major facial fractures in 1020 patients grouped injuries into high G-force and low G-force mechanisms[4]; 21% of patients with low G-force facial trauma had 1 or more associated life-threatening injuries compared with 50% in patients with high G-force mechanisms. Life-threatening injuries included intra-abdominal injury requiring surgery, pneumothorax, chest trauma

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requiring ventilator support, and severe closed head injury. Mortality in the high G-force group was 12%.

In a study investigating the relationship between facial fractures, cervical spine injuries, and head injuries in 1.3 million trauma patients, 7% of facial fracture patients had concomitant cervical spine injury and 68% had associated head injury.[5] Approximately 8% suffered injuries to all 3 areas.

IMAGING

Imaging in facial trauma aims to define the site and severity of facial fractures and to identify injuries that could compromise the airway, vision, mastication, the lacrimal system, and sinus function. Individual fractures should be listed and associated soft tissue injuries described with attention to these areas. If possible, bony findings should be summarized in one of several typical fracture patterns.

Modalities

Imaging in most emergency departments for significant facial trauma begins with CT scanning. Multidetector CT (MDCT) has supplanted plain radiography and has revolutionized the imaging of the maxillofacial trauma. MDCT, more cost efficient and more rapidly performed than facial radiographs, is considered the optimal imaging modality, particularly in the polytrauma setting. MDCT allows safe and rapid volumetric image data acquisition without patient manipulation and accurately depicts both bony and soft tissue injury. Submillimeter slice thickness permits detailed multiplanar reformations (MPRs) and 3-D reconstructions. Fracture fragment displacement and rotation are easily determined and fracture patterns may be readily classified and assessed for stability. Although 2-D transaxial and coronal images are more accurate and sensitive than 3-D reconstructions for individual fracture detection, 3-D imaging provides a global perspective to help classify fracture pattern types. Additionally, 3-D reconstructions are preferred by surgeons for operative repair planning.[6] Nonetheless, it is important to recognize limitations in 3-D imaging, namely the introduction of artifact during the reconstruction process, decreasing the ability to visualize nondisplaced fractures, and difficulty viewing deep fractures on surface renderings.

MR imaging can be a useful adjunct in patients with cranial nerve deficits not explained or incompletely characterized by CT. Its advantages include multiplanar capabilities, excellent soft tissue contrast, and lack of ionizing radiation. The practical limitations of long scan times, limited patient access, poor evaluation of cortical bone, and contraindication in patients with pacemakers, some aneurysm clips, and ocular metallic foreign bodies prevent its primary application in the emergency setting.

Multidetector CT Technique

At Bellevue Hospital, patients with clinically apparent or suspected maxillofacial fractures are scanned from the top of the frontal sinuses through the hyoid with the field of view from the tip of the nose through the temporomandibular joints to always include the entire face and mandible. Acquisitions using 64-MDCT with 0.625-mm detector width and overlapping sections allow high-quality MPRs to be generated; 2-mm thick images in all 3 planes oriented parallel and perpendicular to the hard palate provide symmetric images for optimal interpretation. Images are produced in bone and soft tissue algorithm for radiologist review. Specialized MPRs may be generated depending on the presence and type of fractures. For example, oblique sagittal reformations along the plane of the optic nerve elegantly characterize orbital floor fractures with respect to depression, orbital depth, and relation to the inferior rectus muscle. Panoramic or oblique sagittal planes optimize evaluation of mandibular angle and ramus fractures. 3-D reconstructions are often acquired in patients with complex injuries for better characterization and surgical planning.

Multitrauma patients often require a comprehensive whole-body CT examination to evaluate multiple body regions in a single visit to the CT suite. With current technology, scanning of the head, face, and cervical spine may be acquired as a rapid single acquisition, without requiring gantry tilt and eliminating overlap of these body sections.

FACIAL FRACTURES

Facial fracture complexes are classified by location and pattern into the following categories: nasal, naso-orbital-ethmoid (NOE), frontal sinus, orbital, zygomatic, maxillary, and mandibular. Manson and colleagues[7] have proposed further categorizing each area by the energy of the injury, namely low energy, moderate energy, and high energy. Low-energy injuries show little or no comminution or displacement. Moderate-energy injuries, the most common, demonstrate mild to moderate displacement, whereas high-energy injuries are characterized by severe fragmentation,