MANDIBULAR INJURIES AND FRACTURES

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Annotation

This article provides a comprehensive overview of mandibular fractures, which are among the most common facial bone injuries. Unlike nasal fractures, mandibular fractures often require surgical intervention due to the complex anatomy and essential function of the mandible. The discussion covers the etiology, epidemiology, pathophysiology, classification, and prognosis of mandibular fractures. Trauma—including motor vehicle accidents, interpersonal violence, and sports injuries—is the leading cause. The mandible’s unique ring-like structure often results in multiple fracture sites. Evaluation of associated injuries (e.g., cervical spine and traumatic brain injuries) is critical. Despite a relatively high perioperative complication rate, long-term outcomes are generally favorable. Smoking and alcohol use are noted as key risk factors for postoperative complications.

Keywords: Mandibular fracture, Facial trauma, Maxillofacial surgery, Open reduction and internal fixation (ORIF), Etiology, Epidemiology. Pathophysiology, Multiple fracture sites, Perioperative complications

Introduction

Facial fractures make up a comparatively small proportion of emergency department visits, but of these injuries, the most common are nasal and mandible fractures. While the vast majority of nasal fractures can be managed without surgery, operative intervention for mandible fractures is relatively common due to the complexity of the structure’s anatomy and function. The mandible is a mobile, ring-like bone that frequently fractures in more than one location; these fractures are at risk for wound contamination with oral flora, may be complicated by teeth in the fracture line, and in some cases, can compromise the patient’s airway.[1]

Etiology.The mandible is one of the most commonly fractured facial bones, along with the nasal and zygomatic bones. Most frequently, fractures are a result of trauma, such as motor vehicle accidents, physical altercations, industrial accidents, falls, and contact sports. For this reason, it is critical to evaluate patients with mandible fractures for other associated traumas, to include cervical spine and traumatic brain injuries.[1]

Epidemiology.Vehicular accidents and altercations are the primary causes of mandibular fractures in the united states and throughout the world. In an urban trauma setting, altercations account for most fractures (50%), and motor vehicle accidents are less likely (29%). Males suffer approximately three times as many mandible fractures as females, with the majority occurring in the third decade of life.[1][2]

Mandibular fractures are uncommon in children under the age of six, likely because of the relative prominence of the forehead compared to the chin. When they do occur, they are often greenstick fractures.

Pathophysiology.Because of its ring-like structure, multiple fractures are seen in more than 50% of cases. The most common combination of injuries is a parasymphyseal fracture with a contralateral angle or subcondylar fracture. While studies vary in reported fracture frequencies, the most common individual fracture sites are the body, the condyle, and the angle. The symphyseal/parasymphyseal area is less commonly fractured, and the ramus and coronoid process are rarely involved. In automobile accidents, the condyle was the most common fracture site; whereas, the symphysis was most commonly fractured in motorcycle accidents. In assault cases, the angle is the most common fractured site.[3]

Mandible fractures can be classified by favorableness, based on the association between the direction of the fracture line and the way muscle action either reduces or distracts the fracture fragments. Mandibular fractures are favorable when muscles tend to draw the fracture fragments together and unfavorable when muscle forces displace fracture fragments. An example of a favorable fracture is an obliquely-oriented fracture just anterior to the angle, with the superior aspect of the fracture line situated posterior to the inferior aspect; this configuration causes the masseter to pull the fragments together and stabilize the fracture, meaning that surgical reduction may not be required.[4]

Prognosis.The overall prognosis for patients who suffer mandible fractures is good, particularly in the absence of other associated injuries. While the perioperative complication rate in patients who undergo ORIF is fairly high due to the complexity of the repair (~20%), the long term results are good, with only 7% of patients reporting long term complications, such as abscess, malunion/nonunion, and hardware exposure. Smoking and alcohol use, the latter of which frequently contributed to the original cause of the mandible fracture, are associated with a higher rate of complications; patient age, gender, and type of injury do not appear correlated with outcomes.[5]

Complications.Regardless of treatment modality - conservative management, closed reduction with MMF, or ORIF - the most common complication of mandibular fractures and their treatment is malocclusion. ORIF has a higher risk of developing complications than a closed reduction - 21% vs 17%, particularly when performed by surgeons without a high-volume facial trauma practice. Hypesthesia of the lower lip and chin is also extremely common, with some studies reporting rates as high as 50%. Other less common complications include infection, bony malunion/nonunion, hardware extrusion, persistent trismus or mandibular deviation with opening, and facial nerve injury. Fractures at the angle are associated with the highest rate of developing complications.[6][7][8]

Evaluation.Initial Assessment - History

The diagnostic work-up of mandible fractures begins with a thorough primary survey as outlined by the Advanced Trauma Life Support (ATLS) protocols.[10] Mandible fractures are unique in that severe injuries, such as bilateral body fractures (“bucket handle”) can result in airway embarrassment. In these situations, stabilization of the airway may require tracheotomy. Life-threatening injuries, when present, need to be recognized and managed early before fracture assessment can begin. Before examination, the physician or physicians should be sure to don any necessary personal protective equipment (PPE) given the post-pandemic era we now live in, with the known increased risk of transmission related to manipulation of oronasal mucosal tissues.[11]

A thorough history of present illness and past medical and surgical history will highlight any relevant medical conditions, previous trauma, bone disease, nutritional and metabolic disorders, and psychiatric conditions that may influence timing and management of the fracture.[12]

In addition, the patient's premorbid dental history and occlusion needs should be accounted for. When available, photographs can aid in reduction of the patient's fracture to re-establish the premorbid occlusion.

Initial Assessment - Clinical Examination

Focused evaluation of the head and neck is a part of the secondary survey outlined by ATLS protocols. Examination should begin with inspection and palpation. The classical signs of inflammation, pain, swelling, and erythema will help guide the physician in thorough identification of potential injuries. After examining for any lacerations or sources bleeding that needs to be addressed urgently, the clinician should perform an in-depth fracture assessment. Extra- and intra-oral findings, in addition to a neurosensory examination, will help the physician in identification of fractures or fractures patterns that may be present.

Extra-oral Examination: An extra-oral assessment should begin by examining the face and mandible for any abnormal contours or step defects. Changes to the patient's facial profile and mandibular movements will cue the physician for types of fractures. For instance, a flattened facial profile may be due to a fractured mandibular body, angle, or ramus. A retruded chin may be caused by bilateral parasymphyseal fractures. An elongated face may be the result of bilateral subcondylar, angle, or body fractures. Any facial asymmetry should also signal the physician for the possibility of a mandible fracture.[12]

The advent of faster helical-CT imaging has 100% sensitivity in diagnosing mandible fractures compared with 86% sensitivity of panorex imaging. These CT images can be reformatted into three-dimensional reconstructions to further aid in operative planning of fracture management. Surgical Anatomy.The osteology of the mandible, various muscle attachments and their influence, and presence of developing or permanent dentition, or lack of dentition, need to be understood for accurate treatment of mandible fractures. A full description of a mandibular fracture should include an assessment of its relationship to the external environment (ie, simple/closed, compound/open), type (ie, incomplete, greenstick, complete, comminuted), dentition (ie, primary, mixed, permanent, or lack of dentition), displacement, favorability, and location.

Bony Anatomy of the Mandible.The mandible is a U-shaped bone that crosses anatomical midline. The mandible has thirteen muscle attachments. Organized by function, these are jaw closers (temporalis, masseter, medial pterygoid), openers (digastric, lateral pterygoid), and glottic attachments (genioglossus and geniohyoid). The remaining muscles can influence displacement of fractures and may be involved in soft tissue closure (buccinator, platysma, mentalis, mylohyoid, depressor labii inferiorius, and depressor anguli oris).The major vascular supply to the mandible during development is from the inferior alveolar artery, but transitions to the involved periosteum and muscle attachments as the body ages. During fixation of comminuted or atrophic mandible fractures, areas with poor blood supply, such as the body, careful soft tissue management is mandatory, as the blood supply to these regions is periosteal, rather than endosteal. Periosteal stripping in these areas should be minimized and done only to the extent necessary to apply fixation. Supra-periosteal placement of hardware has been studied in this context, but bears no discernable advantage for healing. The course of the facial artery and vein around the mandible in the antegonial notch should also be appreciated when treatment requires a transcervical approach.[12]

Favorable versus Unfavorable Fractures.Mandibular angle and body fractures can be classified as vertically favorable or unfavorable or horizontally favorable or unfavorable. Favorability is determined by the direction of a fracture line and its relationship to muscle action on the fracture segments. Vertically favorable fractures resist the medial pull of the medial pterygoid muscle on the proximal segment in the vertical plane. Horizontally favorable fractures resist upward the vertical pull of the masseter, temporalis, and medial pterygoid muscles on the proximal segment in the horizontal plane. The more forward a fracture occurs in the body the more the upward displacement is counteracted by the downward pull of the mylohyoid muscles.

Fracture Fixation Principles.The mandible is the only moveable, load bearing bone of the skull. To properly treat mandible fractures, one must first understand basic fracture fixation principles. These can be grouped into tension versus compression and load-bearing versus load-sharing principles While a complex topic, the biomechanics and forces exerted on the mandible should be understood by the treating physician.

Tension versus Compression.At any time, there are counteracting forces of tension and compression on the mandible influenced by muscular attachments and loading. At rest, these forces are equal. While an oversimplification, forces of tension generally separate a fracture and forces of compression bring a fracture together. Under compression, fractures generally undergo rapid healing and a greater resistance to separation. However, without addressing tension forces, overcompression can compromise ideal bony healing leading to nonunion.Studies have shown that in the region of the mandibular body tension exists along the alveolar border while compression exists along the inferior border of the mandible. Moving toward the symphysis and parasymphysis, these two opposing forces become mixed or even inverted due to the introduction of torsional, or rotational, forces.Biomechanically, it is most advantageous to apply bicortical rigid fixation along the zone of tension. Bicortical rigid fixation along the alveolar border is not feasible due to the presence of tooth roots, thin cortical bone, and thin gingival tissue. The inferior border of the mandible is not constrained by these limitations, with the notable exception of pediatric patients in the primary or mixed dentition. Bicortical screw fixation in this region is extremely stable and then only requires placement of a tension band at the alveolar level (either a continuous arch bar at the dentition or a small plate with monocortical screws) to resist tensile forces.[13]

Rigid versus Non-rigid Fixation.Fixation can be grouped into rigid fixation, nonrigid fixation, or semirigid fixation. With rigid fixation, no bony callus if formed during healing and fracture segments are completely immobilized. In nonrigid fixation, micro-mobility of the fracture segments occurs and the fracture cap undergoes callus formation. Rigid fixation techniques include the use of plates and screws (miniplate and tension band with two screws on each side of the fracture), two lag screws, or reconstruction plates with three screws on each side of the fracture. A 2020 paper by Rughubar et al. compared the complication rates in patients with bilateral mandibular fractures randomized to either a combination of rigid fixation for an anterior fracture and nonrigid for the posterior fracture or nonrigid fixation for both fractures and found no significant difference; the risk of complications was significantly higher in patients with moderate to severe fracture displacement, regardless of treatment.[14]

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