

**TITLE: Mandible Fractures**

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**RESIDENT PHYSICIAN: Jacques Peltier, MD**

**FACULTY PHYSICIAN: Matthew W. Ryan, MD**

**SERIES EDITORS: Francis B. Quinn, Jr., MD and Matthew W. Ryan, MD**

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## **Introduction**

Mandible fractures present a unique problem to the facial surgeon. Writings about mandible fractures first appeared in the Edwin Smith Papyrus in 1650 BC. Hippocrates described bandaging fractures as a means of stabilization. His bandages immobilized the fractured segment and allowed healing. Guglielimo Salicetti in 1492 described the theory of mandibular maxillary fixation in which one would "tie the teeth of the uninjured jaw to the teeth of the injured jaw". In 1888, Schede introduced open reduction and placement of a steel plate with 4 screws as a means of treatment. In 1960, Luhr developed and used the compression plate. In the 1970's Michelet and Champy developed the method of using small, bendable non-compression plates along the support structure of the mandible as a semirigid means of fixation. Today the principles of immobilization first used by Hippocrates are combined with the more recent advances of open reduction and internal fixation to treat a variety of fractures. A comprehensive knowledge of the principles and various treatment options are a necessity for the consulting facial surgeon.

## **Anatomy**

The mandible is a cantilever beam that interfaces the skull base via the temporomandibular joint. This relationship creates a ring-like structure prone to certain fracture patterns. The masseter, medial pterygoid, lateral pterygoid, and the temporalis are the muscles of mastication that act to produce motion and support the mandible. The directional pull of these muscles determine stability of certain fracture patterns. The masseter and temporalis muscles exert upward pull on the angle of the mandible, which will distract horizontally unfavorable fractures from each other in a vertical dimension. The medial and lateral pterygoid muscles exert medial pull on the ramus of the mandible and will distract vertically unfavorable fractures medially. Because of the strength of these muscles, displaced fractures often cannot be reduced without the use of a paralytic.

The blood supply of the mandible is via the inferior alveolar artery that runs in the inferior alveolar canal. Additionally, blood supply from the surrounding periosteum plays an

important roll in healing, especially in the elderly and in injuries that include the canal. The nervous supply of the mandible is via V3. The mental nerve runs with the inferior alveolar artery and injury to the canal produces numbness of the ipsilateral lip and chin.

Fractures of the mandible are described as comminuted or simple, open (compound) or closed, favorable or unfavorable, direct or indirect, pathologic, and by location. The coronoid, condyles, subcondylar region, ramus, angle, body, symphysis, parasymphysis, and alveolus are terms commonly used to describe fracture regions. Multiple terms can be used to describe a single fracture.

The mandible is made unique by the presence of teeth. Dental occlusion can be classified as normal (Class I), overbite (Class II), or underbite (Class III). This is based on the relationship of the mesiobuccal cusp of the maxillary first molar to the buccal groove of the mandibular first molar. The universal numbering system for permanent teeth begins with the right third molar of the maxilla to the left third molar of the maxilla (number 16), and to the left third molar of the mandible (number 17) to the right third molar of the mandible (number 32). The 20 deciduous teeth are lettered in a similar fashion from A to T.

## **Epidemiology**

The mandible is the second most frequently fractured bone of the face after the paired nasal bones. The ratio of mandible to zygomatic to maxillary fractures is reported as 6:2:1. In a paper by Ellis of 4711 patients treated with facial fractures, 45% had a fracture of the mandible. He found assault was the most common mechanism, followed by motor vehicle accidents, falls, and sporting accidents. Men are 3 to 6 times more likely to have a mandible fracture. Common associated injuries include lacerations, other facial fractures, intrathoracic injuries, and C-spine fractures in as many as 15% of cases. Fracture sites are influenced by common mechanisms of injury, prominence of the mandible, and inherent areas of weakness. The angle is the most commonly fractured site, followed by the body, condyle, symphysis, ramus, coronoid, and alveolus.

## **Evaluation**

Initial evaluation is part of the secondary survey when adhering to the ATLS protocol. Stabilization of the airway may require tracheotomy in severe crushing bilateral parasymphyseal injuries in which the tongue is displaced back into the airway. Otherwise, the mandible should be evaluated after the patient is stabilized and more life threatening injuries have been addressed. After stabilization, a complete history is obtained. This includes mechanism of injury, jaw pain, sense of malocclusion, trismus and lip numbness. A history of temporomandibular joint arthropathy is important in determining the morbidity of prolonged mandibulomaxillary fixation. Previous history of psychiatric disorders, seizure disorders, malnutrition and gastrointestinal disorders causing severe nausea and vomiting may also lead the surgeon away from mandibulomaxillary fixation. Previous occlusion (Class I, II, or III) will assist the surgeon in adequate reduction.

A complete head and neck examination is required for evaluation of the facial trauma patient. Palpation for step-off deformities, malocclusion, open bite deformities, floor of mouth

hematomas or ecchymosis, crepitus, and chin and lip numbness are often found upon examination. Interincisor distance of less than 35 mm indicates significant trismus. Type and health of dentition must be evaluated as maxillomandibular fixation relies on stable dentition for immobilization. The fracture can often be visualized in the mouth, and examination of teeth in the fracture line is important. Missing teeth may prompt a PA and lateral neck film to inspect the airway or cervical esophagus for a foreign body.

Fractures of a single condyle will produce deviation of the chin towards the side of the fracture. This is a result of decreased translation on the side of the fracture and a pushing action of the opposite condyle. In addition, subcondylar fractures have decreased functional height on the same side of the fracture and lead to premature contact of the dentition resulting in an open bite on the opposite side. Bilateral subcondylar fractures lead to an anterior open bite deformity by the same mechanism. Physical exam should look for paired fractures as the mandible forms a ring-like structure and is predisposed to multiple fractures.

When a fracture is suspected after the history and physical are obtained, radiographic evaluation is the next step in confirming the diagnosis. The single most useful film in the evaluation of mandible fractures is the panorex view. This allows evaluation of fractures of the angle, ramus, body, symphysis and parasymphysis. In addition, the health status of the teeth can be evaluated. A submental view (Town's) is useful for evaluation of the condyles and subcondylar region. If panorex views are not available, a mandible series can be ordered. If midface fractures are suspected, CT face may be used to evaluate the mandible. Plain films may still be indicated as they are more sensitive for minimally displaced fractures. MRI is not indicated in the evaluation of mandible fractures.

## **Management**

Initial management of mandible fractures starts after the patient has been stabilized. All fractures of tooth bearing areas of the mandible are considered open and should be treated with antibiotics that cover mouth flora, specifically gram positive and anaerobic organisms. Mouth rinses with peridex solution or half strength hydrogen peroxide in water are useful to keep the mouth clean. Timing of repair is controversial. Several studies have shown a decreased incidence of infection if compound fractures are repaired within 48 hours. Other studies have shown no change if fractures are repaired in less than a week. Regardless of infection rates, patient comfort dictates that the earliest OR date is the best as displaced fractures are painful.

Treatment options of mandible fractures can be divided into rigid fixation, semirigid fixation, and non-rigid or closed reduction. Methods considered rigid fixation are the lag screw technique, compression plating, reconstruction plates, and external pin fixation. Miniplate fixation and wire fixation are types of semirigid fixation. Maxillomandibular fixation (MMF), gunning splints, and lingual splints are considered non-rigid fixation. Rigid fixation allows for primary bone healing without callous formation. Non-rigid fixation allows for secondary bone formation with inflammatory infiltration and callous formation. Semi-rigid fixation allows for areas of primary and secondary bone formation.

## **Closed Reduction**

Closed reduction is best used in the treatment of favorable, non-displaced fractures. It is also used in situations in which ORIF is contraindicated. Several other treatment scenarios may be best treated with closed reduction. These include grossly comminuted fractures, fractures of the severely atrophic edentulous mandible, fractures with a lack of soft tissue overlying the fracture site, subcondylar fractures, and fractures of children with developing dentition. In severely comminuted fractures where adequate stabilization is unlikely with miniplates, preservation of the periosteal blood supply via closed reduction may decrease infection rates and the incidence of non-union. In adults 60-80 years old, the inferior alveolar artery is abnormal in 60% and absent in 40%. As the periosteum is the major blood supply in these fractures, periosteal stripping may cause increased infection rates when internal fixation is used. Gunning splints with circum-mandibular wiring may be used to obtain closed reduction.

Standard length of maxillomandibular fixation is 4-6 weeks. De Amartuga studied 256 mandible fractures treated with MMF and found children less than 15 needed 2 weeks for bone healing, and healthy adults needed 3-4 weeks. In the elderly, 5-10 weeks may be necessary. In another study, 82% of patients had bone healing by 4 weeks. MMF is considered ineffective for severely displaced fractures. In addition, higher rates of non-union can be expected in the edentulous mandibles treated by this method (up to 20%).

MMF involves placement of arch bars onto the gingiva of the maxilla and mandible. These bars are fixed into place with 24 gauge wire to the interdental spaces of the premolar and molars. Care is taken not to put wires around the incisors as these can be avulsed or moved by placement of wires. Once the arch bars are secure, and the fracture reduced with the patient in normal occlusion, fish loops are placed to wire the mandible to the maxilla. Ivy loops made out of 26 gauge wire are used in selectively bringing occlusal pairs of teeth together. They have an application in children with mixed dentition, in partially edentulous patients who will have additional forms of fixation, and in patients who need temporary occlusion while other methods are being applied such as plates or external fixation. To make ivy loops, 26 gauge wire is cut to a 16 cm length and a small loop is formed in the center of the wire around a hemostat. The ends are inserted between two suitable teeth and the medial end is passed through the loop and then tightened. 28 gauge wire goes through the eyelets for fixation.

## **Open Reduction**

Open reduction involves direct exposure of the fracture site and placement of internal fixation to prevent movement of the fracture site. Open reduction is used in displaced and unstable fractures, with associated midface fractures, and when MMF is contraindicated. In addition, some surgeons advocate ORIF for patient comfort and for expedited return to activity and work. Seizure disorders, psychiatric disorders, gastrointestinal disorders, severe malnutrition, and history of temporomandibular joint arthropathy may lead the surgeon to choose ORIF as it requires shorter periods of MMF. Means of ORIF is left to the surgeon's experience and choice. Arch bars are always placed first to establish occlusion, then ORIF is performed. The plates can be placed intraorally, extraorally via a cervical incision, or percutaneously. Dynamic compression plates (DCP) can be used for most body, angle, symphyseal or parasymphiseal fractures.

A lag screw can also be used to compress bone fragments on either side of the fracture line. This technique is useful for the oblique horizontally directed angle fracture or for parasymphyseal fractures. Only surgeons experienced in technique should use it as there is the potential for malunion if screws are not placed exactly.

Those fractures that have a straight course from the buccal to the lingual cortex may benefit more from the use of a DCP. Fractures that are oblique or saggital are better suited for lag screws. Use of compression hardware in cases of infection or comminution is not recommended. For these cases, large reconstruction plates (e.g. 2.4mm) are the treatment of choice. External fixation is usually necessary in comminuted fractures such as gun shot wound injuries. A tooth that is intact but in the line of the fracture can be left in place and protected by antibiotics but may need attention from a dentist at a later date.

## **Edentulous Mandible Fractures**

Edentulous mandibles present a particular challenge to the facial surgeon. The thin bone and poor blood supply make treatment of these fractures particularly difficult. Non-union is the most feared complication when treating these fractures. In edentulous patients, occlusion is not a consideration, and fracture union is the major objective. Also contributing to difficulty in treating these fractures is the lack of thick bone to place screws in and the lack of teeth for MMF.

Several authors in the 1970's and 1980's advocated closed reduction in atrophic mandibles to preserve periosteal blood supply. In the article "Fractures of the Edentulous Mandible, the Chalmers and Lyons Study" (1976), authors recommend closed reduction as the treatment of choice in these fractures. However, the second study by this group in 1995 involved 167 fractures in edentulous patients of which 81% were treated by ORIF. In this study, there was a 15% complication rate, 12% of which were fibrous union. The authors eventually concluded that ORIF is an acceptable treatment alternative in this group of patients. It is important when plating these fractures to remember that the inferior alveolar neurovascular bundle travels near the top of the remaining mandible.

## **Teeth in the Line of Fracture**

Teeth that fall in the line of the fracture must be examined carefully at the initial contact and at the time of surgery. Neal and associates show that 32% of mandible fractures that have teeth in the line of the fracture have associated morbidity and complications. They found no statistical difference with removal or retention of the teeth. Most authors advocate retention of teeth in the line of fractures if they were previously healthy, have a preserved periodontal plexus, there is no major structural damage, and the tooth does not interfere with adequate reduction of the fracture. If the tooth is helpful in reduction, but will likely be lost, it can be retained during repair and removed 4-6 weeks later when the fracture has healed.

## **Conclusion**

The treatment of mandible fractures has evolved over thousands of years and will likely continue to change. Modern techniques paired with age old principles dictate treatment regimens

of today. Optimal treatment of this condition requires a complete knowledge of treatment options and applying these options for the overall good of the patient.

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