Fractures of the Mandible

A Fracture is defined as a breakage or discontinuity of bone structure (integrity).

Surgical Anatomy:
*The mandible is basically a tubular long bone which is bent into a blunt "V-Shape". The cortical bone is thicker anteriorly and at the lower border of the mandible, while posteriorly the lower border is relatively thin. Thus the mandible is "strongest anteriorly " in the midline with progressively less strength towards the condyle.
It is rare for the # line to pass through the anatomical symphysis which is the thickest and strongest area of the mandible. In clinical practice it will be found that the # passes through the parasymphysial region, to one side of the genial tubercles.
*The mandible differs from all other bones in 2 important aspects:
  1. Any movement inevitably causes both condyles to move with respect to the base of the skull.
  2. Although anatomically the condyles are the articular surfaces of the mandible, functionally the occlusal surface of the mandibular teeth observes this role.
*Bones fractures at sites of tensile strain, since their resistance to compressive forces is greater. The mandible is a strong bone, the energy required to fracture it being 44.6 - 74.4 Kg/m, which is about the same as the Zygoma and about half that of the frontal bone.
*The mandible is more commonly fractured than other bones of the face a fact directly related to:
  1. Its prominent and exposed situation.
  2. Blows to the mandible are transmitted to the base of the skull through the temporomandibular articulation (unlike the "match box-like" of midfacial skeleton which readily absorbs direct trauma)
  3. Lines of relative weakness as in cases of long canine tooth, part-erupted wisdom tooth and unerupted teeth. The alveolar resorption which follows teeth loss weakens the mandible and # of the edentulous body will result from such smaller impact forces.
*The presence of the teeth in the mandible and maxilla is the most important factor which makes #s of these bones entirely different from #s elsewhere:
1. The occlusion of teeth is a delicately balanced mechanism and any disturbance resulting from malunion of # leads to reduction in the masticatory efficiency and comfort, and so restoration of the occlusion is the prime aim in the treatment of #s of the mandible.
2. The presence of the teeth is extremely helpful in the reduction and fixation of #s.
3. Complete #s of the body of the dentatic mandible are open (compound) into the oral cavity and exposed to possible infection.

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**Classification:**

A. According to the nature of injury:
1. Civilian–type fracture: fractures with no gross comminution and no extensive loss of hard and soft tissue, which is mostly due to fights or road traffic accidents.
2. Gunshot–type fracture: fractures with gross comminution and there is extensive destruction of both hard and soft tissue, which is mostly due to missile injury.

The main difference between fractures due to missile injuries and those resulting from blunt trauma can be enumerated as follows:
1) Fractures are usually extensively comminuted.
2) Fractures are always compound and the wounds contaminated by foreign matter and bacteria.
3) The Viability of the bone fragments and the extent of injury to teeth cannot be accurately evaluated preoperatively from clinical and radiographic examination.
4) Wound treatment and the management of any underlying fracture is complicated by actual or potential composite tissue loss.

B. According to the type of #:
1. Simple fracture: is a linear breakage of bone with little damage to surrounding tissues, and no damage in the overlying skin or mucosa. It is a closed fracture with no communication to the exterior or interior. The greenstick fracture is a variant of the simple fracture which is found almost exclusively in children.
2. Compound fracture: in this type, the overlying skin or mucous membrane is perforated and there is wound extending to the fracture site or the fracture end exposed on the mouth or externally on the face; as in dentoalveolar fracture. This is an open fracture with subsequent potential for infection.
3. **Comminuted fracture**: the bone is fragmented into multiple pieces (shattering or splintering). It is generally due to a greater degree of violence such as gunshot.

4. **Pathological fracture**: occurs following minimal trauma to the bone which is already weakened by the presence of generalized skeletal disease (osteoporosis, hyperparathyroidism, osteogenesis imperfecta, osteitis deformans, and fibrous dysplasia) or localized skeletal disease (osteomyelitis, cyst, benign or malignant neoplasm). *Hopkins, (1985)* added other types which are

5. **Complicated #**: occur when injury to the bone also involves, directly or indirectly nerves, major blood vessels or joints.

6. **Impacted #**: some linear #s interdigitate to such extent that there is no appreciably clinical movement. It is unusual in the mandible and is common in the maxilla.

7. **Greenstick #**: in children, the elasticity of bone allows it to bend like a sapling, this is seen usually in # of the condylar neck.

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**C. According to the site of #:**

It is the most useful one for practical purposes which is based on the anatomical location of the injury.

1. Dentoalveolar  
2. Condyle  
3. Coronoid  
4. Ramus  
5. Angle  
6. Body  
7. Symphysis (Midline)  
8. Parasymphysis (Canine region)

<table>
<thead>
<tr>
<th>Site</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Condyle</td>
<td>30%</td>
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<tr>
<td>Angle</td>
<td>5%</td>
</tr>
<tr>
<td>Body</td>
<td>25%</td>
</tr>
<tr>
<td>Symphysis/Parasymphysis</td>
<td>15%</td>
</tr>
<tr>
<td>Ramus</td>
<td>3%</td>
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<tr>
<td>Coronoid</td>
<td>2%</td>
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**D. According to the cause of #:**

The direction and type of impact is the factor that determines the pattern of mandibular injury. Mandibular #s result from:

1. **Direct violence**  
2. **Indirect violence**  
3. **Excessive muscle contraction**

From the point of view of treatment the pattern of mandibular #s can be considered under the following headings:

1. Unilateral #  
2. Bilateral #s  
3. Multiple #s  
4. Comminuted #s

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Clinical Examination:
1. General examination of the patient
2. Local examination of the mandibular fracture

General examination of the patient:
Fractures of the mandible caused by trauma of varying degrees of severity, and this trauma may also cause injury elsewhere in the body. A thorough examination should be done (head, chest, abdomen, and extremities). The patient should be carefully inspected and palpated because the patient may have cerebral hemorrhage, fractured vertebrae or other bones or intra abdominal hemorrhage. Failure to diagnose any of these injuries might result in a surgical disaster; in addition, the medical history should be taken.

Local examination of the mandibular fracture:
First of all the face and the mouth should be gently cleaned with wet gauze to remove the caked blood for accurate evaluation of the soft tissue laceration and bleeding source. Any foreign body as avulsed tooth, fractured fillings or dentures should be removed to keep patent airway tract.
The local examination of mandibular fracture consists of:

1. Extra oral examination:
   i. Inspection; to see if there is ecchymosis, swelling, soft tissue laceration, obvious deformity of the bony contour or anterior open bite.
   ii. Palpation; by gentle palpation with the tips of the fingers over the condylar region bilaterally and then continued downwards a long the lower border of the mandible. There is tenderness over the fracture sites and feel step defect in the bone and bony crepitus. Also gentle pressure on the 2 angles or symphysis region (compression test) always elicits pain in fractured mandible.

2. Intra oral examination:
   i. Inspection; the buccal sulcus is inspected for ecchymosis and then the lingual sulcus is examined for ecchymosis or the presence of fracture sublingual haematoma. Ecchymosis in the buccal sulcus is not necessarily indicative of a mandibular fracture, while on the lingual side it is almost pathognomonic of a mandibular fracture. The teeth should also carefully inspected if there is any avulsed, missing teeth or fractured fillings, and the inner surface of the lip should be examined.
   ii. Palpation; the buccal and lingual sulci are gently palpated, to detect any tenderness and step deformity in the bone, and the teeth mobility. The suspected fracture sites are examined by thumb and forefinger of each hand placed on either side of the possible fracture site and gentle pressure is used to elicit unnatural mobility across the site of fracture.
Common symptoms and signs Mandibular fracture:

- **Pain**: especially on talking and swallowing
- **Numbness** of the lower lip
- **Swelling** and **drooling**
- **Trismus** and difficulty in moving the jaw
- **Bone tenderness** over fracture site
- **Altered occlusion**
- **Loosened teeth** and **gingival bleeding**
- **Mobility** of fractured segment
- **Hematoma** associated with fracture site, especially sublingual

**Tooth in the fracture line:**

*Teeth in the fracture line are a potential impediment to healing:*

1. The fracture is compound into the mouth via the opened periodontal membrane.
2. The tooth may be damaged structurally and lose its blood supply as a result of the trauma so that the pulp subsequently become necrotic.
3. The tooth may be affected by some pre-existing pathological process such as an apical granuloma.

**Management of teeth involved in a mandibular fracture line:**

**a. 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.

**b. 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. (All teeth not covered these conditions should be retained if possible.)

**c. Assessment and treatment of a tooth retained in the fracture line:**

2. Institution of appropriate systemic antibiotic therapy.
3. Splinting of the tooth if mobile.
4. Endodontic therapy if pulp is exposed.
5. Immediate extraction if fracture becomes infected.
6. Follow-up for 1 year and endodontic therapy if there is demonstrable loss of vitality.
Characters, Signs and Symptoms of each mandibular fracture are:

**Dentoalveolar Fractures:**
Classification of dentoalveolar injuries:

1. **Dental hard tissue injury**
   a. Crown infraction (crack of enamel or incomplete fracture)
   b. Crown fracture - Enamel only
   c. Crown fracture - Enamel + dentine
   d. Crown fracture - Enamel + dentine + pulp
   e. Crown-root fracture (vertical fracture)
   f. Crown-root fracture (oblique fracture)
   g. Root fracture

2. **Periodontal injury**
   a. Concussion (no displacement of tooth but tender to percussion)
   b. Subluxation (loosening of tooth without displacement)
   c. Intrusion
   d. Extrusion
   e. Lateral luxation (loosening of tooth with displacement)
   f. Avulsion

3. **Alveolar bone injury**
   a. Intrusion of tooth with comminution of socket
   b. Fracture of single wall of socket or alveolus
   c. Fracture of both walls of socket or alveolus
   d. Fracture of mandible or maxilla involving the alveolus and/or tooth Socket

4. **Gingival injury**
   a. Contusion
   b. Abrasion
   c. Laceration

5. **Combinations of the above**

| Types of splint and suggested duration of treatment in dentoalveolar injuries |
|---|---|---|
| **Injury** | **Splint** | **Duration of splinting** |
| Root fracture | Rigid | 6 weeks minimum |
| Extrusion | Semi-rigid | 7-10 days |
| Lateral luxation | Semi-rigid | 2-3 days |
| Avulsion | Semi-rigid | 7-10 days |
| **Alveolar fracture** | | |
| Block segment of teeth | Rigid | 4-6 weeks |
| Fracture of labial/lingual plate | Semi-rigid | 4-6 weeks |
**Condylar Fracture:**
Fractures involving the mandibular condyle are the only facial bone fractures that involve a synovial joint. Injury to the joint can occur in the absence of any fracture of the articular surfaces. Trauma to this region may therefore be divided into three main types:

1. **Contusion:** apart from damage to the capsular ligaments, such an injury may be accompanied by a synovial effusion, hemarthrosis or tearing of the meniscus. Such injuries are difficult to diagnose without special imaging techniques but they may predispose to later degenerative changes in some cases.

2. **Traumatic dislocation:** irreducible displacement of the condyle from the glenoid fossa is usually anterior and/or medial. Lateral, posterior or central dislocations rarely occur. A coexisting fracture of the condylar neck is common.

3. **Fracture:** includes any fracture above the level of the sigmoid notch. Fractures, fracture/dislocations and dislocations of the condyle are all accompanied by varying degrees of contusion. If the fracture extends into the joint space, hemarthrosis and rupture of the meniscus is more likely to occur and such injuries may predispose to later disturbance of function.

This is the most common type of mandibular fracture (particularly condylar neck). Condylar fracture classified as extracapsular and intracapsular fracture. The extracapsular fracture may exist with or without dislocation of the condylar head inferiorly, medially or laterally due to the pull action of the lateral pterygoid muscle which is attached to the anteromedial aspect of the condylar head. Features:

1) Swelling and tenderness over the TMJ area and there may be hemorrhage from the ear on that side in recent injuries. Bruises in the region should not be mistaken with Battle's sign associated with cranial base #s. clicking and crepitus on TMJ.

2) On inspection intraorally there may deviation of occlusion towards the fracture side and this is especially obvious when the patient open his mouth. Mandibular protrusion is also limited and painful.

3) In bilateral condylar fractures; the signs and symptoms are the same as in the unilateral fracture but present on both sides and there is anterior open bite and may be associated with midline fracture of the mandible.
Condylar fractures can be classified according to:

1. **Age:**
   - Under 10 years
   - 10–17 years
   - Adults

2. **Surgical anatomy:**
   - Involving joint surface: intracapsular
   - Not involving joint surface: extracapsular
     - High condylar neck
     - Low condylar neck

3. **Site:**
   - Unilateral
   - Bilateral

4. **Occlusion:**
   - Undisturbed
   - Malocclusion

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**Coronoid Process Fracture:**
This is a rare fracture. If the tip of the coronoid process is detached, the fragment is pulled upward towards the infratemporal fossa by the pull action of the *temporalis* muscle.

1. Intra oral ecchymosis on the coronoid process region.
2. Tenderness on palpation over the region of the coronoid process.
3. Pain and limitation of mandibular movement especially on protrusion.

**Ramus Fracture:**
This is a rare fracture, may be simple or comminuted, the fragments are splinted between the masseter and the medial pterygoid muscles and little displacement occurs.

In both types of fractures; there are swelling, ecchymosis and tenderness on palpation over the ramus extra and intra–orally and painful mandibular movements.

**Angle Fracture:**
This is the most common fracture after condylar neck fracture. The angle is a weak area since it is the junction of the ramus and the body of the mandible, also the presence of an impacted mandibular third molar weakens the area.

The fracture in this area may be classified as favorable and unfavorable fracture depending on the severity of posterior fragment displacement. The displacement depends on the pull direction of the masseter and / or the
medial pterygoid muscles, and the direction of the fracture line vertically and horizontally through the bone.

In practical view, if the fracture is relatively stable, it is considered a favorable fracture irrespective of the direction of the fracture line, also the presence of an erupted tooth in the posterior fragment which aid in the reduction and immobilization of such fracture regarded as favorable fracture. The signs and symptoms are ecchymosis, swelling, tenderness and bony step deformity.

**Body Fracture:**
Little displacement of the fragments occurs in a unilateral fracture in the premolar and molar areas. Fibers of the mylohyoid on either side of the fracture line probably play an important part in minimizing the displacement in this type of fracture. Features:
1. Extra and intra-oral edema and ecchymosis.
2. Derangement of the occlusion and deformity of the alveolus.
3. Tenderness of the fractured region, and pain on mandibular movement.
4. Unnatural mobility across the fracture site on gentle pressure.
5. Anesthesia or paresthesia of the lower lip, if the inferior alveolar nerve is involved.

**Fracture of the Symphysis (Midline):**
This fracture cause minimal displacement as the fracture line runs between the genial tubercles, and the pull of the geniohyoid and the genioglossus muscles tends to impact the bone ends together. This fracture can be seen in epileptic patient due to fall directly on the chin. This fracture mostly associated with bilateral condylar fracture.

**Parasymphysisal (Canine region) fracture:**
The fracture line running to one side of the genial tubercles and the displacement depend on the pull of the geniohyoid and genioglossus muscles which pull the greater fragment lingual to the lesser fragment.

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Radiographical Examination
1. Intra–oral radiographs
   i. Periapical; to evaluate teeth involved in the fracture line.
   ii. Occlusal and oblique occlusal; to evaluate the relation of teeth to the fracture line.
2. Extra–oral radiographs
   i. Oblique lateral of mandible (right and left side views); to evaluate the fracture line in the body, angle and condylar neck fracture.
   ii. Postero–anterior view of mandible; to evaluate body and angle # together with the type of displacement.
   iii. Panoral tomogram, or orthopantomogram (OPT); the best single overall view of the mandible, including excellent view of the condyles.
   iv. Reverse Towne’s view (elongated PA); to demonstrate fractures of the condylar neck.
   v. Temporomandibular joint views (in open and close mouth); to demonstrate the presence of TMJ dislocation (Transcranial, Transpharyngeal, Arthrography, and Arthroscopy).
   vi. CT scan (computerized tomography scanning); to evaluate intra capsular fracture of the condylar head.
   vii. MRI (magnetic resonance imaging); which gives very accurate details.

Definitive treatment:
Factors affecting method of treatment of mandibular fractures:
1. Fracture pattern.
2. Skill of the operator.
3. Resources available.
5. Presence of other injuries.
6. Degree of local contamination and infection.
7. Associated soft tissue injury or loss.

The steps of definitive treatment consist of:
A- Reduction
B- Fixation and immobilization
C- Follow up and rehabilitation
**A-Reduction:**
It is the process of approximation and repositioning ends of the fractured bone in the proper position. The reduction is usually done under local anesthesia, or by giving sedation as 100mg pethidine or under general anesthesia. There are two types of reduction:

**a- Closed reduction**
This reduction done by manual manipulation by elastic traction or by wires, without surgically exposing the fracture bone ends and no need for general anesthesia. Perfect reduction of the fracture is achieved, if the teeth are restored to their normal alignment and normal bony contour.

**b- Open reduction**
This type of reduction done by manual manipulation after exposing the fracture bone ends surgically, usually under general anesthesia.

**Advantages of open reduction:**
1- The fracture can be reduced exactly by direct vision, so results in perfect approximation of the fracture ends.
2- For the refracturing of malunited or nonunited fracture in order to refresh the bone ends from organizing connective tissue.

**Disadvantages of open reduction:**
1- As the fracture area is exposed, there is more risk of infection.
2- If done under general anesthesia, so more risk and cost to the patient.
3- Submandibular or preauricular skin scar.

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**B-Fixation and immobilization:**
It is maintaining and securing the proper reduction until healing occurs.
A simple guide to the time of immobilization for fractures of the tooth bearing area of the lower jaw is as follows:

**With early uncomplicated treatment in a healthy young adult union can on average be achieved after 3 weeks**

If:
- a. Tooth retained in fracture line
- b. Age 40 years and over
- c. Patients who are smokers
- d. Mobile or comminuted fractures
- e. Children and Adolescents → subtract 1 week

→ add 1-2 weeks
i.e. 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.

### Methods of immobilization for fractures of the dentate mandible (Michael Perry 2015):

#### a. Direct fixation (Osteosynthesis):
- Semi-rigid plates (miniplates)
- Rigid plates (non-compression)
- Compression plates
- Lag screws
- Resorbable plates and screws

#### b. IMF:
- Bonded orthodontic brackets
- Inter-dental wiring (direct wiring, eyelet wiring etc.)
- Arch bars
- IMF Screws

#### c. External fixation

#### d. Other methods (largely historical or where plates not available)
- Trans-osseous wiring
- Circumferential wiring
- Transfixion (kirschner wires)

i.e. in most circumstances **open reduction and internal plate fixation** (ORIF: Open Reduction and Internal Fixation) is now the main form of treatment for mandibular fractures.

### Dental wiring:

Dental wiring is used when the patient has a complete or almost completes dentition. The wire used is 0.35 mm soft stainless steel. The wire should be stretched by a pair of artery forceps before use to prevent wire slack after being in position a few days later, one should avoid overstretching of the wire because it become work hardened and brittle. There are two types of dental wiring:

#### a. Direct wiring:

Soft wire of about 15cm length twisted around a suitable tooth and then the free ends are twisted together by needle holder to produce a plaited wire. Similar wires are attached to other teeth elsewhere in the upper and lower jaws; about five to seven dental wires are applied in each jaw. Then the
fracture is reduced, and finally the plaited wires in the upper and lower jaws are in turn twisted together.

This is a simple method of immobilizing the jaws, but it has the disadvantages that rigid immobilization is not achieved and the wires are connected to the teeth themselves, so that the whole maxilla-mandibular fixation (MMF) must be removed if bone healing have to be checked. This disadvantage can be overcome by using interdental eyelet wiring.

b. Interdental eyelet wiring:

Eyelets are constructed by holding 15 cm length of wire by a pair of artery forceps at either end and stretch it, then giving the middle of the wire two turns around a piece of round bar 3 mm in diameter which is fixed in upright position. These eyelets are fitted between two adjacent teeth. About five eyelets are applied in each jaw. After fracture reduction the upper and lower eyelets are connected with tie wires passing through the eyelets. The tie wires may be positioned in the upper and lower jaws in a cross manner to achieve a rigid immobilization.

The tie wires should be tightened loosely in the molar area, first on one side and then the other sides, then tightens loosely in the incisor area, and then final tightening of all segments. It should be remembered that if the wires are tightened on one side first, a cross overbite is produced, and if the anterior wires are tightened before the wires in the molar area a posterior open bite results.

To evaluate fracture healing it is possible to remove only the tie wires, and if a further period of immobilization is indicated new tie wires can be applied. This technique is simple to apply and very effective.

Arch bar:

Arch bars are used when the patient has insufficient number of teeth to enable effective interdental wiring to be done.

The metal bar (arch bar) should be cut to the required length and bent to the correct shape before starting the operation. Then 15cm length of a stainless steel wire 0.35 mm is stretched and then twisted around adequate number of teeth and reduce the fracture, then the arch bar laid alongside the teeth, in the upper jaw the hooks of the arch bar projected upward, while for the lower jaw the hooks of the arch bar projected downward, the two free ends of the wire attached to the teeth passing above and below the bar, and then twisted tightly together over it. The free end of the plaited wire is cut off short and then tucked behind the hook where it will not irritate the tissues. To do immobilization of the fracture by MMF, the upper and lower arch bars are tied by elastic bands or tie wires between the hooks of the arch bars in a cross manner. It is a simple method and most fractures of the mandible can be effectively treated in this fashion.
Modified Gunning - type splints:
This technique is used when the patient is edentulous in one or both jaws. If the patient is completely edentulous immobilization is carried out by attaching modified gunning type splints to the upper and lower jaws, then MMF is effected by connecting the two splints with elastic bands between hooks. When the patient is edentulous in only one jaw; MMF is carried out by connecting the gunning splints to another splint in the opposing jaw. Gunning splints take the form of a denture but with a bite blocks in place of molar teeth and a space in the incisor area to facilitate feeding. The fitting surface of the splints is lined with black gutta-percha to prevent the hard acrylic from chafing the alveolar ridge. The splints are constructed on models from impressions taken of the patient's mouth. Most old patients have dentures and one can use their dentures as splints after doing modification on them.

The upper splint is fixed to the alveolus by peralveolar wire using an awl to pass 0.5 mm soft wire through the alveolus high up in the canine area on each side and tying the two free ends over the upper Gunning – type splint.

The lower splint is fixed to the alveolus by circumferential wire; a small awl is pushed through the skin beneath the mandible and brought out in the mouth on the lingual side of the mandible, in the canine area. It is threaded with the wire and then gently withdrawn to the lower border of the mandible, but not out through the skin. The tip of the awl is guided round the lower border of the mandible and is then pushed up into the buccal sulcus where the wire is released from the awl and the instrument is withdrawn from the original puncture wound beneath the chin.

Methods of immobilization for fractures of the edentulous mandible:

<table>
<thead>
<tr>
<th>a. Direct fixation (osteosynthesis):</th>
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<tbody>
<tr>
<td>● Bone plates</td>
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<tr>
<td>● Transosseous wiring</td>
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<tr>
<td>● Fixation supplemented by cortico-cancellous bone graft.</td>
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<th>b. Indirect skeletal fixation:</th>
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<tr>
<td>● Pin fixation</td>
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<td>● Custom external fixator</td>
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<th>c. Inter-maxillary fixation (using Gunning-type splints):</th>
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<tr>
<td>● Used alone</td>
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<tr>
<td>● Combined with other methods</td>
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Transosseous wiring:
Transosseous wiring is an effective method for immobilizing a fractured mandible (upper border, lower border of the mandible and edentulous mandibular ridge). Holes are drilled in the bone ends on either side of the fracture line and after reduction of the fracture a 0.5 mm soft wire is passed through the holes across the fracture, then the free ends are twisted tight, cut off short, and the twisted end tucked into the nearest drilled hole.

Transosseous wiring is especially useful in the treatment of edentulous mandibular fracture or for the fixation of edentulous posterior fragment. This method must not be used if the fracture is infected for the presence of metallic foreign body may cause bone necrosis.

Transosseous wiring can be done at the lower border of the mandible through an extraoral submandibular surgical approach or at the upper border by an intraoral incision along the crest of the alveolus, and it is often sufficient for the alveolus alone to be drilled and wired.

A problem arises with lower border wiring of a bilateral fracture through the body of the mandible, for owing to muscular pull in the region of the chin, the upper end of the fracture has a tendency to gape. This problem can be overcome to a certain extent by using a figure-of-eight type of wiring at the lower border or combined with the upper border wiring through the mandible immediately below the level of the alveolar bone crest.

Extra oral pin fixation:
This method is rarely used because:
1) May cause electrolytic action which may produce bone necrosis and ulceration of the skin.
2) The pin may project from the patient’s jaw and may cause trauma and discomfort to the patient.

This method is mostly used when there is infection and transosseous wiring can’t be used. The technique consists of inserting a pair of stainless-steel pins into each fragment which diverge from each other, then the protruding ends of the pins are joined by connecting bars and universal joints to fix both fracture segments of the mandible.

Bone plating:
The main advantage of bone plating is that it provides an extremely rigid fixation and therefore avoids unnecessary MMF at the conclusion of the operation and the patient can eat within few days after fixation.

(Rigid internal fixation is defined as: 'any form of fixation applied directly to the bones which is strong enough to prevent inter-fragmentary motion across the fracture when actively using the skeletal structure').

Bone plates present as straight and curved plates, compression or non-compression, absorbable or non-absorbable, locking or non-locking, with
different lengths and sizes (mini or microplates). Bone plate of the lower border of the mandible may require eyelet wiring or arch bar to the upper border of the fracture line which is firstly fixed after reduction of the mandible.

The disadvantages of this method are:

1. fracturing of the roots of the teeth
2. metal fatigue fracture of the plate
3. fracture of the small fragments of bone ends at the point of screw insertion
4. scar
5. infection and bone necrosis

Compression plates
The theory and practice behind compression osteosynthesis of mandibular fractures is based on the similar treatment of fractures of weight bearing long bones, however, as has been previously pointed out, non-union or delayed union is rarely a problem in fractures of the mandible or other facial bones. In addition precise reduction is essential in the dentate mandible. This is difficult to achieve when using compression plating techniques and, for these and other reasons, it is probably true to say that they have now been abandoned by the majority of maxillofacial units. For the interested reader it may be instructive to explain further why this has occurred.

![Diagram](image)

*Figure 6.4* Diagram to represent the theory of compression plating. During final tightening of the screw head in the eccentric pear-shaped hole (a) there is inward movement as it slides into the wider part and (b) thus pushes the bone fragments together.

As for all rigid plates, compression plates are secured to the convex outer surface of the mandible surface using bicortical screws and they must therefore be sited below the inferior alveolar canal. However skillfully the plate is adapted, there is still a tendency for both the upper border and the lingual plate to open with the tightening of the compression screws. This leads both to distortion of the occlusion and, in a bilateral fracture, to opening of the fracture line on the other side.

Primary bone healing (primary intention or direct bone healing) is seen with the rigid fixation using strong 'load-bearing' devices unlike healing by secondary bone healing observed with use of non-rigid internal fixation.
Transfixation:
Fixation of fractures in the symphysis or angle region can be used after reduction of the fracture by transfixing them with Steinmann pin or Kirschner wire through the fragments. This method also called "Shish Kebab" method.

Fractures of the tooth bearing section of the mandible: synopsis
1. Accurate reduction is essential if there is a good functional occlusion.
2. All of these fractures are compound into the mouth.
3. Teeth in the line of fracture are a potential source of infection and delayed healing.
4. The mandible can be immobilized by direct osteosynthesis, IMF or a combination of both.
5. Non compression miniplate fixation is currently the preferred method wherever the necessary resources are available.
6. Although compression plating is based on sound general orthopaedic principles these are less relevant to the treatment of mandibular fractures than to the skeleton as a whole.
7. Malunion is much more likely than non-union.

Definitive treatment of Condylar region fracture
Clinical management: an overview
Currently there are 3 treatment options:
1. Functional (conservative)
2. Indirect immobilization(IMF)
3. Osteosynthesis (ORIF)

Indications for open reduction and fixation of condylar neck fractures:

<table>
<thead>
<tr>
<th>Absolute indications:</th>
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<tbody>
<tr>
<td>Displacement of condyle into middle cranial fossa</td>
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<tr>
<td>Impossibility of restoring occlusion without ORIF</td>
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<tr>
<td>Lateral extra-capsular displacement</td>
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<td>Invasion by foreign body (e.g. missile)</td>
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<table>
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<tr>
<th>Relative indications:</th>
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<tr>
<td>Bilateral fracture with associated mid-face fracture (particularly where one condylar fracture is dislocated or angulated)</td>
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<tr>
<td>Bilateral fracture with severe open bite deformity</td>
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<tr>
<td>Unilateral fracture with dislocation, overlap or significant angulation of the condylar head</td>
</tr>
<tr>
<td>When inter-maxillary fixation is contraindicated for medical reasons</td>
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<td>M. Perry 2015</td>
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</tbody>
</table>
| **Children under 10 years** | - Entirely *functional* where possible (spontaneous correction of malocclusion).  
- Indirect immobilization by IMF for control of *pain* but should be released after 7-10 days  
- With intracapsular # → careful follow-up and monitoring of growth, any sign of *ankylosis* require *surgical intervention* | |
| **Adolescence 10-17 years** | - The same principles above with some modification (less capacity of spontaneous correction)  
- *Malocclusion* indicate → IMF 2-3 weeks  
- Argument for ORIF major displacement of condyle in *severe fracture dislocation* | |
| **Adults** | - Stable occlusion → *conservatively* no IMF  
- Malocclusion → IMF for 2-3 weeks | -Malocclusion is usual → IMF for 3-4 weeks. followed by post IMF *physiotherapy* and jaw exercise to avoid chronic limitation (i.e. prolonged IMF can result in *capsular contraction* and limitation of mouth opening)  
-With displacement: (Low condylar neck # → ORIF) (High condylar neck # → either ORIF if possible or IMF for 3-4 weeks) followed by intermittent night elastics to avoid relapse, selective grinding of teeth may required | - No or minimal displacement → *no active treatment* is necessary  
- # usually *unstable* and displaced → ORIF at least for one side to restore ramus height  
- In very high condylar neck # → ORIF but if not possible IMF for 6 weeks  
- If associated with major *midfacial* # → Bilateral ORIF is desirable  
- Retromandibular and Transparotid approaches used for difficult cases |
Fractures of the condylar region: synopsis
1. Fractures of the condylar region involve the temporomandibular joint either directly or indirectly.
2. Permanent disturbance of function of the TMJ is common when carefully looked for but is usually not significant. Fractures that involve the subcondylar area in children can occasionally lead to significant disturbance of growth. Fractures into the joint space can result in fibrous or bony ankylosis that appears to be more common in some racial groups than others.
3. 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.
4. Significantly displaced subcondylar fractures in adults, particularly when there are bilateral fractures, should be treated by ORIF.
5. Retromandibular or transparotid surgical approaches to the subcondylar region give rapid and sufficient access for the application of bone plates that must be of adequate strength.
6. Treatment of fractures of the condylar region in all age groups is still less than ideal and although guidelines exist they remain to be evaluated fully.

C-Follow up and rehabilitation:
The postoperative care of a patient with mandibular fracture may be divided into three phases:
1. The immediate post operative phase; when the patient is recovering from the general anesthesia until about one week:-
   * If MMF has been carried out, bedside instruments such as scissors, wire cutter, screw driver necessary to remove the fixation should be available in emergencies.
   * The patient should be returned from the theatre with nasopharyngeal tubes in position and should be left insitu until the patient recovers consciousness, and the tongue should be sutured by transversely inserting the needle into the back of dorsum of the tongue and pull the tongue forwards and adhere the free ends of the thread by plaster to the chin until the patient being conscious.
   * The patient should be nursed lying on his side during recovery to enable saliva and blood to escape through the fixation outside the mouth. An efficient suction apparatus must be at the patient’s bedside and a polythene tube is attached to the sucker nozzle which can be passed through the nasopharyngeal tube to clear the nasopharyngeal airway and the mouth.
*The patient should be given antibiotic 1,000,000 units penicillin daily for five days. Give the patient mild analgesic and anti-inflammatory drugs to relieve pain.
* Parenteral fluid therapy and monitoring the vital signs.

2- *The intermediate postoperative phase, from 2nd week to 4th week; when the mandibular-maxillary fixation is still in position:*-
* Periodic postoperative radiographs must be taken to evaluate union of the fracture.
* Fixation must be checked to see if the splints become loose and to tighten the dental wires and to change the damaged elastic bands.
* The patient should eat semi-solid or liquid diet and passing the diet by rubber tube through a gap in the fixation or round the back of the lower teeth in the retromolar region.
* Ask the patient to gargle with normal saline and chlorhexidine mouth wash, instructions and motivations for good oral hygiene is given.

3- *The late postoperative phase, from 4th week to 6th week:*-
* About 4 weeks after immobilization, the fracture site should be examined by gentle movement across the fracture line after loosening of fixation, if the union is complete and rigid, the fixation apparatus is removed by cutting the dental wires in case of direct or eyelet wiring, arch bars, cap splints, Gunning splints and extraoral pin fixation. While bone-plating or transosseous wires left in situ unless causing complications.
* Selective grinding of teeth cusps or selective tooth extraction if there is traumatic occlusion.
* The vitality test of teeth should be checked to do R.C.T for non vital tooth.
* Reassurance of the patient if there is paraesthesia or anesthesia of the lower lip.

**Fractures of the mandible in children: synopsis**
1. Modification of the principles of treatment is necessary to take account of:
   a. capacity for rapid bony union fractures are stable between I and 3 weeks
   b. the mixed dentition and multiple buried developing teeth
   c. potential interference with subsequent growth
2. Accurate reduction is less important as further growth will often compensate for occlusal discrepancies.
3. Direct osteosynthesis should be avoided if possible. However, plating or wiring the lower border may occasionally be indicated.
4. IMF can be applied to deciduous teeth if needed but finer diameter wire should be used. Bonded orthodontic brackets are preferred if possible.
5. Fractures of the condyle require special consideration.
6. A prolonged period of follow-up is important
Complications of Mandibular Fracture:
1- Paraesthesia or anesthesia
2- Skin scar
3- Derangement of occlusion
4- Ankylosis of TMJ

Predisposing factors almost certainly 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 meniscus: experimental work on large primates has shown that more restriction of movement occurs when an intracapsular fracture is accompanied by excision of the meniscus. Furthermore, Remnants of the meniscus can be found in the medially displaced mass of bone, a finding that is common in human cases of bony ankylosis. Disruption of the meniscus is likely to occur in two particular types of fracture: a severe intracapsular compression injury or a fracture/dislocation.

Figure 3.2 Diagrammatic representation of condylar fractures that may cause disruption of the temporomandibular joint meniscus. (a) Coronal view of normal condyle and meniscus. (b) Impaction injury causing intracapsular fracture haemarthrosis and damage to the meniscus. (c) Medial fracture dislocation with tearing of the meniscus.
5- Mal-union, delayed union or non-union
6- Deformity of the mandible and malposition of the fragments
7- Pyogenic infection, gingivitis, actinomycosis
8- Traumatic myositis ossificans of the masseter muscle

Malunion:
It means unacceptable malposition and incorrect union of the fracture, usually as a result of imperfect reduction & fixation of the fracture. Postreduction radiographs must always be taken to evaluate the union of the fracture. Mild malunion can be left without treatment in certain situations (children, edentulous); however, selective grinding or extraction of teeth may be sufficient in dentulous patients. Gross deformity of the bony contour or derangement of occlusion may necessitate surgical refracturing and immobilization.

Delayed union:
If the time taken for a mandibular fracture to unite is unduly protracted it is referred as "delayed union". Bone fracture heals at different rates, in children takes less time than older patients. If union is delayed beyond the expected time for that particular fracture (taking the site and the patient’s age into consideration) it must assumed that the healing process has been disturbed. Delayed union may be due to inadequate reduction and immobilization or infection at the fracture site.

Non-union:
It means that the fracture is not only not united but will not unite on its own. Radiographs show rounding off and sclerosis of the bone ends reveals a condition referred to as "eburation", or the bone ends unite by fibrous tissue "fibrous union". Non-union of the fracture may be due to the presence of infection, presence of non-vital tooth in the fracture line, inadequate reduction and immobilization and insufficient blood supply to the bone ends. If radiographs reveal marked eburation of the bone ends or excessive bone loss or fibrous union, the fracture site should be explored surgically to refresh the fracture bone ends or bone graft may be required.