

Fractures of the Mandible

A

fracture is defined as a break in the continuity of the bone which happens either as a result of violence or because the bone is unhealthy and unable to withstand normal stresses.

Fractures of the mandible are common due to the prominence of the mandible. The impact forces that are required to produce mandibular fracture are higher than those of the maxilla.

The teeth are important in determining where fractures occur. The long canine tooth and the partially erupted or unerupted wisdom tooth both represent lines of relative weakness.

Classification of mandibular fractures

According to the type of fracture, mandibular fractures can be classified into:

Simple/closed: A type of single fracture that does not have communication with the external environment.

Compound/opened: A type of fracture that extends into external environment through skin, mucosa, or periodontal membrane.

Comminuted: When the bone is fragmented into multiple pieces. This usually requires considerably more energy than does a simple fracture.

Greenstick: When only one cortex of the bone is broken with the other cortex being bent, it is found exclusively in children.

Pathologic: Caused by pre-existing pathological condition of bone (such as osteomyelitis, neoplasms or generalized skeletal disease) that leads to fracture from minimal trauma.

Complicated/complex: Fractures associated with the damage to the important vital structures complicating the treatment, as well as prognosis, including the severely atrophied mandible.

Single: Only one fracture line in the same bone.

Multiple: Two or more lines of fractures on the same bone that do not communicate.

Fractures of the mandible can also be classified according to the anatomic site into:

✓ **Dentoalveolar**

✓ **Condylar**

✓ **Coronoid**

- ✓ **Ramus**
- ✓ **Angle**
- ✓ **Body (molar/premolar area)**
- ✓ **Symphysis/Parasymphysis**

Mandibular fractures classified according to their tendency to displace as a result of the pull of the attached muscles into:

- ✓ **Favorable** when the muscles tend to pull the fragments together (minimizing displacement).
- ✓ **Unfavorable** when they are significantly displaced by the muscles.

These are further considered as **vertically** or **horizontally** favorable or unfavorable, depending on the direction of displacement. Although this principle can be applied to any fracture of the mandible where there are muscles attached, it is most commonly used with angle fractures.

Direct and indirect fractures

When the force is applied to the mandible, the point of application of the force is compressed causing **direct fracture** and the resultant vector travels along the bone and applies tensile force on the point intersected by this vector causing **indirect fracture**. Whenever a direct fracture is seen at the site of primary impact, one must examine the corresponding indirect fracture site and rule out the indirect fracture. Common combinations of direct and indirect fractures are:

- ✓ Symphyseal (direct) fracture combined with bilateral subcondylar (indirect) fractures also called parade ground fracture or guardsman's fracture.
- ✓ Parasymphyseal (direct) fracture combined with contralateral subcondylar or angle (indirect) fracture.
- ✓ Body (direct) fracture combined with contralateral angle or subcondylar (indirect) fracture.

Clinical features

The main clinical features of mandibular fractures include:

- ☐ Pain especially on talking and swallowing leading to drooling of saliva.
- ☐ Swelling due to edema and hematoma causing facial asymmetry.

- ❑ The teeth near the fracture site may become loosened, displaced or avulsed with laceration of the gingiva.
- ❑ Bleeding from the fracture site.
- ❑ Trismus and difficulty in moving the jaw.
- ❑ Bone tenderness over fracture site.
- ❑ Mobility of fractured segment.
- ❑ Step deformity palpable at the site due to the displacement of the fracture segments.
- ❑ Numbness of the lower lip due to injury to the inferior alveolar nerve.
- ❑ Malocclusion.
- ❑ Sublingual hematoma which is regarded as a pathognomonic sign of fracture.
- ❑ In some cases of bilateral subcondylar fractures with condylar displacement and shortening of the ramus leads to premature contact of the posterior teeth and anterior open bite.
- ❑ Bilateral parasymphyseal fracture may be readily displaced posteriorly under the influence of the genioglossus and geniohyoid muscles allowing the tongue to fall back and obstruct the oropharynx which constitutes a threat to the airway especially in patients with depressed level of consciousness.
- ❑ In some cases of condylar fractures bleeding from the ear may result from laceration of the anterior wall of the external auditory meatus. It is important to distinguish bleeding originating in the external auditory canal from the more serious middle ear hemorrhage which signifies a fracture of the petrous temporal bone and may be accompanied by **cerebrospinal otorrhea**.

Imaging

The clinical diagnosis of the fracture is essential but radiographs confirm the diagnosis of the fracture and are mandatory. The principle is to obtain at least two views, each taken at right angles to the other, in order to assess the degree of displacement and angulation of the fragments.

- ✓ A panoramic radiograph (OPG) represents the best single overall view of the mandible including the condyles. The combination of a posteroanterior (PA) view of the mandible and OPG usually provide a complete view of the mandible.

- ✓ If OPG is not available, PA mandible with left and right oblique lateral views can be taken.
- ✓ The **Townes projection** (anteroposterior) and the **reverse Townes projection**; in both projections the central ray is angled at 30° to the horizontal base line, which shows the image of the condylar head and subcondylar region clear of the dense bony structures of the base of the skull.
- ✓ Occlusal views are valuable for demonstrating midline fractures of the mandible with minimal displacement.
- ✓ CT scan is not normally undertaken for isolated mandibular fractures unless there are complicating factors such as significant comminution, it is also useful in the assessment of displaced and comminuted fractures of the condylar region where it will demonstrate considerable detail that would otherwise not be clear on standard radiographs.

Treatment

The aim of treatment is primarily to restore function, namely to restore both the occlusion and pain-free normal movements of both TMJs.

Factors affecting treatment of mandibular fractures

1. The fracture pattern.
2. The skill of the operator.
3. The resources available.
4. The general medical condition of the patient.
5. The presence of other injuries.
6. The degree of local contamination and infection.
7. Associated soft-tissue injury or loss.

The principles of treatment of fractures are:

- ✓ Reduction; it is the restoration of functional alignment of the fractured bone fragments.
- ✓ Fixation.
- ✓ Immobilization.
- ✓ Rehabilitation.

Treatment of mandibular fractures can be **closed** or **open**

Closed treatment

It consists of closed reduction with indirect fixation and immobilization with intermaxillary fixation (IMF) [also called mandibulomaxillary fixation (MMF)]. It is the traditional conservative treatment of mandibular fractures. Closed reduction is achieved without surgical exposure of the fracture site by manipulation or elastic traction and indirect fixation utilizes the standing teeth to place the teeth in normal occlusion and immobilize them in that position thus indirectly reduce the bone fragments. This method can be used as a definitive treatment of mandibular fractures or as temporary fragment stabilization in emergency cases before definitive open treatment.

The main indications of closed treatment are:

- ✓ Non-displaced favorable fractures.
- ✓ Limited resources and facilities for open treatment.
- ✓ Medically compromised patients where conservative line of treatment is required.
- ✓ Grossly infected fractures.
- ✓ Pediatric fractures with mixed dentition phase.
- ✓ Edentulous fractures.

Advantages of closed treatment

- ✓ Non-invasive, simple, easy to master.
- ✓ Can be performed under local anesthesia.
- ✓ Less expensive.

Disadvantages of closed treatment

- ✓ The closed treatment does not ensure anatomical reduction of the fracture.
- ✓ In certain cases, closed treatment may be difficult especially in cases of malocclusion, missing, diseased, or damaged teeth.
- ✓ The immobilization may not be adequate which delays the healing.
- ✓ The treatment induces morbidity to the patient due to the IMF affecting feeding and speech.
- ✓ Closed treatment is contraindicated in some conditions, e.g., epilepsy, chronic respiratory diseases, in compliant patient, or chronic alcohol or drug abuse.

Methods of immobilization

After proper reduction and achievement of good occlusal relationship, the upper and the lower jaws are immobilized by fixing them together in occlusal relationship by IMF, this can be achieved by:

❖ Bonded orthodontic brackets

By bonding a number of modified orthodontic brackets onto the teeth and applying light wires or intermaxillary elastic bands.

❖ Interdental wiring

This method is only applicable when the patient has a complete, or almost complete, number of suitably shaped teeth, 0.5 mm soft stainless wire is usually used. Many different techniques for wire fixation exist such as direct interdental wiring and eyelet or Ivy loops. After applying the fixation wires, tie wires are applied to immobilize the mandible.

❖ Arch bars

They are tooth-borne devices used in IMF of dentate patients. They are the most versatile form of IMF. Arch bars are indicated where the patient has an insufficient number of suitably shaped teeth or when a direct linkage across the fracture is required. They can be custom made or commercially manufactured available in aluminum, stainless steel, and nowadays also titanium, as well as various alloys. Many patterns or designs of arch bars are present such as Erich and Jelenko patterns. Recently hybrid arch bar systems that use bone support have been developed.

❖ IMF screws

These screws are self-drilling and self-tapping. The screw head is elongated and contains holes for wire placement. They are inserted through small incisions in the labial vestibule avoiding injury to the apices of the nearby teeth, it is regarded as a rapid method to achieve IMF.

❖ Cap splints

They are fabricated by making an impression of the fractured jaw and preparation of the cast on which a cap splint made of acrylic or metal can be fabricated and used for fixation of the fracture.

❖ **Dentures or Gunning-type splints**

In edentulous jaw fractures, complete denture can be used as a splint and if the patient is not denture wearer Gunning-type splints can be fabricated. They are fixed to the jaws by circum-mandibular and maxillary peralveolar wires or screws, and IMF is achieved by connecting the two splints with wire loops or elastic bands.

❖ **External pin fixation**

This method is seldom used nowadays, it is indicated in special conditions, such as infected fractures, fractures caused by gunshot injuries or pathological fractures. Ideally, at least two self-tapping screw pins are placed either side of the fracture or defect. The fracture is then reduced and the pins linked by an external bar framework.

Period of immobilization

With early uncomplicated treatment in a healthy young adult union can on average be achieved after 3 weeks, at which time the fixation can be released. As an empirical guide a further 1–2 weeks should be added for each and any of the following circumstances:

1. Where a tooth is retained in the fracture line.
2. Patients aged 40 years and over.
3. Patients who are smokers.
4. Mobile or comminuted fractures.

Rules such as these are designed for guidance only, and it must be emphasized that the IMF should be released and the fracture tested clinically before the fixation is finally removed.

Open treatment

It consists of open reduction and internal fixation (ORIF) or direct skeletal fixation. In open reduction the fracture site is surgically exposed and the fracture is reduced under direct vision and the fractured fragments are immobilized by different internal direct fixation methods.

ORIF is now considered the main method of treatment of mandibular fractures. The main indications for open treatment:

1. Displaced unfavorable fractures.
2. Multiple fractures of the facial bones
3. Fractures of an edentulous mandible with severe displacement.
4. Delay of treatment and interposition of soft tissue between non-contacting displaced fracture fragments.
5. Special systemic conditions contraindicating IMF.

Depending on the planned method of internal fixation and the site of the fracture, three different surgical approaches to the mandibular body, with slight modifications, are possible: intraoral, extraoral, or combined access.

Methods of internal fixation (osteosynthesis)

❖ Interosseous or Transosseous wiring

It is the direct skeletal fixation of two or more bone fragments with the aid of wire ligatures pulled through previously drilled holes, it is considered a non-rigid fixation method.

❖ Miniplates (miniaturized plates)

These are the most common form of internal fixation used in the management of mandibular fractures. They provide semi-rigid or load sharing fixation. The miniplate principle involves placing the miniplates in anatomically correct position, the plate can be anchored using only the outer cortical bone with so-called “**monocortical**” screws which are 2 mm in diameter.

❖ Three-dimensional titanium miniplates

They are based on the principle of the quadrangle as a geometrically stable configuration for support. The plates are adapted to the bone and are secured with monocortical self-cutting screws.

❖ Non compression rigid plates (Reconstruction plates)

These plates provide rigid or load bearing fixation, they are mainly used in the management of infected, severely comminuted fractures, in fractures where there are continuity defects, and in fractures in which

delayed union or non-union has occurred. They require bicortical screws and are fixed in place at or near the lower border of the mandible in order to avoid damage to the inferior alveolar nerve and the dental roots.

❖ **Compression plates**

These plates provide rigid fixation, the principle of compression plating is by transforming the downward force of screw insertion into a compressive force. This type of plates does not offer much advantage to the patient in the treatment.

❖ **Lag screws**

In oblique fractures, compression lag screws can be applied without plates, they are placed perpendicularly across the fracture line in order to avoid displacing the fragments. This technique appears to be ideal for parasymphyseal and symphyseal fractures, but it becomes technically more difficult in body or angle fractures because the risk of damage to the inferior alveolar nerve increases.

❖ **Bioabsorbable plates and screws**

These are made from materials that undergo degradation, so they do not have to be removed after fracture healing. They are mainly indicated in pediatric fractures.

Teeth in the line of fracture

Teeth in the fracture line may cause infection of the fracture site either from the oral cavity via the disrupted periodontium or directly from an infected pulp or chronic apical infection. Infection of the fracture site will result in protracted healing or even non-union.

Absolute indications for removal of a tooth from the fracture line:

1. Longitudinal fracture involving the root.
2. Dislocation or subluxation of the tooth from its socket.
3. Presence of periapical infection.
4. Advanced periodontal disease.
5. Already infected fracture line.
6. Acute pericoronitis.

7. Where a displaced tooth prevents reduction of the fracture.

Relative indications for removal of a tooth from the fracture line:

1. Functionless tooth that would probably eventually be removed.
2. Advanced caries.
3. Doubtful teeth that could be added to existing dentures.

Otherwise teeth that are structurally undamaged and potentially functional should be retained and antibiotics administered. Teeth in line of fracture should be followed up for 1 year and should be endodontically treated if there is demonstrable loss of vitality. If fracture becomes infected, immediate extraction should be performed.

Complications of mandibular fractures

Intraoperative and early postoperative complications

☐ **Misplaced fixation**

Damage caused by misplaced fixation devices like transosseous wires or plates, the risk of damage to structures within the body of the mandible like the inferior alveolar canal and root apices is less when using monocortical screws.

☐ **Infection of the fracture site**

The main contributing factors are:

- ✓ Compound fractures with gross contamination.
- ✓ Inadequate stabilization of the fracture.
- ✓ Loose fixation devices.
- ✓ Immunocompromised patients, e.g., diabetics and alcoholism.

Most infections are usually mild, with intraoral swelling and discomfort. However these can progress to cellulitis, abscess formation, fistula, osteomyelitis, and, rarely, necrotizing fasciitis.

The infection should be prevented by good antibiotic prophylaxis, maintenance of wound hygiene, adequate immobilization, effective management of the teeth involved in the fracture line and ensuring that the fixation devices are not loose. The infection will invariably interfere with the healing of the fracture.

The principles of management are

- ✓ Control the infection (incision and drainage, and antibiotics)
- ✓ Remove any focus of infection (teeth, sequestra, or plates and screws)
- ✓ Optimize the healing environment (patient's health, oral health)
- ✓ Immobilize the fracture.

□ **Nerve damage**

Anesthesia or paresthesia of the lower lip as a result of injury to the inferior dental nerve is the most common complication of fracture of the body of the mandible. Damage to the inferior alveolar nerve can also result from treatment which is most commonly associated with open treatment.

Facial nerve damage may complicate some fractures of the ramus and condyle, either as a result of a penetrating injury severing branches of the nerve, or blunt trauma.

Late complications

□ **Malunion**

The healing of the fracture is an abnormal or non-anatomical position. It can occur as a result of inadequate reduction, inadequate immobilization or if no treatment is done. It may result in occlusal discrepancies and poor esthetics.

If malalignment is noticed early in the postoperative phase it may be corrected by returning the patient to the operating room for repeated reduction.

Minor malunions do not usually cause major clinical problems, because the dentition often readjusts to a new bite. Alternatively, judicious selective grinding can balance the new occlusion satisfactorily.

However, significant malunions of the mandible can produce gross occlusal derangement and facial deformity which can be resolved by operative reconstruction usually in the form of refracture or planned osteotomy or ostectomy with rigid fixation, bone graft may be required in some cases.

□ **Delayed union**

It occurs when the union of the fractured segments is delayed beyond the expected time for that particular fracture. It results from disturbance of the healing process by local factors such as infection, or general factors such as osteoporosis or nutritional deficiency. The delay in union is managed by prolonging the period of immobilization.

□ **Non-union**

It is failure of the fracture to unite on its own. Non-union can be caused by local or general factors:

1. Infection of the fracture site.
2. Inadequate immobilization and excessive mobility of fractured fragments.
3. Unsatisfactory apposition of bone ends with interposition of soft tissue.
4. The ultra-thin edentulous mandible in an elderly debilitated patient.
5. Loss of bone and soft tissue as a result of severe trauma, e.g. missile injury.
6. Inadequate blood supply to fracture site, e.g. after radiotherapy.
7. The presence of bone pathology, e.g. a malignant neoplasm.
8. General disease, e.g. osteoporosis, severe nutritional deficiency, disorders of calcium metabolism.

In nonunion, the fragments are united by fibrous tissue rather than the bone and pseudarthrosis (false joint) results. The bone ends become rounded off and sclerosed (eburnation).

Treatment is surgical exploration of the fracture site and any obvious impediment to healing such as a sequestrum or devitalized tooth removed. The bone ends are then freshened and the jaw is immobilized using rigid fixation. Bone graft may be needed.

□ **Complications associated with internal fixation**

These may include exposure of the plates especially when placed near the oral mucosa. Plates may also become infected. transosseous wires may cause pain or discomfort.

□ **Sequestration of bone**

Comminuted fractures of the mandible may be complicated by the formation of bone sequestra. A sequestrum may be a cause of delayed union or act as a potential source of infection. In some cases a sequestrum may extrude spontaneously into the mouth with quite minimal symptoms, but otherwise a localized abscess forms and surgical removal of the dead bone becomes necessary.

Mandibular fractures that require special considerations

Pediatric fractures

Fractures of the mandible are uncommon in children and some modifications to the principles of treatment are necessary when the fracture occurs in a child. The main characteristics of mandibular fractures in children are:

- ✓ Bone in young children is resilient and greenstick fracture is more likely to occur and there is a greater risk of damage to developing teeth.
- ✓ Mandibular fractures in young children heal very rapidly and some fractures are stable within a week, and firmly united within 3 weeks.
- ✓ Treatment is generally of a conservative nature.
- ✓ Mandibular fractures may disturb the growth of the mandible if unerupted permanent teeth or teeth germs are lost.
- ✓ Fractures of the condyle require special consideration.
- ✓ When fixation is needed in very young with unerupted or very few deciduous teeth a splint for the lower jaw alone may be used. This is constructed as a simple acrylic and retained by two light circummandibular wires.
- ✓ When sufficient firm erupted deciduous and permanent teeth are present, eyelet wires or arch bars can be used.
- ✓ When there is significant displacement of fragments, ORIF may be necessary. In this situation any plate or wire fixation must be strictly confined to the lower border to avoid damage to developing teeth.
- ✓ Slight imperfection in reduction can be accepted when a fracture is treated, because continuing growth and eruption of teeth will compensate in most cases for the imperfect alignment the fragments.

- ✓ Prolonged follow-up is required in order to be sure that there are no long-term effects on both mandibular growth and the normal development of the permanent dentition.

Fractures of the condyle

Fractures involving the mandibular condyle are the only facial bone fractures that involve a synovial joint. Many classification systems have been proposed for fractures of the condylar region, generally they can be classified into fractures of the head of the condyle (intracapsular) or the neck of the condyle.

Treatment of condylar fractures

All intracapsular fractures and all fractures in growing children should be treated conservatively. Immediate or early mobilization should be encouraged. However, if the occlusion is disturbed IMF is applied and maintained until stable union can be expected to be present, the period of immobilization should not exceed 10-21 days.

ORIF of condylar fractures

Absolute indications:

- ✓ Displacement of condyle into middle cranial fossa
- ✓ Impossibility of restoring occlusion with closed treatment.
- ✓ Lateral extra-capsular displacement.
- ✓ Invasion by foreign body (e.g. missile)

Relative indications:

- ✓ Bilateral fracture with associated mid-face fracture (particularly where one condylar fracture is dislocated or angulated)
- ✓ Bilateral fracture with severe open bite deformity
- ✓ Unilateral fracture with dislocation, overlap or significant angulation of the condylar head
- ✓ When IMF is contraindicated for medical reasons.

Surgical approaches for ORIF

- ✓ The main approaches to the TMJ are the pre-auricular, submandibular, retromandibular or transparotid approaches.

- ✓ The intraoral approach has the advantage of avoiding facial scarring and risk of injury to the facial nerve but the major disadvantage is limited access.
- ✓ Minimally invasive endoscopic repair of condylar fractures offers less morbidity and operating time, as well as quick patient recovery.

Fixation methods in ORIF

Among the fixation methods that have been used are; transosseous wire, Kirschner wire (K-wire), miniplates, lag screws, bioresorbable Plates and Pins and more recently ultrasound activated resorbable plates and pins.

Complications

- ☐ Malocclusion.
- ☐ Limitation of range of movement.
- ☐ Displacement of the disc (reducible or irreducible).
- ☐ Chronic pain associated with dysfunctional movement or with osteoarthritis.
- ☐ Ankylosis of the TMJ; fractures that involve the joint space, particularly in young patients, seem most prone to result in this complication. Ankylosis can be fibrous or bony. Predisposing factors include:
 1. Age: the major incidence is below the age of 10 years.
 2. Type of injury: intracapsular trauma with crushing of the condyle.
 3. Damage to the disc: disruption of the disc is likely to occur in two particular types of fracture: a severe intracapsular compression injury or a fracture dislocation.
- ☐ Disturbance of growth in children; when the fracture involves the condylar cartilage and the articular surface, subsequent disturbance of growth may occur. The effect of damage is failure of development of the condylar process and a smaller mandible on the affected side.

Fractures of the edentulous mandible

The physical characteristics of the mandible are altered considerably following the loss of the teeth:

- ✓ The alveolar process undergoes resorption and the mandible becomes atrophic and thin.

- ✓ The resistance of the bone to trauma is further reduced by changes in the structure of the bone associated with the process of ageing.
- ✓ The blood supply of the edentulous mandible is more periosteal due to the diminished endosteal blood supply of the mandible.
- ✓ The healing potential of the bone is reduced and the healing of the fracture is a slow process and the complications such as nonunion are more likely to occur.
- ✓ Smaller cross-sectional area of bone at the fracture site and the absence of the stabilizing influence of teeth.
- ✓ Fractures are much less frequently compound into the mouth than when teeth are present. As a result if treatment is by closed reduction the risk of subsequent infection is much reduced.

Treatment

- ❖ Undisplaced fractures require no active treatment.
- ❖ The edentulous mandibular fractures can be treated by closed reduction using the Gunning type splints or if the patient is a denture wearer, the dentures can be modified to allow IMF, which can be used as a splint.
- ❖ When ORIF is required, reduction should be made with minimum exposure of the fracture site to minimize interference with the periosteal blood supply.
- ❖ Autogenous bone grafting may be needed in very thin mandible.
- ❖ It must be remembered that accurate anatomical reduction is not required as any inaccuracy is easily compensated by adjustment of dentures and that in very thin mandible stable fibrous union may be an acceptable result in the very old or infirm patient.

Comminuted mandibular fractures

Comminuted mandibular fractures result from high energy injuries such as missile injuries, these injuries are associated with soft tissue damage and many of these fractures are open (compound) and contaminated. The bone fragments are often difficult to manipulate and secure, while maintaining their soft tissue attachments and are therefore at risk of becoming loose or devitalized later on.

The traditional method of treatment of these fractures used closed techniques, thereby avoiding periosteal stripping and further devitalizing

the bone. Recently ORIF has been advocated to provide a load bearing fixation and stability across the fracture. In severe injuries after airway and hemorrhage control, temporary IMF or external fixation can be used until definitive ORIF.