Management of Mandibular Fractures

An Essay
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Tamer Essam Hussein

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LIST OF ABBREVIATIONS

ACS	American College of Surgeons
AO / ASIF	Association of Osteosynthesis / Association for the Study of Internal Fixation
ATLS	Advanced Trauma Life Support
CMW	Circummandibular Wires
C-Spine	Cervical Spine
CT	Computed Tomography
H.F.	Horizontally favorable
H.U.	Horizontally Unfavorable
IDW	Interdental Wiring
IMF	Intermaxillary Fixation
MB	Mesiobuccal
MMS	Maxillomandibular Stabilization
PRS	Piriform Rim Suspension
RIF	Rigid Internal Fixation
RTA	Road Traffic Accident
TMJ	Temporomandibular Joint
V.F.	Vertically Favorable
V.U.	Vertically Unfavorable

Introduction

Few injuries are as challenging as those of the face. Surgeons who undertake treatment of facial injuries have a dual responsibility, restoration of function & the pre-injury appearance. A third goal is to minimize the period of disability. The prominence, position, and anatomic configuration of the mandible are such that it is one of the most frequently injured facial bones, like the nose and zygoma.

Although there are few facial emergencies, the literature has underemphasized the advantages of prompt definitive reconstruction of facial injuries and the contribution of early operative intervention to superior functional and aesthetic results. Economic, sociologic, and psychological factors operating in a competitive society make it imperative that an aggressive, expedient, and well-planned surgical program be outlined, executed, and maintained to return the patient to an active and productive life as soon as possible while minimizing aesthetic and functional disabilities.

The mandible is a movable, U-shaped bone consisting of horizontal and vertical segments. The horizontal segments consist of the body on each side and the symphysis area centrally. The vertical segments consist of the ramus, which articulates with the skull through the condyles and temporomandibular joints. The angle is where both the horizontal and vertical segments meet. The mandible articulates with the maxilla through the occlusion of the teeth and is attached to other facial bones by a complex system of muscles and ligaments.

During mastication, a combination of sagittal bending, corpus rotation and transverse bending occurs. The result is a complex pattern of stresses and strains (compressive, tensile, shear, torsional) in the mandible. To be able to resist these forces and bending and torsional moments, not only the material properties of the mandible but also its geometrical design is of importance. In the longitudinal direction, the mandible is stiffer than in transverse directions, and the vertical cross-sectional dimension of the mandible is larger than its transverse dimension. These features enhance the resistance of the mandible to the relatively large vertical shear forces and bending moments that come into play in the sagittal plane**.**

Mandibular fractures occur more commonly in males and are most often caused by interpersonal altercations. More than one-third of fractures occur in the 25 to 34 year old age group, and 55 percent of cases involve illicit drug use. The mandible is the site of injury in approximately 40 percent of pediatric facial trauma cases, which are most commonly a result of motor vehicle accidents.

Fracture location by site includes condylar (36 percent), body (21 percent), angle (20 percent), symphysis (14 percent), alveolar ridge (3 percent), ramus (3 percent), and coronoid fractures (2 percent). Patients with mandible fractures often have other serious injuries that warrant additional attention, including cervical spine injuries or other facial fractures.

The mechanism of injury can provide valuable information in the examination and treatment of patients with mandibular trauma. Interpersonal altercations tend to result in a higher incidence of angle fractures, whereas motor vehicle accidents are associated with parasymphyseal fractures. Pediatric patients with jaw pain after a fall need to be evaluated carefully for condylar fractures, which may be bilateral. Past medical history should be assessed, because seizure disorders, alcohol abuse, temporomandibular joint problems, and nutritional or metabolic derangements can influence treatment and outcomes. It is important to have an idea of the preinjury dental occlusion, because it will be abnormal in many patients. Dental impressions, if present, can be extremely helpful and should be requested from the patient's surgeon.

A complete head and neck examination is indicated in the evaluation of the patient with suspected mandibular trauma. In addition, the temporomandibular joint is examined in the cooperative patient by placing a finger in the external auditory canal. The condylar head will translate anteriorly without significant pain if the joint is not injured. Both subjective and objective malocclusions are very common. Unilateral condylar fractures commonly present with a contralateral open bite and deviation to the ipsilateral side upon opening. Bilateral condylar fractures may present with anterior open bite and premature posterior contact.

Concomitant injuries must be ruled out, especially after motor vehicle accidents or gunshot wounds, and the principles of Advanced Trauma Life Support (ATLS) should be followed. Bilateral body or angle fractures can result in airway distress. In cases of mandible fractures secondary to interpersonal conflict, loss of consciousness occurs in 20 percent, and the possibility of closed head injury should be considered.

Radiographic examination is imperative for confirmation of mandibular fractures. A careful radiologic examination should be performed in all suspected fractures with particular attention to the condyle and subcondylar area. Plain films are less useful at present because of the superiority of CT scans taken in the axial and coronal planes. The panoramic radiograph (Panorex) is still helpful but may be difficult to obtain in patients with multiple trauma. It may also blur fractures in the midline. Specialized examinations, such as occlusal films, palatal films, and apical views of teeth, are helpful in detecting alveolar fractures and in analyzing the degree of tooth injury.

Definitive repair of a mandibular fracture is not a surgical emergency, and treatment is often delayed in the multiply injured patient. A recent study comparing patients undergoing repair within 3 days of injury to those repaired after 3 days found no increase in complication rates. The only mandibular fracture that is considered an emergency though, is a bilateral parasymphyseal fracture, where upon lying supine the patient's tongue falls backwards closing the pharynx hence suffocating him. Mandibular fractures are essentially open fractures that should be considered contaminated, because of the oral flora, and many surgeons utilize prophylactic antibiotics. After concomitant injuries and comorbid conditions are evaluated, treatment planning can begin.

Different treatment modalities and protocols exist for the treatment of mandibular fractures, depending on their location, types, pattern and their effect on occlusion, as well as extremes of age and sex. Indications for open reduction and internal fixation of mandible fractures include most symphyseal and parasymphyseal fractures, displaced body and angle fractures, and certain condylar fractures. Whilst indications for closed reduction of mandibular fractures remain controversial but may include nondisplaced or grossly comminuted fractures, fractures in the presence of mixed dentition or in the atrophic mandible, and fractures of the coronoid or condyle. External fixation and intraoral appliances were once widely used for closed reduction but have now been largely replaced by other methods.

Controversy exists over the management of mandibular fractures in the edentulous patient. The severely atrophic mandible, with a height of less than 20 mm, is especially problematic. Barber advocates a conservative approach, using the patient's dentures or Gunning splints to provide closed reduction and intermaxillary fixation, whereas Ellis advocated rigid internal fixation by using large plates. External fixation may also be considered in comminuted fractures.

There are several differences in the treatment of mandible fractures in children. The treatment of the fractured pediatric mandible represents a therapeutic challenge to the surgeon. The mandible of a child is still growing, and any open reduction of fractures can disrupt growth centers, especially of the condyle. There are also many unerupted teeth, which tend to weaken the bone. The bone of a child is more elastic and fractures tend to greenstick or minimally displace conservative management, possibly with a brief period of intermaxillary fixation is appropriate. When surgical management is indicated, interdental wiring, occlusal splints, drop wires, and monocortical plates and screws with their early removal are all legitimate treatment options. The use of resorbable plates also is an increasingly attractive option but further studies need to be conducted on their safe and appropriate application in pediatric mandibular fractures.

Aim of the Essay

The aim of this essay is to give a detailed review about fracture mandible and the different treatment modalities that exist.

Embryology of the mandible

The mandible, a first pharyngeal arch derivative, originates from neural crest cells that travel ventrally to take their position within the mandibular and maxillary prominences during the fourth week after conception. After formation of the mandibular division of the trigeminal nerve, interactions between the mandibular ectomesenchyme and the mandibular arch epithelium result in the formation of an osteogenic membrane between days 36 and 38 of development[1] (FIGURE 1)

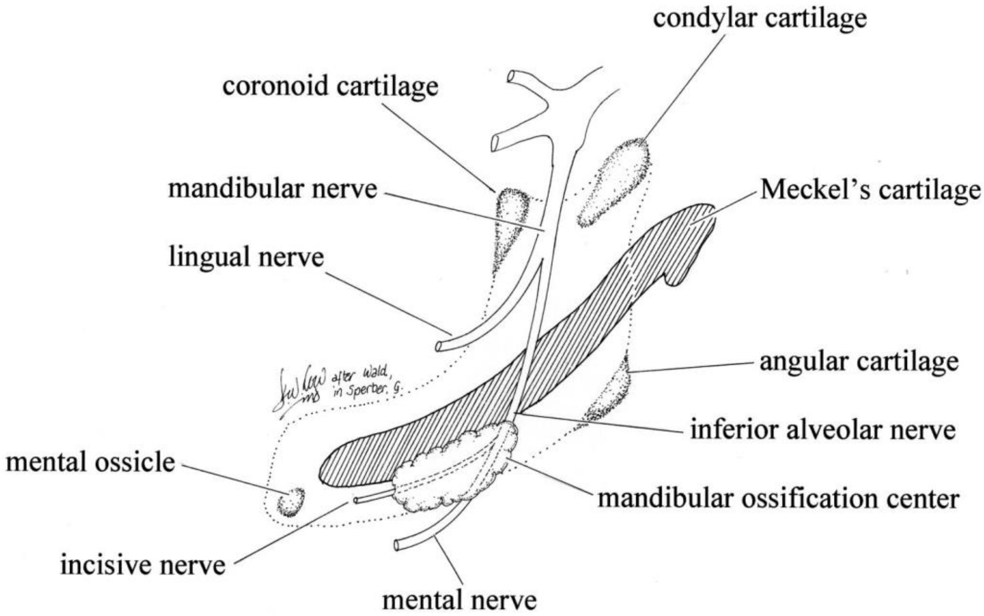

Figure 1. ***Schematic diagram of embryological development of the prenatal mandible****.* *The location of the mandible's primary ossification center is located at the bifurcation of the inferior alveolar nerve into its incisive and mental branches. Meckel's cartilage (striped area), the primitive framework for mandibular growth, will undergo nearly total osseous obliteration by week 24 after conception. Remnants at the dorsal border will transform into the sphenomandibular and anterior malleolar ligaments. The secondary cartilages of the coronoid, condyle, mental ossicles, and angular cartilage will all contribute to musculoskeletal structures later in development.*

Meckel's cartilage, the initial nonossifying template for early mandibular growth, forms between 41 and 45 days after conception[2]. At the sixth week of life, a single ossification center for each half of the mandible forms lateral to Meckel's cartilage at the bifurcation of the inferior alveolar nerve and artery into its mental and incisive branches[3]. From this center, ossification proceeds ventrally to the body and dorsally to contribute to the mandibular ramus. Furthermore, bone deposition begins to proceed superiorly around the neurovascular bundles to provide a bony framework for the developing teeth[1].

The primitive temporomandibular joint begins to organize during the seventh and eighth weeks of development, with condensation of a presumptive condyle and articular discs. At 9 weeks of development, following the initiation of muscle movements by the masticatory apparatus, cavitation of the inferior joint occurs. This process results in the formation of a recognizable joint capsule at the eleventh week[4].

Between the tenth and fourteenth weeks of development, secondary cartilages form that will eventually give rise to the coronoid process, mental protuberance, and condylar head. The secondary cartilage of the coronoid process gives rise to additional intermembranous bone and contributes to formation of the temporalis muscle. Secondary cartilages of the mental protuberance form ossicles in the fibrous tissue of the symphysis that will later aid in the conversion of its syndesmosis to a synostosis through endochondral ossification during the first year of life[5].

The condylar secondary cartilage is the primitive form of the future condyle, providing the cartilaginous material that will provide the stimulus for endochondral ossification of the condylar neck later in development. During this time and subsequently throughout development, the condylar cartilage takes on stratified organization with five principal layers: (1) Articular cartilage, (2) Chondroprogenitor cells, (3) Chondroblasts, (4) Nonmineralized hypertrophic chondrocytes, and (5) Mineralized hypertrophic chondrocytes[6].

It is this particular cellular organization that allows the joint to function as both an articular surface and a site of bone deposition, with the first endochondral bone being deposited during the fourteenth week after conception. With increasing age, the articular portion of the condylar cartilage increases in thickness, while the sizes of the chondroprogenitor cells and chondroblasts remain relatively stable[7].

After formation of the mandible's primary components, the structure itself grows at a rate that is linearly related to gestational age and fetal weight[7]. At 24 weeks gestation, almost all of Meckel's cartilage is replaced by intermembranous bone. Dorsally, at the temporomandibular joint, portions of the fibrous perichondrium associated with Meckel's cartilage transform into the sphenomandibular and sphenomalleolar ligaments[1]. Near the end of prenatal development, the secondary cartilage of the condyle is almost all replaced by bone, except for the upper end, which persists into adulthood, acting as both a growth and articular cartilage. The formation of the deciduous dentition is first noted at 4.5 months after conception, with calcification of the central and lateral incisors taking place at the time. Growth of the condylar cartilage and remodeling of the mandibular woven bone to mature trabecular bone are both processes that to some extent depend upon the production of mechanical strain by the fetal masticatory apparatus[1].