Paparella IV: Section 1: Plastic and Reconstructive Surgery

Chapter 18: Mandibular Fractures

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Fracture of the mandible is one of the more common maxillofacial injuries, ranking second only to nasal fracture in recorded incidence. Males are more often affected than females, and the injury is more often observed in the 11- to 30-year age group. The fracture usually occurs as a result of a motor vehicle accident, interpersonal altercation, sports contact, or fall. The injury is rare in children, but when it is seen, child abuse must also be considered as a possible cause.

Traditionally, the mandible is divided into specific anatomic areas, and a fracture of the mandible is classified according to its location in one or several of these areas. Thus, a fracture is designated as condylar or subcondylar if it runs from the mandibular notch to the posterior border of the ramus; coronoid if it runs from the mandibular notch to the anterior border of the ramus; ascending ramus if it extends horizontally through both anterior and posterior borders of the ramus or from the mandibular notch vertically to the anterior border; angle if it is distal to the second molar and between the body and ramus; body if it occurs between the mesial portion of the canine and distal portion of the second molar and extends from the alveolus to the inferior border; symphyseal and parasymphyseal if it runs in the region of the incisors to the inferior border; and alveolar if it is confined to the alveolar ridge. Using this classification, there is a high incidence of subcondylar, angle, and parasymphyseal fractures and a relatively low incidence of ascending ramus, coronoid, and alveolar fractures. About one-half of the fractures also are unilateral with equal distribution on the right and left sides. Of the multiple fractures, most involve two sites, and some involve three, but fractures rarely occur in more than three different areas.

Pathophysiology

The reason why a fracture occurs at a specific site of the mandible is related to anatomic strength and weaknesses of the bone and the external force applied to the structure. The U-shaped mandible is made up of a smooth, rounded, thickened lower border; a reinforced mental protuberance; and a relatively thin alveolar ridge, ascending ramus, and condylar neck. In children the mandible is highly resistant to stress; in the elderly it is brittle and atrophic. The ascending ramus is strengthened by a thickened crest created by force fields from the insertion of muscles. The angle and condylar neck are somewhat strengthened by the reinforcing ridges and muscle crests oriented primarily to resist compressive forces. The body of the mandible is strengthened by similar cortical thickenings secondary to the muscle insertions, i.e. the mylohyoid and the lateral oblique line. Additional strength and protection is provided by the muscles of mastication, which form a compressible sling around the ramus.

Areas of weakness in the mandible are created by the incisive fossae (for mental nerves), impacted or unerupted teeth, and abscesses or cysts. Long-term absence of teeth also leads to atrophy of the body and further weakening of this structure. The angle and condyle are somewhat resistant to anteroposteriorly oriented stresses, but they are relatively weak considering the lateral forces that usually occur from trauma to these areas. The thin alveolar process provides a minimal amount of spongy bone, which offers little if any protection against traumatic forces.

The direction of force on the mandible is an important factor in causing a fracture. The force can be applied directly to the mandible or transmitted across it to some other region of the bone. Blows to the symphysis commonly cause parasymphyseal fractures, but they can also cause unilateral or bilateral condylar fractures. If the force to the chin is directed upward or to the side, the angle on the condyle is also fractured. Blows to the alveolar ridge often cause segmental fractures, and if the force is applied directly to the body, an ipsilateral body fracture can occur alone or in association with a contralateral angle or condylar fracture. Ascending ramus fractures often occur as a result of a direct force to the area. Coronoid fractures frequently develop as a consequence of a depressed zygoma injury.

The displacement of a fracture is related to the site of injury and the direction of the force. The degree to which fractures are distracted or unstable depends on the direction of the line of fracture and the relationships of muscle pull to this line. One group of muscles, the depressor-retractors, made up of the digastric, geniohyoid, genioglossus, and mylohyoid, pulls the anterior portion of the mandible downward and backward. The mylohyoid can also pull the body medially. Another group, the elevators, made up of the temporalis, masseter, and medial and lateral pterygoid muscles, pulls the posterior portion of the jaw upward and forward. In addition, the pterygoid muscles assert powerful medial forces.

Depending on the pull of the muscle and the line of the fracture, the fracture segments are brought together (a favorable relationship) or apart (an unfavorable relationship). Figure shows favorable and unfavorable fractures in both horizontal and vertical directions involving the angle of the jaw. Parasymphyseal fractures are often described as unfavorable because the depressor-retractor muscles of one side have a different direction of pull from those of the opposite side. Low condylar fractures are often pulled medially by the lateral pterygoid muscle.

Diagnosis

A careful evaluation of the events causing the injury and a review of dental health are important. Interpersonal altercations are commonly associated with body and condylar fractures, whereas automobile accidents are common causes of parasymphyseal and condylar fractures. Gunshot wounds are often associated with comminution of the bone in the path of the missile.

If possible, a pretrauma relationship of the jaws should be established. Dental records may be useful; if the patient has had orthodontic treatment, occlusal models are often available. Information regarding tooth pain, orthodontic and endodontic treatments, and dental extractions is helpful.

Additional history should be obtained regarding the possibility of other injuries or preexisting disease that can affect the risks involved in anesthesia and the healing of the fractures. Many patients with mandibular fractures have associated cranial or cervical injury or other types of injury to the body that may take precedence. It is important to determine any cardiovascular, chronic lung, kidney, or liver disease, or any systemic disorder, such as diabetes mellitus, that can affect patient management. A history of tetanus immunization and allergy to antibiotics is also important.

A complete physical examination should evaluate all anatomic and functional systems. The patient should be immediately tested for respiratory obstruction, bleeding, hypoxia, or shock. Particular attention should be paid to the cervical spine, chest, abdomen, extremities (including hip), central nervous system, eyes, and temporal bone. Appropriate consultations, as deemed necessary, should be obtained with medical and surgical specialties.

With regard to the mandibular fracture, the patient should be questioned about the ability to close and open the mouth, and any areas of pain or numbness. Inspection often reveals edema and ecchymosis over the area of injury and lacerations of the oral mucosa over the fracture site. Lacerations are common at the point of impact or at the entrance or exit of high-velocity missiles. Depending on the location of the fracture, the jaw may be displaced downward, backward, or to the side. The patient may have difficulty in speaking or swallowing. Saliva collection in the buccal gutters is to be expected, and a foul odor may be detected from accumulation of debris and blood and the inability of the patient to cleanse the oral cavity naturally.

An evaluation of the occlusal relationships is important. Often the lower jaw is held in an immobile position because of the pain or discomfort, but nonetheless an attempt should be made to determine the degree of opening and deviation of the jaw from side to side, and the position of the teeth with regard to occlusion. Condylar fractures can cause premature contact of the molars and an open bite deformity. Bilateral body or angle fractures may be associated with retrognathia. More than one fracture can cause a crossbite problem.

Palpation of the jaw will determine irregularity of contour (steps) and areas of tenderness. Failure to feel the condyle moving in and out of the glenoid fossa, and deviation of the jaw to one side, suggest a condylar fracture. Manipulation of the mandible should elicit movement of the proximal and distal segments and any crepitation at the fracture site.

Radiographic Analysis

Standard radiographs, panoramic views, computed tomographic (CT) scans, and dental views are useful to define the exact site(s) of fracture. The modified Towne view is excellent in determining fractures and medial displacement of the condyle. The anteroposterior view of the mandible is helpful in determining symphyseal and parasymphyseal injury, whereas the right or left lateral oblique views show best body, angle, and ascending ramus fractures. Dental films can be excellent in evaluating the presence and degree of tooth injury and in demonstrating fractures that involve the symphyseal region. The panoramic x-ray is useful in showing occlusal relationships and most fractures of the mandible. For injuries of the condylar head and glenoid fossa, the CT scan and tomograms in the lateral plane are useful. Open and closed temporomandibular joint films can also provide information on joint function.

Classification

Classifying mandibular fractures helps to determine the appropriate therapy. Classification systems traditionally depend on location, fracture line, severity of fracture, and relationship to favorable or unfavorable muscular forces. Compound fractures are fractures with an opening into the mouth or through the skin. The term "greenstick" indicates an incomplete fracture. Comminuted fractures are fractures made up of multiple small fragments. Unfavorable fractures are unfavorable in a horizontal or vertical direction; conversely, favorable fractures have stability and favorable relationships for the fracture line and muscular forces. A classification should also determine whether the teeth are in a fracture line and whether teeth are present or absent (edentulous) to the side of the fracture. Any atrophy of the mandible should also be defined.

In general, when there are unfavorable relationships of fractured segments of the mandible, it is necessary to provide an open approach for reduction and fixation. Fracture through a tooth root is often associated with nonviability of the tooth, and in these situations there is a need to remove the tooth. Loss of teeth on the side of the fracture tends to cause instability, and when this occurs, there is a need for internal or external fixation. For the severely atrophic jaw, repair requires either conservative reduction and fixation with splints or dentures, or reinforcement of the thin alveolus with bone grafts.

Treatment Strategies

The objectives of treatment are to restore preinjury occlusion and facial symmetry and contour. In addition, there should be a solid union, carefully avoiding complications such as infection, nonunion, or malunion. During the period of immobilization, adequate nutrition should be maintained.

The initial clinical evaluation should determine the overall medical condition of the patient. With this information, one should devise a plan to prepare the patient for definitive therapy. An adequate airway should be ensured and bleeding should be brought under control. Some mandibular fractures can lead to posterior displacement of the tongue; when this is recognized, the tongue should be pulled held forward with an oral airway. Intubation or tracheostomy may be necessary. Most bleeding can be controlled by digital pressure, but when it occurs from a major vessel injury, exploration and repair are indicated. All other associated injuries should be determined and prioritized for treatment. For injuries requiring urgent attention, appropriate medical and surgical services should be coordinated.

Most patients require tetanus toxoid, but if there is a suspicion that they have not been immunized and there are open wounds, passive immunization should be given in the form of Hyper-Tet (250 to 500 U) and arrangements made for subsequent active immunization. Prophylactic antibiotics such as penicillin should be used to prevent infection of bone and soft tissues. If the patient is having pain, the jaw can be temporarily stabilized with a Barton-type dressing.

Timing of definitive treatment is important and should be planned after the initial evaluation and care. Ideally a patient should undergo definitive surgery within 5 to 7 days, but an extension of time is indicated when vital signs are unstable or a correct diagnosis is still awaited. Surgical intervention should be planned with other procedures deemed necessary by the consulting services.

Definitive Treatment

Fractures of the mandible require reduction and fixation for 4 to 6 weeks, depending on the general health and age of the patient. Initially, the fracture is reduced and the patient placed into preinjury occlusion. The fracture is then fixed with a closed or open method. Selection of the appropriate procedure usually takes into consideration the age, nutritional status, and health of the patient; the state of dentition; the size of the mandible; the line and direction of the fracture; the number and sites of fracture; the displacement of the fracture; the degree of contamination; and any associated injury.

Restoration of Preinjury Occlusion

Regardless of whether the patient is a candidate for open or closed treatment, initial efforts should be directed toward restoration of occlusion. Available methods include, but are not limited to, circumdental wires and loops and intermaxillary fixation. Frequently the loop techniques are used as temporary measures, while intermaxillary fixation is often used as a means of continuous or long-term fixation.

The Ivy type of loop is probably the most popular simple method of applying a circumdental wire and loop. Although two adjacent teeth are needed for this technique, it is possible to apply a modification of the method to a single tooth. A small eyelet is first formed by twisting a 25-gauge wire around a No. 7 Fr. Frazier suction tip or the jaws of a small mosquito clamp. The free ends of the wire are inserted into the gap between two adjacent teeth, separated, and wrapped around the neck of the teeth. One length of the wire is brought back through the eyelet, and both wires are then twisted on each other and secured to the teeth. Additional tension is obtained by twisting down on the eyelet. Usually, at least one loop is applied to each set of molars, and the upper and lower jaws are held to each other in occlusion with rubber bands or No. 28 wires. Circumdental wires should be avoided on the incisor teeth, since too much stress can cause avulsion of these weakly held teeth from their tooth sockets.

Intermaxillary fixation by the arch-bar method requires extended operative time, but the technique provides more stable long-term fixation. For this method, a prefabricated arch bar (usually the Erich type) is bent and cut to fit the dental arch. The bar is secured to the teeth in an orderly sequence with 25-gauge wire ligatures. After starting with the first premolar on one side, the bar is secured to the first premolar of the opposite side and then to all the appropriate teeth on both sides. Incisors again should be avoided, especially when other teeth are present and can provide sufficient attachment of the bar. Wire ligatures should be placed between teeth, rather than through the interdental papilla, so as not to injure the periodontium. The wires should be wrapped around the arch bars in a diagonal fashion, but in dealing with canine teeth a modification is necessary to provide a horizontal ligature. Wires should be firmly twisted around the arch bar in a clockwise fashion, and kept close to the neck region of the tooth with a Freer elevator. Although prestretching of the wire may prevent loosening, additional tightening is often required and should be carried out at the end of the procedure. The wires should be cut long enough so that the ends can be twisted and turned back beneath the arch bar. Loose ends should be avoided, since they can cause irritation of the adjacent buccal mucosa.

Arch bars can be secured to each other with either rubber bands or 28-gauge wire. Rubber band fixation provides for gentle traction and dynamic reduction and fixation. Rubber bands can also be cut quickly if there is a need for emergency opening of the mouth, i.e. for vomiting during the postoperative period. Wire fixation methods can bring about a tighter and longer period of fixation and facilitate oral hygiene. The main disadvantage of the wire technique is that a wire cutter needs to be on hand to cut the wires if an emergency arises.

Other methods of intermaxillary fixation include non-continuous and continuous loops, and reinforced arch bars. These are a matter of personal preference and do not offer any substantial advantages. For more information regarding Kazanjian buttons and Gilmer, Essig, and Stout wires, appropriate sources should be consulted.

Closed Methods of Reduction and Fixation

Mandibular fractures can often be treated with one or several closed methods of reduction and fixation. The most popular method is intermaxillary fixation with arch bars or loops, but if the patient is edentulous the arch bar must be affixed to a denture or prefabricated splint. As an alternative, hooks can be affixed with acrylic cement.

Dentures or splints should be secured to the lower jaw with circum-mandibular wires and to the upper jaw with circum-zygomatic wires. For the circum-mandibular wire technique, a 24- or 25-wire is passed around the right body, left body, and symphysis of the mandible. The method requires that an awl or passing needle be first placed through a small stab incision beneath the jaw to the inside of the mandible. The wire is picked up or passed and brought out into the subcutaneous tissue. The awl or passing needle with wire is then advanced in a plane close to the periosteum of the mandible and seated with a sawing action. The wire is then secured to the denture or prosthesis through a small drill hole or groove on the occlusal surface.

For the circumzygomatic attachment, the awl or passing needle is passed beneath the zygoma into the upper labiogingival sulcus. The wire is brought around the zygomatic arch and passed back into the buccal sulcus. The wire is again seated with a sawing action and secured directly to the upper arch bar or denture, or indirectly with an intervening loop of lighter wire. For stabilization of the anterior portion of the upper denture, one must be certain to add a drop wire from the piriform aperture or anterior nasal spine to the denture or prosthesis at its midpoint. To achieve occlusion, rubber bands or wires are attached to the arch bars or, in the case of dentures or splints, to hooks or arch bars previously attached to the denture or prosthesis.

Open Method of Reduction and Fixation

Many techniques are available for open reduction and fixation. The traditional method is interosseous wire fixation, but in recent years internal and external rigid fixation techniques have become quite popular. With the open method, fracture sites are directly visualized, providing a direct approximation of the fractures.

Surgical Approaches

Exploration of the *condyle* is through either a Risdon (submandibular) or a preauricular incision. The Risdon incision is in a crease line several centimeters below the angle of the jaw; to avoid injury to the mandibular branch of the facial nerve, the nerve should be identified and preserved in its subplatysmal location. Elevation of the masseter muscle is necessary to achieve satisfactory exposure of the sigmoid notch and condylar process. For the preauricular approach, the incision should be placed in a crease line in front of or behind the tragus at a level just superior to the facial nerve. If the incision is to curve anteriorly as in the "hockeystick" variation, the incision should be kept posterior to the frontal branch of the facial nerve. The superficial temporal vessel should be ligated and the dissection carried out to the zygomatic arch. Using the zygoma as a guide, the elevation should be continued inferiorly to the lateral surface of the head of the condyle. The capsule should then be followed inferiorly to the condylar neck. Care must be exercised to avoid injury to the temporomandibular joint capsule and to the branches of the internal maxillary artery, which lies deep within the wound.

An external approach to the *angle and ascending ramus* of the mandible is similar to the Risdon method. Intraoral exposure is also possible by means of an incision just lateral and posterior to the molar region.

Open methods for the *body* require an incision in a crease line several fingerbreadths below the lower portion of the jaw. In approaching the body, one should again identify the mandibular branch of the facial nerve. In the submandibular region, the nerve usually travels below the mandible and between the fascial layers of the submandibular gland and platysma. Often the facial vessels (artery and vein) are in the field of dissection and need to be ligated.

For the *symphyseal* or *parasymphyseal* exposure, the dissection should be carried out under the anterior lower portion of the jaw. Here, the mandibular branch of the facial nerve has run superiorly and is out of the field. In this submental region the surgeon must avoid injury to the mental nerve that lies just beneath the canine and first premolar tooth. An intraoral approach 4 to 5 mm below the gingival margin is also possible, but this dissection comes very close to the mental nerve, which should be avoided by careful exposure and identification.

Open Techniques

Interosseous Wire Fixation. In applying interosseous wires, occlusion is obtained by intermaxillary fixation, and the fracture is exposed by an open technique. Fine adjustments are accomplished with Dingman or Lane bone forceps. Small drill holes for the wires are placed at right angles to the fracture and parallel to the lower border of the jaw. In children, one must be particularly careful to place the holes very close to the cortical margins so as to avoid injury to unerupted teeth. Sagittal split fractures of the mandible should be recognized and appropriately managed by proper placement of the hole through the full thickness of the jaw. Simple horizontal of figure-of-eight wires should be applied to maintain the reduction. Usually, drains are avoided and the wound is closed in anatomic layers.

Interosseous wires can also be placed by intraoral open techniques. For these methods, it is often necessary to use offset drills and passing awls. Intraoral methods avoid external skin incisions. Exposure is also quite good since the fracture lies just beneath the mucoperiosteum.

For the intraoral treatment of symphyseal and parasymphyseal fractures, the mandible is carefully degloved, avoiding the mental nerve. With an offset drill, holes are made to the side of the fracture just through the anterior cortex. The holes are then directed through the fracture site, and a 25-gauge wire is passed across the fracture. The wire is subsequently secured by twisting down on the outer cortex. The mucoperiosteal incision is closed with chromic catgut sutures.

For intraoral repair of angle fractures, a hole is drilled horizontally through the lingual and facial cortices. The wire is then passed around the body of the mandible with an awl, and tightened to reduce and fix the fragment.

Internal Plate Fixation. Various plating devices that provide internal fixation can also be used to repair the fracture. Rigid internal fixation is commonly obtained by a specially manufactured compression plate applied to the lower portion of the jaw. In this technique, occlusal relationships are first obtained, and an arch bar or tension bar is secured to the upper portion of the jaw in the region of the alveolar ridge. The design of the compression plate causes a sliding of the screws, which in turn pushes the mandibular fragments together. The superiorly placed tension band or arch bar keeps the upper portion of the jaw from distracting. Eccentric dynamic plates are also available and can be used for the combined horizontal and vertical compression.

Compared with interosseous wiring methods, compression plates require more exposure and there is thus a risk of extensive periosteal injury. On the other hand, the technique provides rapid healing and sufficient strength to remove intermaxillary fixation. Thus, the patient is able to eat and speak normally. Different-sized plates and designs are available. Some plates use a titanium stainless steel or chromium-cobalt alloy. Some systems require a tapping method for the screws placement; others provide a self-tapping screws.

Noncompression plates (Champy) are also available, but these use different principles in immobilizing the fracture. They are applied along force trajectories and lines of stress of the mandible. The plates must also be carefully applied to fit smoothly along the external contour of the jaw. Like compression plates, they offer the advantage of early jaw mobility and strength.

External Fixation. Rigid fixation can also be obtained by applying a fixation device external to the mandible. Several types of systems using pins or screws are available; the most popular method is the Joe Hall Morris biphase. For this technique, small drill holes are first placed on both sides of the fracture site and screw pins are secured to the inner cortex of the mandible. The jaw is reduced under direct visualization and the pins are held together temporarily with bars and universal joints. An acrylic bar is then manufactured from a quick-setting acrylic and placed over the end of the screws to harden. For fractures involving small fragments or fractures of the condylar neck, small Steinmann pins can be placed through the fragments and secured to the acrylic. Like internal rigid fixation, external rigid fixation provides for early jaw mobilization. The main disadvantages are the scars created by the incisions for the external pins, and the discomfort of wearing a bar externally to the jaw for 6 weeks.

Factors Affecting Open and Closed Methods

Fracture Site. In general, fractures of the coronoid process are treated by closed surgical techniques. Most condylar fractures, assuming that displacement is not severe and that there is sufficient posterior dentition to pull the fragment into a natural position, can also be managed by closed methods. Some nondisplaced subcondylar fractures, in the presence of satisfactory occlusion, can be treated with a soft diet and continued observation. However, if there is failure to achieve reduction or if there is persistence of an open bite (such as may occur with severely displaced fragments or bilateral condylar fractures), the condylar fracture should be treated with an open reduction and fixation. Many body and angle fractures can be managed by closed methods, especially when there is sufficient dentition and the fracture is located in a favorable line. On the other hand, angle fractures are often unstable and require open reduction. Parasymphyseal and symphyseal fractures also are usually unstable, and open techniques are desirable.

Fracture Patterns. The line of the fracture also dictates the method of choice. For example, fractures in favorable lines can be treated with closed methods, and fractures in unfavorable lines usually must be treated with open methods. Multiple fracture lines in one region or comminution of fractures with loss of bone create unstable situations; in these situations, the jaw should be stabilized with an open method.

Dental Status. Patients with good dentition are often candidates for closed techniques. Those who are edentulous or partially edentulous can be treated with closed methods, but usually a denture or splint is required. If dentures either are unavailable or fit poorly, splints can be manufactures. In the absence of dentures or splints, the open techniques become the procedure of choice.

Age. Since older patients often have an atrophic edentulous mandible, special techniques are needed for adequate fixation and reduction. The preferred course of treatment is a closed method or, at least, reinforcement with a bone graft. If there is a need to maintain nutrition and allow the patient to open the mouth, a method of internal and external fixation becomes desirable.

In children, injury to the developing teeth should be avoided, and thus closed methods are often preferable. The arch bar or Ivy loops should be secured only to those teeth that will not be extruded. Bernstein and McClurg advocated closed methods for condylar fractures in children, but suggested an open method for condylar fractures in young adults or teenagers.

Course of Healing. The choice of technique also depends on the course of healing. Some closed methods may not effect a desirable reduction and fixation, and another technique, usually an open method, must be administered. Patients should undergo x-rays postoperatively to ensure adequate positioning and fixation; if the treatment is not successful, additional measures should be carried out.

Decisions Regarding Internal and External Fixation. Internal and external rigid fixation techniques provide a means of obtaining normal jaw function during the period of healing. These methods are thus particularly appropriate in individuals in whom nutrition is important and early joint mobility desirable. They are also useful for comminuted fractures or loss of bone after gunshot injury. Rigid fixation has the advantage of providing sufficient stability in most unstable fractures.

One of the disadvantages of internal rigid fixation is the need for extensive dissection of the periosteum to place the plate and obtain the appropriate number of drill holes. The technique therefore is of limited use in patients with an atrophic mandible, and dangerous in children in whom developing teeth could be injured. Another disadvantage is that many plates require removal.

The external fixation device, the biphase, is not as accurate as the internal rigid plate method and does not provide compression. However, the technique is useful in bridging defects and pinning small fragments, such as a condyle. It is also useful in patients who have infection at the fracture site where stability is desirable and foreign material should be avoided.

Postoperative Care

Antibiotics should be given for 5 days after fixation and reduction of mandibular fractures, and the patient should be instructed in a course of oral hygiene and nutrition. Usually the teeth can be kept clean with gentle brushing or irrigation with a Water Pik. Nutritional supplements often need to be added to the diet. Postoperative radiographs should be obtained to ensure reduction. The patient should be seen in the office every 1 to 2 weeks to check on the adequacy of continued reduction and fixation.

At approximately 6 weeks (earlier for children, later for the elderly), fixation devices can be removed. The patient should be evaluated for pain, tenderness, and mobility of the fragments. If there is incomplete union, an additional period of fixation may be necessary to complete the healing process.

Complications

Nonunion

Nonunion is a condition that develops when all attempts to stimulate bone across the fracture site have failed. The term implies that there has been a long enough period of fixation and that scar tissue has grown into the fracture site, preventing growth of bone and apposition of bony fragments. This complication can be expected in about 2 to 3 per cent of all mandible fractures. Predisposing causes include inadequate reduction or immobilization, infection, or poor health associated with systemic disorders such as diabetes, cancer, and renal failure. Early treatment should consist of antibiotics, irrigation, debridement, and removal of foreign bodies such as nonviable tooth roots. Fixation should be continued for a longer period. Late treatment requires debridement of the edges of the mandible so as to obtain bleeding and prepare the recipient site for application of bone grafts from the iliac crest, rib, or outer cortex of skull. The healing mandible often has to be stabilized by plates, external fixation devices, or titanium crib grafts.

Malunion

When the mandible heals in a position different from the patient's normal occlusion, the condition is considered a malunion. Predisposing factors are inadequate reduction and fixation, treatment compromised by nonunion, and comminuted or multiple fractures of the jaw. Failure of the patient to cooperate may also be an important factor. A treatment plan for malunion requires a careful analysis including radiographs and dental models. Minor adjustments of the occlusion can be obtained by contouring the crowns of the teeth or by orthodontic therapy. When malunion is severe, the jaw needs to be osteotomized, reset to occlusion, and stabilized by appropriate fixation devices. Bone grafts may also be a necessary part of the procedure.

Temporomandibular Joint (TMJ) Ankylosis

Inability to open the mouth more than 5 mm suggests ankylosis. If the injury is confined to an area outside the TMJ, as seen with fixation of the coronoid to the zygoma or fixation of the angle of the jaw to the lateral pterygoid plate, the complication is called extracapsular ankylosis. Usually, however, the ankylosis is due to an abnormal growth of tissue within the joint and the development of bone within the joint capsule. Predisposing factors are TMJ fracture and long periods of fixation associated with other maxillary and mandibular fractures.

Contemporary treatment suggests that ankylosis can be prevented by early jaw motion. Children with TMJ injuries should have fixation devices removed from the jaws at 2 to 4 weeks, and then be engaged with active jaw exercises. If ankylosis develops, the jaws should be forced open by the application of an increasing number of tongue blades to the interincisal opening. Late ankylosis is not so easily reversed and surgery must be contemplated. In the extracapsular types, coronoidectomy or pterygoid plate resection may be necessary. When there is fixation within the TMJ, either the joint must be reconstructed with autografts or allografts, or the condyle will have to be removed (condylectomy) or released from the ramus and a new pseudojoint created in the subcondylar or ramus region.