Introduction

Of first concern when confronted with a facial injury is the general status of the patient, with particular attention being paid to hemorrhage and shock. The patient's wounds should be protected from further injury. There is some controversy as to whether or not the bony repair should precede or follow the soft-tissue repair. As a general rule, the soft-tissue wounds should be cleansed, debrided, and repaired and the reduction of the fracture postponed. The surgeon should search carefully for foreign material. It must be remembered that each fragment of bone is a potential center for osteogenesis, and therefore none that has a chance for survival is removed. Small fragments which are completely detached usually do not survive. On occasion, reduction and fixation can be accomplished prior to soft-tissue repair. If there is to be an interval between soft-tissue repair and the reduction and fixation of the fractures, certainly this should not be longer than a week. The patient is given prophylactic treatment for tetanus, and antibiotics. Anti-inflammatory enzymes are administered as indicated. It may be necessary to consult a neurosurgeon, ophthalmologist, and/or dentist.

The fractured bones should be stabilized with a Barton bandage in order to prevent further mobilization, and to reduce the pain and shock as well.

A tracheotomy is performed if there is any indication of impending airway obstruction.

The desired objectives of the treatment of facial fractures are based on the prevention of the following:

1. Abnormalities in the position of the eye and ocular motility.
2. Facial disfigurement.
3. Sensory and motor nerve dysfunction.
4. Dental malocclusion.
5. Nasal obstruction.
6. Interference with sinus drainage.

The examination should include a search for the following signs and symptoms:

2. Ecchymosis: subconjunctival, circumorbital, and intra-oral.
3. Epistaxis: anterior and posterior.
4. Deformities: obvious and by palpation.
5. Eyes: ocular motility, diplopia, displacement, and pupillary function.
6. Sensory nerve function: infraorbital nerve and distribution of other branches of the second division of the fifth cranial nerve.
7. Malocclusion.
8. Trismus.
11. Tenderness and pain.
12. Evidence of infection: in the wound; sinus infection (a suppurating hematoma of the antrum).

**Nasal Fractures**

An accurate history of previous injuries or operations, as well as of the injuring force, is important. X rays are taken and should include the Waters' projection, lateral view, and a projection of the nasal bones from above, obtained by placing a dental x-ray film in the mouth, just under the hard palate.

**Simple Nasal Fracture**

**Anesthesia.** Local anesthesia can be used for the reduction of most simple nasal fractures. A local anesthetic agent should be placed at three sites. (1) Injection at the root of the nose will block distribution to the nose from the orbital nerves. (2) Injection in the upper lip, just inferiorly to the columella, and laterally on each side from this point, will block infraorbital nerves. (3) The sphenopalatine ganglion may be blocked by placing cotton pledgets, saturated with 4% cocaine or a like topical anesthetic agent, in the superior, middle, and inferior meatus of each nasal cavity. These pledgets should be left in placed for approximately 5 minutes and then be replaced by additional cocaine-impregnated cotton pledgets. Some prefer to block the sphenopalatine ganglion on each side by way of the greater palatine foramen.

**Technique of Reduction.** The instruments used for reduction of a nasal fracture are a straight round-end elevator, Ashe forceps, and Walsham forceps. Simple depressed fractures of the nasal bones can usually be elevated into place with a straight elevator, with the operator using the index finger of his left hand, if he is right-handed, or that of the right hand (if he is left-handed) for palpation.

Fractures of the nasal bones, in which difficulty is encountered in manipulating the fragments in place, may be reduced by placing one blade of either the Ashe or Walsham forceps inside the nose on the under surface of the nasal bone, while the other blade remains external on the outer surface of the nasal bone. Manipulation, tested by digital palpation, will result in proper placement of the fractured segment.

If there is deviation of the entire nasal structure to one side and buckling of the nasal septum, one blade of the Ashe forceps is inserted into each nasal cavity. The first manipulation with the forceps in this position is in an antero-superior direction, while the external nose is palpated and manipulated with the operator's fingers. The nasal pyramid is then returned to its midline position, and any buckling of the nasal septum is corrected.

Simple nasal fractures do not require intranasal packing. If, on the other hand, the nasal bones are severely comminuted and unstable, careful nasal packing, with either aureomycin ointment-impregnated iodoform gauze or finger-cot packing, will support the
fragments until they are fixed in place. Occasionally it is necessary to also use external splinting such as that employed following a rhinoplasty.

Certain nasal fractures, especially those associated with dislocation or buckling of the nasal septum, cannot be reduced by the closed techniques. Treatment should consist of open reduction and one of the various rhinoplasty techniques.

**Compound Nasal Fractures**

Many nasal fractures are compounded by either external or internal lacerations. The external wounds should be carefully debrided and the nasal fractures reduced, as has been described. Internal and external splinting is required quite frequently.

**Nasomaxillary Fractures**

A severe blow to the anterior aspect of the nose may result in a deformity often referred to as "the smashed nose." When severely depressed, many of these fractures cannot be dealt with by closed reduction, internal packing, and external splinting. These fractures often involve the ascending process of the maxilla, the nasal bones, the ethmoid bone, and the nasal process of the frontal bone. A fracture of the roof of the ethmoid sinuses or cribriform plate can be associated with "the smashed nose" and a resultant cerebrospinal fluid rhinorrhea. The nasolacrimal apparatus may also be injured.

An excellent way of treating these fractures is by the use of two pieces of 24-gauge, stainless-steel wire and lead plating. The nasal bones are elevated and held in position by an assistant while the stainless-steel wire is passed through the skin, a fracture line, the nasal septum, and out by way of a fracture line on the opposite side. By using a heavy straight needle, an attempt is made to place these sutures at approximately the junction of the nasal bone and the ascending process of the maxilla, one of them just below the nasal process of the frontal bone and the second approaching the inferior aspect of the nasal bones. The wire sutures are placed through lead and silicone sheetings which have been fashioned to the size and contour designated by the problem at hand. Intranasal packing may also be necessary for support. Since contamination is likely in this location, it is very important to use aureomycin-impregnated, 1-inch iodoform gauze for the intranasal packing. This packing can be removed at the end of 5 days; the external splints should remain in place approximately 10 days.

**Fracture of the Zygomatic Bone (Zygoma or Malar Bone)**

The zygomatic bone articulates with the temporal bone, frontal bone, the greater wing of the sphenoid bone, and the maxillary bone. Essentially, it forms the prominence of the cheek. It also forms a portion of the lateral and inferior rim of the orbit, the lateral wall of the orbit, and the zygomatic arch.
**Signs and Symptoms**

The signs and symptoms of fracture of the zygomatic bone are:

1. Flattening of the upper cheek.
2. Diplopia.
3. Limited ocular mobility.
4. Paralysis in the distribution of the infraorbital nerve.
5. Subcutaneous emphysema.
6. Epistaxis (bleeding from the antrum).
7. Trismus.

**Diagnosis**

Flatness of the face may be quite obvious. On the other hand, if edema and hematoma are present, flattening may be temporarily masked. The infraorbital rim is carefully palpated. The "stepping-off" deformity or notching of the infraorbital rim is characteristic of this fracture. Sensation is tested over the nose, cheek, and upper lip and compared with that in the uninjured side. Since the thinnest bone is in the region of the infraorbital foramen, the infraorbital nerve is quite often involved. The zygomatic arch is carefully palpated. This may be depressed. Pain or limited motion of the mandible is indicative of a depression of the zygomatic bone on the underlying coronoid process. Escape of air into the soft tissues may produce periorbital emphysema or proptosis. The crepitation is characteristic of zygomatic bone fracture.

The patient is tested for diplopia and extraocular motility. Diplopia is present in approximately 10% of the subjects. It is probably due to displacement of the lateral palpebral ligament. This ligament is not necessarily detached, but rather is carried away from its normal position by the displaced zygoma.

Transillumination of the sinuses will usually demonstrate limited or no transillumination of the antrum on the involved side. Lack of transillumination is due to edema of the mucosal lining of the sinus and the presence of blood. X rays will also demonstrate filling of the maxillary sinus and possibly air in the orbit or in the surrounding tissues. They will show the position of the fragments and displacement of the parts, but must not be relied on entirely for exact positioning or diagnosis.

**Treatment**

In a small group of these fractures there is no significant displacement and no therapy is required. Most fractures of the zygomatic bone are the result of a direct blow over the malar prominence which produces posterior and medial displacement of the bone. Other zygomatic fractures have accompanying lateral or medial rotation. With a lateral rotation, the inferior orbital rim is displaced downward; with medial rotation, the inferior orbital rim is displaced upward.

If, when the patient is first seen, severe edema and ecchymosis are present, it probably does no harm to wait until these have subsided, when reduction will be more easily
accomplished. As a rule, it is not possible to reduce fractures later than 3 weeks following their occurrence.

**Indirect Reduction** (Keen Method). In this method, reduction is accomplished by way of the gingivo-buccal sulcus. A small incision is made in the buccal mucosa behind the maxillary tuberosity. A curved elevator is inserted behind the tuberosity of the maxilla and the necessary force is applied to manipulate the displaced malar bone into its proper position. The manipulation can be guided externally by the operator's hand that is not holding the elevator. Often reduction of the fracture is effected easily and effectively by this method. Some surgeons object to this procedure because of the possibility of contaminating the field of the fracture. A cowcatcher splint, made of throat sticks, is all the dressing necessary.

**Temporal Route** (Gillies Method). Strong and effective force can be implemented through this approach. An incision is made at or above the hairline over the temporal fascia. The elevator must be passed *through* the temporalis fascia, but not through the temporalis muscle. The temporalis muscle proceeds inferior to, and attaches itself to, the coronoid process of the mandible. The elevator will be improperly directed if it is positioned either external to the fascia or deep to the temporalis muscle. The operator's hand not used for directing the instrument can be used for assisting with the manipulation.

**Intranasal Technique** (Shea Method). A nasoantral window is made in the inferior meatus in the usual fashion. A large, curved trocar is inserted into the antrum. With this leverage and with external palpation, the fractured bone can be manipulated into place.

**Transantral Route** (Lothrop Method). A Caldwell-Luc incision is made. A heavy, curved elevator is introduced into the antrostomy opening in the canine fossa. If the fragment(s) is not stable, the maxillary sinus can be packed with aureomycin-impregnated, 1-inch, iodoform-gauze stripping. The end of the packing is introduced into the nasal cavity through the nasoantral window. The packing is very effective in stabilizing the fractured bone, thus making this route more practical than the transnasal approach. A layer of Gelfoam above the packing will ensure against a sharp bony fragment becoming attacked to the packing.

**Open Reduction.** All displaced fractures in which it is either impossible to manipulate the fragments into position or the fragments are unstable after reduction must be treated by open reduction and internal wire fixation. The most practical places for intraosseous wiring are in the region of the zygomaticofrontal suture line, the infraorbital rim, and the medial aspect of the zygomatic arch. These areas are approached by incisions in the skin lines superior to the outer canthus, below the infraorbital rim, and over the zygomatic arch. Holes are drilled with a small bur after the fracture has been reduced and stabilized. Instruments such as the Kocher forceps, the Lahy thyroid clamp, and towel clips are useful for this manipulation. Usually, 26-gauge wire is suitable for fixing the fragments. The wire is tightened by twisting. After cutting the wire, it is important to bend the end flush with the surface of the surrounding bone.

If all methods of reducing an old fracture are unsuccessful, the malar deformity and floor of the orbit are repaired by using autogenous bone grafts. The bone can be obtained from the iliac crest; on occasion, however, the nasoseptal cartilage and bone or the anterior wall of the antrum will provide sufficient material for the graft.
Kirschner Wire Technique. Kirschner wires, which come in three diameters (0.62, 0.45 and 0.35 inch), can be drilled into bone without making a dermal incision. The wire must not extend more than 2 inches beyond the chuck of the drill in order to prevent bending and misdirection. An unstable zygoma, after simple reduction by the above-described methods, can be fixed by drilling a Kirschner wire through its body, across the nose, and into the opposite malar bone, while the fragment is held in the proper position. The wire is then cut off 0.5 inch from its entrance point and is covered with sterile cork.

Fractures of the Zygomatic Arch

The diagnosis of a mandibular arch fracture is usually not difficult, for there is pain in this region which is aggravated by talking and chewing. Trismus may be present. Motion of the mandible may be limited. The symptoms are caused by the contact of the medially displaced zygomatic arch with the coronoid process and the temporalis muscles. The depressed fracture of the zygomatic arch can be seen as a depression in this area and is easily palpated.

Method of Reduction

A fracture of the zygomatic arch, without displacement of a fragment, can be treated by elevation with a heavy bone hook. A small incision is made over the center of the arch at the point of maximum depression. The hook is inserted beneath the arch from below, and the fracture is reduced by lateral traction.

The Gillies technique may be used to reduce a fracture of the zygomatic arch, especially when it is combined with a malar fracture.

Open reduction wiring of a zygomatic arch fracture is frequently necessary. This open reduction is accomplished through a horizontal incision over the zygomatic arch. The fragment ends are drilled and wired with #26-gauge stainless-steel wire.

Midfacial (Maxillary) Fractures

Midfacial fractures should be treated as early as possible in order to restore normal function and acquire a good cosmesis. The objectives of therapy are to obtain normal dental occlusion and facial contour and to prevent infection.

During the immediate post-injury period, attention should be directed toward maintenance of an adequate airway and the control of infection. If the airway is impaired by pharyngeal edema or displaced by bony support, a tracheotomy should be performed. Severe hemorrhage from the internal maxillary artery or one of its terminal branches is not uncommon in association with a midfacial fracture. This hemorrhage is controlled by local packing. If this is not successful, ligation of the internal maxillary artery or external carotid artery should be considered.

If the patient is seen shortly after the accident, the reduction of the midfacial fracture is usually not difficult unless the bone is severely comminuted or infection is present. On occasion, reduction of a fracture is delayed either because of the patient's neglect or because
of an associated or severe injury, such as a cervical spine fracture or trauma to the intracranial structures. In these instances, granulation tissue and fibrosis interferes with reduction. It may be necessary to expose the fracture line and separate the malfixation with an osteotome. There are a number of methods to accomplish fixation of midfacial fractures:

1. Intramaxillary fixation with a Barton bandage, when the midfacial fracture is both stable and not displaced.
2. Intermaxillary fixation, using arch bars or wiring artificial dentures in place.
3. Open reduction and wiring of fracture segments.
4. Wire slings from the zygoma, inferior orbital rims to the teeth, or arch bars.
5. Internal pin fixation.

**Classification of Midfacial Fractures**

*The Le Fort I* is a lower midfacial fracture. It may be unilateral or bilateral. The fracture line is transverse through the lower maxilla and into the lower nasal cavity. The resulting segment of the maxilla includes the teeth, a portion of the maxillary sinus, the hard palate, and, on occasion, the lower segment of the pterygoid plates. There may be an associated vertical fracture, usually in the midline, dividing the lower midface into two segments.

*The Le Fort II* fracture line passes through the nasal bone, lacrimal bone, floor of the orbit, inferior orbital rim, and across the upper portion of the maxillary sinus and pterygoid plates to the pterygomaxillary fossa. Fractures of the cribriform plate and roof of the ethmoid sinuses, with spinal fluid rhinorrhea and damage to the lacrimal system, may occur with this fracture.

*The Le Fort III* is a complete separation of the facial bones from their cranial attachments. The fracture line extends across the suture line between the nasal bones and the nasal process of the frontal bone, along the ethmoid junctions with the frontal bone, and across the supraorbital fissure, the lateral wall of the orbit, and the frontomaxillary and zygomaticomaxillary suture lines. The Le Fort III fracture is usually associated with multiple fractures producing the "dish-face" deformity. It is commonly associated with intracranial complications such as spinal fluid leaks by way of the roof of the ethmoid sinuses and cribriform plate.

**Specific Treatment**

*Le Fort I.* Stable fractures of the lower midface which are not displaced can be treated by using a snug Barton-type dressing. This treatment is effective even when the patient is toothless and wears dentures. When the patient has dentures the maxillary denture is applied and adjusted so that it is in occlusion with either the lower teeth or the lower denture. Intermaxillary fixation is carried out for 2 days, by using a Barton-type bandage or a head cap
with a chin support. The patient is placed on a liquid diet for 2 weeks. At the end of this period the fracture is usually well healed.

When occlusion is perfect and the fracture segment does not move with palpation, the Barton-type bandage may be omitted. The patient, however, should be placed on a liquid diet for a period of 2 weeks.

Intermaxillary fixation must be applied when dental occlusion is not perfect.

Loose teeth should be considered. Most often a loose tooth, unless very unstable, will become fixed in place without treatment. If a tooth is very loose, it is wired to adjacent teeth with a #26-gauge stainless-steel wire. A dental arch bar is applied and wired in place to stabilize a number of loose teeth when there are fractured segments of alveolus. In the latter instance it is necessary also to apply a mandibular arch bar and rubber bands for intermaxillary fixation to ensure proper dental occlusion.

On occasion there is loss of a portion of the maxillary alveolus with exposure of the maxillary sinus. This must be treated as an oroantral fistula. A packing in the maxillary sinus with its ends protruding into the nasal cavity through an oroantral window is essential in these cases.

A fractured alveolar segment in an edentulous patient may be handled in one of the following ways:

1. A good reduction and positioning of the segment may be accomplished by inserting the dentures and securing immobilization with a Barton bandage.

2. The fracture line is exposed and the segment is fixed in place by direct wiring.

3. The alveolar segment may be fixed by inserting a Kirschner wire after proper repositioning of the fractured segment.

**Vertical Fractures with Le Fort I.** In a vertical fracture associated with a lower midfacial fracture, if there is no displacement, no specific therapy is necessary. When the vertical fracture line is either separated or displaced and the patient has upper teeth, one side of the arch bar is applied and wired and place, and the vertical fracture is reduced. The opposite side of the arch bar is then wired in place. If the teeth are widely separated in the anterior midline, they should be wired together before the dental arch bars are applied. The application of a mandibular arch bar and intermaxillary fixation are necessary to ensure good dental occlusion.

Direct exposure of the fracture line in the wiring of the fragments is the treatment of choice when confronted with a vertical fracture in which there is separation of the segments and the patient's upper jaw is edentulous. A Kirschner wire may be used to pin a unilateral segment, consisting of a Le Fort I and a vertical segment, to the stable opposite side. If there are bilateral segments, each may be pinned to the opposite zygoma. An unstable fragment in a bilateral Le Fort I fracture, with or without a downwardly displaced vertical fragment, may require a combination of the application of dental arch bars and wire sling support from the
infraorbital rim or the zygomaticofrontal suture line, or both. A small skin incision is made over the zygomaticofrontal suture line or infraorbital rim and a long segment of #25-gauge stainless-steel wire is inserted through a drill hole. Both of the ends of this wire are inserted into a #16 or #18 spinal needle. The needle is passed from the infraorbital rim down along the front face of the maxillary sinus to the alveolar ridge. The ends of the wire are grasped from below and the needle removed. One end of the wire is placed behind, and the other in front of, the arch bar. The fracture is reduced and the ends of the wires twisted. For posterior support the needle containing the two ends of the wire is passed medial to the zygomatic arch and along the lateral surface of the maxilla to the alveolar ridge. Again the ends of the wire are grasped from below and the needle is removed. Following the fracture reduction the ends of the wire are secured to the posterior aspect of the dental arch bar.

**Le Fort II Fracture.** In the Le Fort II fracture, undisplaced and stable fragments are treated conservatively as has been described for Le Fort I fractures. A superiorly displaced segment is rocked loose and pulled inferiorly. Downward traction and restoration of normal dental occlusion can be accomplished by intermaxillary fixation with arch bars and rubber bands. In a unilateral Le Fort II fracture, stabilization can be secured with a Kirschner pin directed through the stable fragment and into the stable opposite side.

A Le Fort II fracture in which the segments are displaced downward is much less stable and difficult to manage. It is approached by direct wiring and the application of dental arch bars and wire slings from the inferior orbital rim or zygomaticofrontal suture line.

**Le Fort III Fracture.** It is difficult to outline specific methods for reduction and fixation of the Le Fort type III fracture, for there are usually multiple fracture lines and other associated facial fractures. Whenever possible the fracture lines are approximated superiorly and the fragments are wired in place. The pinning technique is not usually feasible. The application of a wire sling from the zygomaticofrontal region to a maxillary arch bar is often necessary in addition to intermaxillary fixation.

**Fractures of the Orbit**

During this past decade the incidence of orbital fractures has increased along with automobile accidents. The advent of the seat belt may have had much to do with the increase in the numbers of orbital fractures, for, as an automobile suddenly decelerates during a crash, the head of the driver is thrust forward, and the face strikes either the steering wheel or the dashboard. Such an accident is the cause of approximately 50% of orbital fractures. The human fist accounts for about 20%, while a ball, a human elbow, or a fall on the face account for approximately 25% each. The remaining 5% are due to various unusual accidents.

**Anatomy**

In order to understand the mechanism of the orbital fracture, certain anatomic relationships must be reviewed. The lateral wall of the orbit is formed by the frontal process of the zygomatic bone and the greater wing of the sphenoid bone. This wall is rather thick and quite sturdy. The orbital process of the frontal bone forms the orbit's superior wall. This also offers good support. The anterior wall is formed by the lamina papyracea and the lacrimal bone. The lamina papyracea, as its name implies, is quite thin, but is fairly well
supported by the ethmoid cell partition. The floor of the orbit is formed by the orbital process of the maxillary and zygomatic bones and extends backwards and upward on an inclined plane. A very thin area of bone is located immediately anterior to the inferior orbital fissure. The orbital floor is further weakened by the canal through which the infraorbital nerve passes. The orbit is conical in shape. A blow to the orbit will displace its contents posteriorly, resulting in the blow-out type of fracture. This usually occurs in the thin area that is just anterior to the inferior orbital fissure. Orbital fracture may, of course, occur in other areas, the second most common being the medial aspect of the floor of the orbit in the region of the infraorbital canal or of the lamina papyracea.

**Signs and Symptoms of Orbital Fracture**

**Enophthalmos.** Fractures of the orbit may result in varying degrees of enophthalmos, which, when in excess of 5 mm, is disfiguring. It may not be apparent immediately after the injury because of edema or hemorrhage. As would be suspected from our knowledge of the anatomy of the orbit, there are a number of mechanisms or combinations thereof responsible for enophthalmos:

1. There may be an escape of orbital fat into the maxillary sinus along with the fracture of the floor of the orbit. This may occur with the comminuted fracture or the hinged, or so-called "trapdoor", fracture. In some instances the maxillary sinus has been found to be filled with this orbital fat.

2. The inferior rectus or inferior oblique muscles may herniate into the antrum and be entrapped by bony fragments in a blow-out fracture.

3. Atrophy of the orbital fat may occur subsequent to injury or infection.

4. Enophthalmos may also occur as a result of fracture and downward displacement of a major portion of the orbital floor, including the inferior orbital rim. This situation is usually associated with more complex fractures of the malar and zygomatic bones.

**Exophthalmos.** Occasionally, the orbital floor is fractured and displaced upward, causing exophthalmos. In such fractures the inferior orbital rim is usually involved. The force causing this type of fracture has been applied over the anterior wall of the maxillary sinus, just inferior to the inferior orbital rim.

**Diplopia.** Disturbance in eye muscle function is a relatively common finding in patients with fracture of the floor of the orbit, because the most common site of the blow-out type of fracture is in that portion of the floor which is weakened by the infraorbital canal or groove. The inferior oblique muscle arises from the orbital floor near the lateral margins of the lacrimal groove, and the inferior rectus muscle is located, in direct relation with the infraorbital canal, on the inferior aspect of the orbital contents.

The inferior oblique and inferior rectus muscles are those involve with disturbances in oculomotor function associated with fractures of the floor of the orbit. The site of the fracture and entrapment of these muscles has much to do with the clinical picture. If the muscle is entrapped anterior to the equator of the globe, the involved eye will be fixed in a
downward position. The oculomotor imbalance will not be greatly marked with downward gaze but much exaggerated with upward gaze. If the muscle is entrapped posterior to the equator of the globe, the involved eye will be fixed in the elevated position. In these instances, the oculomotor imbalance will not be marked with upper gaze and exaggerated with downward gaze. If the inferior rectus muscle is entrapped at the level of the equator of the globe, the involved eye will appear normal in the primary position but will remain fixed when downward or upward gaze is attempted. In fractures of the floor of the orbit lateral to the infraorbital canal, oculomotor function is rarely affected.

The branch of the third cranial nerve supplying the inferior rectus muscle courses along the lateral border of this muscle and enters the inferior oblique muscle at approximately the point where the two muscles cross. Injury to these branches of the third cranial nerve, especially the inferior oblique branch, can be associated with fractures of the floor of the orbit and the manifestations of such injury must be differentiated from those due to muscle entrapment.

Transient diplopia may be associated with fracture and dislocation of the zygoma. This is most commonly seen when the bone has been displaced as a single fragment. It is caused by hemorrhage and edema which produce superior displacement of the orbit.

**Facial Asymmetry.** Facial asymmetry is not the usual finding in patients with blow-out fractures of the orbital floor. It is typical, however, when the fracture involves the inferior orbital rim or in fracture-dislocation of the zygoma.

**Sensory Nerve Injury.** Hypoesthesia or anesthesia of the areas supplied by the infraorbital nerve may be associated with fracture of the floor of the orbit. Either manifestation is positive indication that the fracture involves the infraorbital canal or groove. Disturbance in the function of the infraorbital nerve associated with an intact orbital rim is indicative of an orbital floor fracture involving the infraorbital groove or canal. Anesthesia of the infraorbital nerve is positive indication for exploration and decompression.

**Ocular Complications.** There are a number of ocular complications which can occur in association with orbital fracture:

1. Subconjunctival hemorrhage and ecchymosis of the lids are the usual findings following blunt trauma to the orbit. They are transient and only rarely complicated by cicatricial entropion.

2. Corneal abrasion may occur, but is not common because the lids are usually closed at the time of injury.

3. Injury to the pupil and iris may produce mydriasis or iridodialysis.

4. The lens may be dislocated anteriorly or posteriorly; this can be complicated by iridocyclitis, secondary glaucoma, or corneal edema.
5. Hyphema (hemorrhage into the anterior chamber of the eye) is not uncommon in this type of injury. It usually clears in a few days but may be complicated by secondary glaucoma, pigmentation of the cornea, or heterochromia of the iris.

6. Glaucoma may well be the most common ocular complication following orbital injury producing a fracture. The increase in intraocular pressure may not occur for weeks or even years after the injury.

7. Injury to the retina may be associated with fracture of the floor of the orbit. Edema of the retina is common and usually transient.

**Diagnosis**

Diagnosis of a fracture of the floor of the orbit with a resultant disturbance in eye muscle function, facial asymmetry, enophthalmos, infraorbital nerve injury, or other complication is not difficult. On the other hand, this fracture can be overlooked when it is associated with devastating bodily injuries which require immediate lifesaving measures. Also, the symptoms can be masked by edema, hemorrhage, ecchymosis, and hematoma. On occasion, the defect may not become apparent for a number of weeks after the initial injury.

Certainly a patient with a history of injury to the orbit, a unilateral enophthalmos, disturbance of eye muscle function, and anesthesia or hypoesthesia of the infraorbital nerve associated with an intact orbital rim should be considered to have a blow-out fracture of the orbit. A break in the continuity of the orbital rim makes the diagnosis quite obvious.

Entrapment of the inferior oblique or inferior rectus muscle is diagnosed by testing the patient's gaze in the vertical plane. The diagnosis is confirmed by the traction test, which is carried out as follows: The conjunctiva is anesthetized with a drop of topical anesthetic solution. The tendon of the inferior rectus muscle is grasped through the sclera with a tooth forceps. Entrapment of the muscle is demonstrated by a restriction of ocular excursion.

X rays are of extreme value in diagnosing fractures of the floor of the orbit. The Waters view gives a good picture of the contour of the floor of the orbit and rim in relation to the maxillary sinus. The Caldwell view also demonstrates the floor of the orbit. The typical picture is that of depression of the floor of the orbit with prolapse of orbital contents into the antrum. A maxillary sinus filled with blood may mask these findings. There may also be a fracture in the lamina papyracea or the ethmoid bone, subcutaneous emphysema, or demonstration of air in the orbit. Antero-posterior laminograms of the orbit are quite useful in diagnosing fractures of the floor of the orbit.

**Treatment**

Indications for surgical treatment for fracture of the floor of the orbit are (1) the presence of enophthalmos; (2) a disturbance in the eye muscle function manifested by diplopia; (3) facial deformity; and/or (4) a persistent anesthesia in the distribution of the infraorbital nerve.
Operation is performed with the patient under general anesthesia. The patient’s entire face is prepared so that the surgeon may have access to the floor of the orbit by way of the antrum as well as through an infraorbital incision. The side of the face to be operated upon is draped but the other side is left exposed so that it can be used for comparison.

The degree of enophthalmos is determined by comparison with the unaffected orbit. The oculomotor muscle function is tested with toothed forceps for forced duction of the eye muscles. The freedom of motion of each muscle is tested and compared with the motion of the opposite normal side.

Fracture of the floor of the orbit, especially when the patient is treated within two or three weeks following the accident, can quite often be satisfactorily reduced by way of the maxillary sinus. The anterior wall of the maxillary sinus is exposed by using the Caldwell-Luc incision. The peristemeum is elevated from the entire front face of the maxillary sinus, so that the infraorbital nerve and foramen may be examined. The size and contour of the maxillary sinus are determined by viewing the x-ray film. The anterior wall is carefully removed with a small cutting bur. It can be used as a bone graft to the floor of the orbit. Sufficient exposure is necessary for viewing the floor of the orbit from below and also for the insertion of a finger for palpation of the fracture.

Prior to reduction of the floor of the orbit with a finger in the maxillary sinus, it is useful to reduce the enophthalmos from above by using traction sutures of #4-0 silk passed around the tendons of the superior and inferior oblique muscles. This accomplishes two things: (1) it will usually free an entrapped muscle, and (2) it provides additional space for replacement of the orbital contents and elevation of the floor of the orbit. In most instances, when the orbital contents are replaced and the fracture reduced, the orbital contents and the floor of the orbit remain in place. Whether or not the orbital floor remains in good position, the antrum should be packed. This is a requisite especially when the fracture is associated with discontinuity of the orbital rim or a depressed fracture of the malar bone. A layer of Gelfoam is placed against the roof of the antrum so that the packing will not become adhered to or involved with a spicule of bone. The entire antrum is then packed with aureomycin-impregnated conforming gauze, the end of which projects into the nasal cavity through a nasoantral window. The Caldwell-Luc incision is sutured in the usual fashion.

The infraorbital approach to the floor of the orbit is used in those cases in which reduction is not readily attained by the inferior approach. The incision for this approach is made in the natural skin fold of the lower lid, approximately 3 mm below the margin of the tarsal plate. It is extended obliquely downward in its lateral portion. The skin is elevated from the orbicularis oculi muscle for a distance of approximately 3 mm below the incision. At this point the orbicularis oculi muscle is split longitudinally. The orbital septum is followed downward to the point where it is inserted into the inferior orbital rim. The periosteum is incised along the rim and elevated from the floor of the orbit. The floor of the orbit can be exposed by gradually inserting an orbital retractor; while this is being done a finger in the antrum often facilitates the maneuver and aids in reducing the herniated orbital contents and replacing the bony fragments. Traction on the sutures around the insertions of the inferior and superior rectus muscles is also helpful at this time. There are a number of grafts and substances which can be utilized to support the orbit when there is a badly comminuted fracture of the orbital floor. These include iliac bone grafts, the anterior wall of the antrum,
the nasal septum, fascia lata, and silicone rubber sheeting. As with any similar procedure, use of autogenous material offers the best chance for success and for avoiding complications. The iliac bone graft is taken from the inner aspect of the ilium. The cortical surface of the bone should face upward.

If an additional space-occupying substance is needed, especially in an old fracture with marked increase in the over-all size of the orbit, fascia lata may be placed superior to the bone graft in order to further support the orbital contents and eliminate the enophthalmos.

**Anesthesia of the Infraorbital Nerve.** If there is complete anesthesia of the infraorbital nerve distribution, and the fracture is found to involve the infraorbital canal and foramen, a decompression procedure is in order. This is carried out by way of the infraorbital incision. A block of bone which includes the superior rim of the infraorbital canal is removed. The nerve is carefully dissected and decompressed and the block of bone replaced.

**Fractures of the Mandible**

Fractures of the mandible are the most common type of facial fracture. This is to be expected, taking into consideration the position of the jaw in relation to the remainder of the skull. Management of these fractures is most important not only for cosmesis, but also for dental occlusion and mastication.

**Anatomy**

In order to evaluate and treat a fracture of the mandible properly, knowledge of the anatomy of the mandible and its surrounding structures is essential. Familiarity with the origin, insertion, and direction of pull of the various muscles of the mandible makes evaluation of any particular fracture with reference to its displacement and determination of the best method for reduction and immobilization relatively simple.

**Muscles of the Mandible.** There are three groups of muscles which provide the variety and versatility of mandibular function. These are the elevators, the depressors, and the protrusors.

*Elevators of the Mandible.* The *masseter* muscle extends from the zygomatic arch to the lateral surface of the mandible. Its insertion covers most of the lateral surface of the coronoid process, ramus, and angle of the mandible. The masseter muscle elevates the mandible.

The *temporal* muscle arises in the temporal fossa, descends medial to the zygomatic arch, and inserts on the medial surface on the coronoid process. It both elevates and retracts the mandible.

The *medial pterygoid* muscle arises from the pterygoid fossa and the pyramidal process of the palatal bone and is inserted on the medial and inferior surface of the ramus at the angle below the mylohyoid groove. It elevates the mandible by exerting a force in an upward, forward, and inward direction.
Depressors of the Mandible. The *geniohyoid* muscles originate from the body of the hyoid and insert on each side of the midline into the postero-inferior aspect of the mandible. They pull the anterior mandible inferiorly.

The tendon joining the anterior and posterior bellies of the *digastric* muscle is attached, but not fixed, to the hyoid bone by a pulley made of deep cervical fascia. The anterior belly inserts into the digastric fossa on the inner surface of the mandible. The digastric muscle depresses and pulls back the anterior mandible.

Protrusors of the Mandible. The *lateral pterygoid* muscle originates with two heads, one from the lateral pterygoid process, and the other from the greater wing of the sphenoid bone. It inserts into the anterior surface of the neck of the mandible. It pulls the head on the mandible forward medially. The lower fibers exert a downward pull on the head of the mandible.

The *mylohyoid* muscle extends from the mylohyoid line in the median raphe. It does not influence mandibular function other than when there is a fracture of the symphysis or anterior body regions. Under these circumstances, it either brings the fragments together or causes overriding of the fracture.

Diagnosis of Mandibular Fracture

The diagnosis of fracture of the mandible is not difficult to make when there is a history of injury to the jaw and the following signs and symptoms are present:

1. Swelling, ecchymosis, or laceration of the skin overlying the mandible or the intraoral mucous membranes.

2. Pain. Following fracture of the mandible, pain due to injury of the inferior alveolar nerve, mandibular periosteum, and soft tissue can be quite severe. Pain also may be the result of entrapment of the muscles between fragments and/or muscle spasms.

3. Anesthesia. There may be anesthesia of one side of the lower lip, alveolar ridge, and teeth when the inferior alveolar nerve is injured or sectioned. This is indicative of a fracture of the body of the mandible.

4. Tenderness elicited by either external or intraoral palpation.

5. Malocclusion. Any dislocation associated with fracture of the mandible will produce at least a degree of malocclusion which is noted by the patient. The patient will not only complain that his teeth do not meet properly, but also will be able to indicate the site of dislocation. The patient with dentures will complain that he is unable to insert them and that attempts to do so are painful.

6. Mobility and crepitation. Manipulation of the mandible will elicit mobility at the site of the fracture. This mobility often produces crepitation. In the edentulous patient, on intraoral palpation a ridge may be detected at the site of the fracture.
7. Malfunction. Complaints of abnormal and painful chewing are not uncommon. There may also be some interference with speech.

8. Impairment of the airways. Severe fracture of the mandible with displacement, hematoma, ecchymosis, and edema of the soft tissues renders the patient unable to cope with his salivary secretions and bleeding. There can be a complete obstruction of the airways necessitating an emergency tracheotomy.

**Classification of Mandibular Fractures**

The Dingman classification is both practical and simple. The mandible is divided into seven regions: body, symphysis, angle, ramus, coronoid process, condylar process, and alveolar process. The management of fractures of each of these areas will be discussed separately.

**Dingman classification of mandibular fractures:**

1. The region of the **body** is that portion of the mandible between a vertical line drawn between the canine and first premolar teeth, extending to the anterior border of the attachment of the masseter muscle (20% of mandibular fractures).

2. The **symphysis** area is that portion of the mandible between the symphysis and mentum and a vertical line drawn beneath the canine and first premolar teeth (15% of mandibular fractures).

3. The region of the **angle** is defined as that portion of the mandible lying underneath the attachment of the masseter (20% of mandibular fractures).

4. The **ramus** of the mandible is that portion below the coronoid process, above the posterior border of the insertion of the masseter muscle (3% of mandibular fractures).

5. The **coronoid process** is that portion above a line which extends downward and forward from the inferior aspect of the sigmoid notch (2% of mandibular fractures).

6. The **condylar process** is that portion of the mandible superior to, and separated from, the ramus by a line drawn posteriorly and slightly inferiorly from the inferior aspect of the sigmoid notch (35% of mandibular fractures).

7. Fractures of the **alveolar process** involve the teeth and the alveolar process immediately inferior (5% of mandibular fractures).

**General Treatment of Mandibular Fractures**

For the proper management of the mandibular fracture, certain factors and principles must be observed. Usually the patient can describe the severity, direction, and force of the blow that caused the fracture. This information is of value in determining the site and severity of the bone injury.
Whether or not there is displacement of the fractured bone must be determined. The site of the fracture can be ascertained roughly by palpation and manipulation, but more accurately by x rays.

The direction of the fracture line is often important. For example, in a fracture in the region of the body extending downward and forward from the molar region the segments are relatively stable and are not likely to be displaced because of muscular action. In a fracture in the same region extending downward posteriorly from the molar region the segments are unstable and are quite apt to be displaced.

The bevel of a fracture is also important. If the edges of the bone in a fracture of the body are beveled in an anteromedial direction, the posterior segment will be displaced medially. If they are beveled in the opposite direction the mandible will be rendered stable by the muscle pull.

In general, with a knowledge of the origins and insertions of the muscles and ligaments attached to the mandible, along with knowledge of the location and direction of the fracture, the surgeon should be able to predict quite accurately the degree and direction of displacement.

Multiple fractures of the mandible are quite common. Each fracture should be considered separately.

It is important to determine whether or not a tooth is involved in the fracture line. As a rule, the presence of teeth render the fracture segments more stable that they would be in the edentulous mouth. On occasion a tooth may become displaced and interposed between the fracture segments, making reduction difficult and necessitating the tooth's extraction.

If the patient is edentulous or partially so, it is important to learn whether or not he has a denture. If the denture has been broken at the time of injury, it should be repaired immediately so that it can be used for both splinting and immobilization of the mandible.

Mandibular fractures do not necessarily require immediate reduction. It is often wise to wait several days so that other injuries may be evaluated, x-ray studies may be made, as indicated, and measures may be instituted for reduction of the swelling and prevention of infection.

Since a fracture of the mandible must be considered to be compounded, broad-spectrum antibiotic therapy is instituted along with oral hygiene. Elevation of the patient's head, placing him in the semi-sitting position, and the application of cold compresses should assist in the reduction of swelling. Immobilization, with a Barton bandage, will stabilize the fragments temporarily, prevent further displacement and bleeding, and also help to control muscle spasms and pain. X rays should include the antero-posterior views, right and left lateral views, and intraoral occlusal views.
Fractures of the Body of the Mandible (20%)

The body of the mandible is that portion delineated by a vertical line, drawn posteriorly between the canine and first premolar teeth and the anterior border of the attachment of the masseter muscle.

Treatment. In fractures of the body of the mandible the segments are either stable or unstable. In a fracture extending downward and forward from the molar region the segments are relatively stable, and, because of muscle action they are unlikely to be displaced. In a fracture of the body extending downward and posteriorly from the molar region the segments are likely to be unstable and displaced. Most fractures through the body of the mandible occur in patients with teeth and can be managed by closed reduction and intermaxillary fixation with arch bars and rubber bands. In a stable fracture of the body of the mandible the segments can be immobilized by wiring together two teeth on each of the fracture line. If the fragments are displaced inferiorly, or if the widest separation of the fracture line is inferior, then open reduction and inferior interosseous wiring is the treatment of choice. If the widest separation is superior, then the interosseous wiring is placed below the alveolar ridge, by the intraoral route.

Considerable displacement occurs with bilateral fractures through the body of the mandible. The anterior fragments are pulled downward and the posterior fragments are displaced upward and medially. Bilateral open reduction, interosseous wiring, and intermaxillary fixation are required. It may be necessary to use intramedullary pinning or a metal plate to stabilize a comminuted fracture of the mandibular body.

Open Reduction. A 4-cm incision is made at least 1 cm below the inferior border of the mandible. The center of the incision is placed over the fracture line and the dissection is carried through the platysma to the underlying fascia. The mandibular branch of the facial nerve is superficial to this fascia and must be avoided. Usually the facial artery and vein can be identified. These are ligated and reflected upward along with the fascia, thus preventing injury to the marginal mandibular branch of the facial nerve. The dissection is carried directly to, and through, the periosteum on the inferior border of the mandible. The periosteum is elevated medially and laterally on both sides of the fracture line. Granulation tissue, small bone fragments, and entrapped muscle must be removed from the fracture site.

In a fracture running from the outer to the inner surface of the mandibular body in an oblique direction, it is best to place wire around the inferior margin of the mandible and through a single drill hole which includes both fragments.

In order to accomplish a restoration of exact occlusion, intramaxillary fixation with arch bars and rubber bands is usually necessary in a patient with teeth. In a fracture through the body of the mandible in an edentulous patient, with artificial dentures, stabilization may be attained by circumferential wiring, which includes both the body of the mandible and the denture. Postoperative oral hygiene is extremely important with this type of fixation. The fracture is reduced and the segments held in place by wiring through either two or four drill holes. These drill holes are made less than 1 cm superior to the inferior border of the mandible in order to avoid the mandibular canal and mandibular branch of the fifth cranial
nerve. After twisting the wire it is cut to the length of approximately 5 mm, bent at right angles, and tucked into one of the drill holes.

Interosseous wiring through four drill holes is used when the fracture segments are quite unstable.

The periosteum is carefully approximated, the subcutaneous layers are closed with #4.0 chromic catgut suture material, and the skin is closed with #5.0 silk or plastic material. A Penrose drain may be inserted if there has been gross contamination or if there is a possibility of continued bleeding and hematoma formation. In either case, postoperative antibiotic therapy is essential.

**Intraoral Reduction of Any Edentulous Fracture.** The superior aspect of the fracture line can be readily identified by the stepping effect at the fracture line, which is easily palpated on the alveolar ridge. An incision is made along the superior aspect of the lateral alveolar ridge posterior to the fracture line. It is continued anteriorly and inferiorly over the body of the mandible, so that a flap of tissue including all layers of the bone can be reflected inferiorly and superiorly. The periosteum is elevated over the inner and outer aspect of the alveolar process on each side of the fracture line. Drill holes are made 0.5 cm below the crest of the alveolar ridge. It is best to place a retractor or elevator medial to the mandible when making the drill holes so that the soft tissues will not be injured. A #25-gauge stainless-steel wire is passed into one drill hole and out the opposite one so that it can be twisted on the lateral surface of the mandible. The medial surface of the mandible must be inspected to make certain that a loop of wire does not remain here. The twisted end of the wire is cut and tucked into one of the bur holes. It is important to place this wire 0.5 cm below the alveolar crest so that it will not interfere with the proper fitting of an artificial denture.

In a supero-inferior oblique fracture in an edentulous mandible the fragments can be immobilized by circumferential wiring.

In severely comminuted fractures an intramedular pinning technique or the application of a metal plate may be required.

**Fractures of the Mandibular Symphysis**

The portion of the mandible designated as the symphysis is the region between the symphysis menti and a vertical line drawn between the canine and first premolar teeth. Approximately 15% of mandibular fractures occur in this area.

**Treatment.** Only a small percentage of these fractures appear in the exact midline. These are handled easily, for these is usually no displacement of the segments. A mandibular arch bar is sufficient for immobilization.

A fracture of the region of the symphysis is usually oblique, is often accompanied by a condylar fracture, and the fragments are generally displaced. If the fracture is easily reduced by manipulation, intermaxillary fixation with arch bars is employed. Otherwise it is necessary to approach the fracture line directly and to utilize an open reduction.
The incision for open reduction is made 1.5 cm behind the inferior border of the mandible. This site is important, for a scar anterior to it will be quite noticeable. If there is edema and ecchymosis at the time of the operation, the exact placement of this incision is difficult. Some surgeons prefer to mark the line of incision preoperatively with the patient in the erect position.

The incision should be 1.5 to 2 inches in length. It is carried through the platysma, directly to the inferior border of the mandible. A slight anterior retraction of the incision may be necessary for this dissection. All bleeding is controlled with electrocoagulation.

As soon as the inferior border of the mandible is approached, the fracture line should be easily palpable. The periosteum of the inferior border of the mandible is incised on each side of the fracture line. The periosteum is elevated on the anterior aspects of the mandible on each side of the fracture line. It is also necessary to elevate the periosteum in the posterior aspect of the mandible. In so doing, the anterior attachment of the belly of the digastric muscle is detached. The dissection is continued until both ends of the fracture are clearly viewed.

Bone chips and granulation tissue are removed. Muscle that has become trapped in the fracture line must be dissected free.

The fracture is reduced by using bimanual manipulation and also with the aid of bone forceps. If the reduction is simple and the segments do not tend to be unstable after the reduction, a hole is drilled through the mandible on each side of the fracture line. The mandible is then wired with #24 or 26 stainless-steel wire. The twisted end is buried in one of the drill holes. The wound is closed without drainage by carefully approximating all layers. Hemostasis is imperative.

If the fracture line is oblique, it may be best to drill a hole directly through both fragments and twist the wire below the inferior margin of the mandible, rather than place a drill hole on each side of the fracture line. Once the open reduction has been completed the upper and lower arch bars are applied for intermaxillary fixation.

A fracture of the symphysis in an edentulous patient is somewhat more difficult to stabilize, especially when the fracture line runs obliquely, supero-inferiorly. Four holes are dripped for a figure "8" wiring. It also may be necessary to place a wire around the entire symphysis. This can be accomplished by inserting the wire through a #18 or #19 spinal needle and inserting it first anteriorly around the symphysis and then, after threading the other end of the wire into the spinal needle, around the posterior surface of the mandible. The wire is twisted antero-superiorly.

Mandibular Fracture in the Region of the Angle (20%)

The region of the angle is defined as that portion of the mandible lying underneath the attachment of the masseter muscle. It is not uncommon for a fracture in this region to be accompanied by a fracture of the body of the mandible on the opposite side. Subcondylar fractures are also commonly associated with an angle fracture.
If there is no displacement or only slight displacement of the fragments, intramaxillary fixation with arch bars and rubber bands is the treatment of choice. Open reduction is accomplished by either the external or intra-oral approach and wire fixation. As a general rule, the intra-oral approach is used with the edentulous patient and is carried out as has been described for fractures of the mandibular body.

The extra-oral open reduction should be accomplished in patients with teeth. A 4-cm incision is made 1.5 cm below the angle of the mandible. Dissection is carried through the platysma and then superiorly through the inferior border of the mandible. The masseter muscle is identified and incised along the inferior margin of the mandible. The periosteum is incised anteriorly and posteriorly through the fracture line, and elevated both anteriorly and posteriorly. When making the drill holes it is important to protect the soft tissues posteriorly with either a retractor or an elevator. The wiring is accomplished as has already been described. Figure "8" wiring may be necessary when the fragments are unstable. If a molar tooth interferes with proper reduction of the fracture, it must be extracted. Intermaxillary fixation with arch bars and rubber bands may or may not be necessary in addition to the open reduction.

Mandibular Fractures in the Region of the Ramus (3%)

The ramus of the mandible is that portion below the coronoid process and neck of the mandible, above the posterior border of the insertion of the masseter muscle.

Fractures of the ramus are uncommon because of the thickness of this structure and the protection afforded it by the masseter, temporalis, and medial pterygoid muscles. They represent only 3% of all mandibular fractures. The fragments are usually adequately immobilized by intramaxillary fixation. This holds true even when a fracture of the ramus is associated with other fractures of the mandible.

Mandibular Fractures of the Coronoid Region (2%)

The coronoid process is divided from the ramus by a line extending downward and forward from the inferior aspect of the sigmoid notch. Fractures through the coronoid process are quite rare and represent only 2% of all mandibular fractures. Probably the reason for this is that the coronoid process is protected by the overlying zygomatic arch and the masseter muscle. Fractures of the coronoid process are caused either by direct trauma or by sudden contraction of the temporalis muscles.

Usually fractures of the coronoid process do not require any specific surgical intervention because of the splinting effect of the temporalis and masseter muscles. If the fracture interferes with dental occlusion, intramaxillary fixation will be necessary.

Fractures of the Condylar Process of the Mandible (35%)

The condylar region is that portion of the mandible superior to, and separated from, the ramus by a line drawn posteriorly and slightly inferiorly from the inferior aspect of the sigmoid notch. The region is divided into a neck and an articular head.
Fractures in the condylar region are most often caused by indirect force, for this area is well protected by the zygomatic process and the muscles and ligaments associated with the temporomandibular joint. Fractures in the condylar region represent 35% of mandibular fractures. For the most part these fractures occur either above or below the insertion of the lateral pterygoid muscle.

Fractures in the condylar region can be diagnosed by depressions caused by a premature closure of the bite on the involved side. These depressions are due to an upward pull of the elevators of the mandible and result in an open-bite deformity in an anterior direction on the opposite side. There may be edema and ecchymosis over the temporomandibular joint region. Tenderness is usually elicited in this area. There is pain in the region of the temporomandibular joint or ear with motion of the jaw. A bilateral fracture in the condylar region will result in an open-bite deformity due to premature contraction of the molars. This is caused by overriding of the fracture segments and contraction of the elevators of the mandible. In bilateral fractures, the patient is usually unable to protrude the mandible for these fractures occur below the level of the attachment of the lateral pterygoid muscle.

As a general rule, fractures of the condylar process should be treated by intramaxillary fixation with arch bars and rubber bands. A satisfactory occlusion and good function will usually result even when the fragments heal and are malpositioned. After the arch bars have been applied the operator's thumb is placed over the lower mandibular molar teeth and inferior pressure is exerted. At the same time the fingers of the operated are used to apply external pressure superiorly against the anterior mandible. By so doing the open-bite deformity can often be immediately corrected and the teeth brought into good occlusion using intramaxillary fixation. If this is not possible, rubber bands are applied to the arch bars and the teeth will usually fall into good occlusion within a day or two.

Open Reduction of Condylar Fractures. Open reduction is indicated in the adult, edentulous patient with bilateral subcondylar fractures with an open-bite deformity, and in children in whom there is a considerable degree of separation in the fracture line so as to interfere with the growth center of the condyle. The incision for open reduction of the condylar process is in the immediate preauricular region, beginning at the root of the helix and extending inferiorly to the inferior aspect of the tragus. The dissection is conducted along the anterior surface of the conchal cartilage to the fascia over the temporomandibular joint. This incision and approach avoid injury to the facial nerve, superficial temporal artery, and internal maxillary artery. The fascia over the temporomandibular joint is incised, the fracture line is identified, and the periostem is elevated away from the fracture line.

A second incision is made 1 cm posteriorly and below the angle of the mandible. The masseter muscle is exposed. The periosteum over the angle of the mandible is incised, and elevated medially and laterally. A drill hole is made through the angle of the mandible and a #25-gauge stainless-steel wire inserted through this. This wire is left long and grasped with a needle holder or heavy hemostat so that downward pressure can be exerted on the ramus. By using this traction wire, the mandible is pulled inferiorly. A periostemel elevator is inserted to elevate the periosteum on the postero-medial aspect of the ramus of the mandible. The periosteal elevator is held behind the fracture line to protect the soft tissues, and a drill hole is made through each fragment. A long piece of wire is placed through the drill holes and
grasped by a hemostat, which has been inserted from below along the postero-medial aspect of the ramus of the mandible. The two ends of the wire are pulled through the incision at the angle of the mandible and twisted from the point. Scissors are inserted through this same route to cut the twisted ends of the wire.

It may be necessary to carry out open reduction of the condylar process bilaterally. Intramaxillary fixation by arch bars and rubber bands is also necessary.

Fractures of the Alveolar Region

Fractures of the alveolar process involve the teeth and the alveolar process immediately inferior to them. These fractures may be an extension of fractures occurring in other regions or they may occur independently. In some cases a large segment of alveolar bone may be displaced by a direct blow.

Since soft-tissue damage is usually associated with this type of fracture, the mucous membrane must be carefully re-approximated after the reduction has been accomplished. In alveolar fractures, immobilization may be accomplished by wiring the teeth of the fractured segment to adjacent teeth, or by applying an arch bar. As a general rule, it is probably best to use arch bars and rubber bands to establish intramaxillary fixation and good dental occlusion.

Postoperative Management

Oral hygiene is essential when intra-oral apparatus or wiring has been employed. The patient should keep his teeth and gums as clean as possible and free from foreign material. This can be done with the aid of an Asepto syringe and warm saline solution. A small toothbrush may also be useful for removal of debris.

Antibiotics are usually administered, because any fracture of the mandible should be considered as being compounded. They can be given in a liquid form or by the intramuscular route, and their use should be continued for at least one week.

Proper nutrition is essential. A high-protein diet with vitamin and mineral supplements is administered. With the advent of blenderized meals this is not the problem that it was in the past.

It is important to place the patient in a semi-sitting position and to apply cold compresses during the first day or two following either the injury or the operation.

A careful follow-up of the patient is imperative, with examinations at approximately one-week intervals at which time the intramaxillary fixation apparatus is inspected. It may be necessary to tighten wires or to readjust their ends in order to protect the soft tissues. The rubber bands may become weakened or broken and should be replaced when necessary.

Approximately 4 weeks after the reduction the rubber bands are removed from the arch bars and the stability of the mandible is tested. If the mandible feels stable, the patient is instructed to return in a few days. At this time, if his teeth are still in good alignment, the
arch bars are removed. If at the end of 4 weeks the fracture does not feel stable or if the teeth are not in good occlusion, the rubber bands are replaced for 2 additional weeks. If a tooth has been involved in the fracture line, it is best to leave the intermaxillary fixation in place for 8 weeks.