Facial Trauma, Mandibular Fractures

Introduction

Mandible fractures are a frequent injury because of the mandible’s prominence and relative lack of support. As with any facial fracture, consideration must be given for the need of emergency treatment to secure the airway or to obtain hemostasis if necessary before initiating definitive treatment of the fracture.

History of the Procedure

The first description of mandibular fracture was as early as 1650 BC, when an Egyptian papyrus described the examination, diagnosis, and treatment of mandible fractures. Many patients received either improper treatment or no treatment and, subsequently, died. Hippocrates was the first to describe reapproximation and immobilization through the use of circumdental wires and external bandaging. The importance of establishing proper occlusion first was described in a textbook written in Salerno, Italy, in 1180. Maxillomandibular fixation was first mentioned in 1492, in an edition of the book Cirugia printed in Lyons. Chopart and Desault used dental prosthetic devices to immobilize fracture segments.1

Most fracture treatment, however, involved some form of external bandage or wrap, occasionally used in conjunction with a bridle wire, until the 19th century, when Gilmer reformed the treatment of fractures by fixated full arch bars on the mandible and the maxilla. In 1888, Schede was the first to use a solid steel plate held by 4 screws for fixation.2

The technique of rigid internal fixation was developed and popularized by Arbeitsgemeinschaft fur Osteosynthesefragen/Association for the Study of Internal Fixation (AO/ASIF) in Europe in the 1970s. The basic principles of the AO, outlined by Spiessl, call for primary bone healing under conditions of absolute stability.2 Rigid internal fixation must neutralize all forces (tension, compression, torsion, shearing) developed during functional loading of the mandible to allow for immediate function. This is accomplished by interfragmentary compression plates. Use an inferior border plate to counter compression forces and a superior border plate or arch bars to counter traction or tension forces at the superior border.3

AO reconstruction plates also impacted the management of comminuted and infected mandibular fractures; Ellis reported a 7.5% infection rate in treatment of mandibular angle fractures with an AO reconstruction plate without intermaxillary fixation (IMF).5

During the same time that Spiessl was expounding the AO doctrine, Champy et al in France were developing the concept of adaptive osteosynthesis. Champy advocated transoral placement of small, thin, malleable, stainless steel miniplates with monocortical screws along an ideal osteosynthesis line of the mandible. Champy believed that compression plates were unnecessary because of masticatory forces that produce a natural strain of compression along the inferior border.2

These 2 changes of AO rigid internal fixation and the Champy method of monocortical miniplates revolutionized the treatment approach to mandibular fractures. Many fractures previously treated with closed reduction or open reduction with wire osteosynthesis are now commonly treated with open reduction with plate and screw fixation. An example of this evolution is the treatment of comminuted mandibular fractures. These were thought to be treated best by closed reduction to minimize stripping of the periosteum of small bone fragments. Although this treatment modality is still used, rigid fixation now enables the clinician to avoid closed reduction with the use of reconstruction plates and good soft tissue coverage.5

Frequency

Numerous investigators have reported studies on populations on all continents; fractures of the mandible have been reported to account for 36-70% of all maxillofacial fractures.3,10-12 All reports apparently show a higher frequency in males aged 21-30 y.3,10 Other contributing factors, such as socioeconomic status, environment, alcohol use, and mechanisms, show greater variability.3,13

Etiology
Major etiologic factors vary based on geographic location. Investigators in countries such as Jordan, Singapore, Nigeria, New Zealand, Denmark, Greece, and Japan reported motor vehicle accidents to be the most common cause; in reports from other countries such as Greenland, Finland, Scotland, Sweden, Bulgaria, and Canada found assaults to be the most common etiology.

Results in the United States have been divided. In 1982, Olson and associates demonstrated that vehicular accidents caused 48% of fractures. In 1985, Fridrich and associates demonstrated that altercations accounted for 47% of fractures and automobile accidents for 27%. Also in 1985, Ellis et al reported that 43% were caused by vehicular accidents, 34% were caused by assaults, 7% were work-related, 7% occurred as the result of a fall, 4% occurred in sporting accidents, and the remainder had miscellaneous causes.

Vaillant and Benoist described 14 cases of gunshot injuries to the mandible; 2 children had injuries that resulted from accidents, and the adults’ fractures were caused by suicide or assault.

**Location of mandibular fractures**

Fridrich and associates showed that most fractures occur in the body (29%), condyle (26%), and angle (25%) of the mandible. The symphyses account for 17% of mandibular fractures, whereas fractures of the ramus (4%) and coronoid process (1%) have lower occurrence rates. In automobile accidents, the condylar region was the most common fractured site. In motorcycle accidents, the symphysis was fractured most often. When assault was the cause, the angle demonstrated the highest incidence of fracture.

**Associated injuries with mandibular fractures**

Fridrich and associates reported that in patients with mandible fractures, 43% of the patients had an associated injury. Of these patients, head injuries occurred in 39% of patients, head and neck lacerations in 30%, midface fractures in 28%, ocular injuries in 16%, nasal fractures in 12%, and cervical spine fractures in 11%. Other injuries present in this group were extremity trauma in 51%, thoracis trauma in 29%, and abdominal trauma in 14%. Of the 1067 patients studied, 12 (2.6%) died of their associated injuries before the mandible fracture could be treated.

**Number of fractures per mandible**

In patients with mandible fractures, 53% of patients had unilateral fractures, 37% of the patients had 2 fractures, and 9% had 3 or more fractures.

**Pathophysiology**

**Classification of mandibular fractures**

- Simple or closed - Fracture that does not produce a wound open to the external environment, whether it be through the skin, mucosa, or periodontal membrane
- Compound or open - Fracture in which an external wound, involving skin, mucosa, or periodontal membrane, communicates with the break in the bone
- Comminuted - Fracture in which the bone is splintered or crushed
- Greenstick - Fracture in which one cortex of the bone is broken and the other cortex is bent
- Pathologic - Fracture occurring from mild injury because of preexisting bone disease
- Multiple - Variety in which two or more lines of fracture on the same bone are not communicating with one another
- Impacted - Fracture in which one fragment is driven firmly into the other
- Atrophic - Fracture resulting from severe atrophy of the bone, as in edentulous mandibles
- Indirect - Fracture at a point distant from the site of injury
- Complicated or complex - Fracture in which considerable injury to the adjacent soft tissues or adjacent parts occurs; may be simple or compound

Classification by anatomic region

- Symphysis - Fracture in the region of the central incisors that runs from the alveolar process through the inferior border of the mandible
- Parasymphyseal - Fractures occurring within the boundaries of vertical lines distal to the canine teeth
- Body - From the distal symphysis to a line coinciding with the alveolar border of the masseter muscle (usually including the third molar)
- Angle - Triangular region bounded by the anterior border of the masseter muscle to the posterosuperior attachment of the masseter muscle (usually distal to the third molar)
Right mandibular body fracture. Left mandibular angle fracture going through tooth #17.

- **Ramus** - Bounded by the superior aspect of the angle to two lines forming an apex at the sigmoid notch

Right mandibular ramus and left mandibular parasymphyssis fractures.

- **Condylar process** - Area of the condylar process superior to the ramus region

Right mandibular condylar fracture.

- **Coronoid process** - Includes the coronoid process of the mandible superior to the ramus region
- **Alveolar process** - Region that normally contains teeth
Mandibular sagittal symphysis fracture and dentoalveolar fracture.

The effect of muscle action on the fracture fragments is important in classification of mandibular angle and body fractures. Angle fractures may be classified as (1) vertically favorable or unfavorable and (2) horizontally favorable or unfavorable. The muscles attached to the ramus (masseter, temporal, medial pterygoid) pull the proximal segment upward and medially and the symphysis of the mandible is displaced inferiorly and posteriorly by the pull of the digastric, geniohyoid, and genioglossus muscles.

The muscular forces acting upon the mandible.

When the fractures are vertically and horizontally unfavorable, the fragments tend to be displaced.

An "unfavorable" angle fracture with distracting muscular forces.

Conversely, these same muscles tend to stabilize the bony fragments in horizontally and vertically favorable fractures.
A "favorable" body fracture with muscular force not tending to distract the fracture.

Condylar fractures are classified as extracapsular, subcondylar, or intracapsular. The lateral pterygoid tends to cause anterior and medial displacement of the condylar head. Five types of condylar fractures are described in order of increasing severity:

- Type I is a fracture of the neck of the condyle with relatively slight displacement of the head. The angle between the head and the axis of the ramus varies from 10–45°.
- Type II fractures produce an angle from 45–90°, resulting in tearing of the medial portion of the joint capsule.
- Type III fractures are those in which the fragments are not in contact, and the head is displaced medially and forward. The fragments are confined within the area of the glenoid fossa. The capsule is torn, and the head is outside the capsule.
- Type IV fractures of the condylar head articulate on or in a forward position with regard to the articular eminence.
- Type V fractures consist of vertical or oblique fractures through the head of the condyle.

Presentation

History

- A complete medical and psychiatric history is important for diagnosis and future treatment of mandible fractures.
- Thoroughly explore possible bleeding disorders, endocrine disorders, or bony and collagenous disorders prior to surgery.
- History of previous mandibular trauma can help prevent misdiagnoses.
- Any pretraumatic temporomandibular joint dysfunction needs to be documented in detail prior to treatment.
- The source, size, and direction of traumatic force are helpful in diagnosis.
  - Fractures sustained by a fist tend to have single, simple, or nondisplaced fractures whereas patients involved in motor vehicle accidents sustain compound comminuted fractures.
  - Localized trauma (eg, pipe, stick, hammer) tends to cause a single comminuted fracture since the force is concentrated in a small area.
  - Trauma distributed to a larger surface area may cause several fractures (eg, symphysis, condyle) secondary to distribution of the force throughout the mandible.
  - Direction of the force can help in making the diagnosis of concomitant fractures. Trauma directed to the chin often results in a symphyseal fracture with concomitant unilateral or bilateral condylar fractures.

Clinical examination

- Advanced trauma life support protocol
  - Note facial lacerations, swellings, and hematomas. A common site for a laceration is under the chin, and this should alert the clinician to the possibility of an associated subcondylar or symphysis fracture.
From behind the supine or seated patient, bimanually palpate the inferior border of the mandible from the symphysis to the angle on each side. Note areas of swelling, step deformity, or tenderness.

Note areas of paresthesia, dysesthesia, or anesthesia along the distribution of the inferior alveolar nerve. Numbness in this region is almost pathognomonic of a fracture distal to the mandibular foramen.

Standing in front of the patient, palpate the movement of the condyle through the external auditory meatus. Pain elicited through palpation of the preauricular region should alert the clinician to a possible condylar fracture.

Observe any deviation on opening of the mouth. Classically, deviation on opening is toward the side of the mandibular condyle fracture. Note any limited opening and trismus that may be a result of reflex muscle spasm, temporomandibular effusion, or mechanical obstruction to the coronoid process resulting from depression of the zygomatic bone or arch.

Changes in occlusion are highly suggestive of a mandibular fracture. A change in occlusion may be due to a displaced fracture, fractured teeth and alveolus, or injury to the temporomandibular joint.

Look for intraoral mucosal or gingival tears. Floor of the mouth ecchymosis may indicate a mandibular body or symphyseal fracture.

If a fracture site along the mandible is suggested, grasp the mandible on each side of the suspected site and gently manipulate it to assess mobility.

Indications

The indications for closed versus open reduction have changed dramatically over the last century. The ability to treat fractures with open reduction and rigid internal fixation (ORIF) has dramatically revolutionized the approach to mandibular fractures.\(^31\)\(^32\)

Traditionally, closed reduction (CR) and ORIF with wire osteosynthesis have required an average of 6 weeks of immobilization by maxillomandibular fixation (MMF) for satisfactory healing. Difficulties associated with this extended period of immobilization include airway problems, poor nutrition, weight loss, poor hygiene, phonation difficulties, insomnia, social inconvenience, patient discomfort, work loss, and difficulty recovering normal range of jaw function. In contrast, rigid and semirigid fixation of mandible fractures allow early mobilization and restoration of jaw function, airway control, improved nutritional status, improved speech, better oral hygiene, patient comfort, and an earlier return to the workplace.\(^33\)\(^34\)\(^12\)

Schmidt et al\(^35\) and Shetty et al\(^36\) performed financial analysis comparing patients treated with closed reduction and MMF with those treated with ORIF, and found, at least within the patient population at risk for mandible fractures, that the closed treatment was more cost-effective.

Indications for closed reduction

- Nondisplaced favorable fractures: Open reduction carries an increased risk of morbidity, thus use the simplest method to reduce and fixate the fracture.
- Grossly comminuted fractures: Generally, these are best treated by closed reduction to minimize stripping of the periosteum of small bone fragments.
- Fractures in children involving the developing dentition: Such fractures are difficult to manage by open reduction because of the possibility of damage to the tooth buds or partially erupted teeth.\(^37\) A special concern in children is trauma to the mandibular condyle.\(^38\) The condyle is the growth center of the mandible, and trauma to this area can retard growth and cause facial asymmetry. Early mobilization (7-10 d of intermaxillary fixation) of the condyle is important. If open reduction is necessary because of severe displacement of the fracture, the use of resorbable fixation or wires along the most inferior border of the mandible may be indicated.
- Coronoid fractures: These fractures usually require no treatment unless impingement on the zygomatic arch is present.
- Treatment of condylar fractures: This is one of the more controversial topics in maxillofacial trauma.\(^39\) Indications for open reduction are discussed below. If condylar fractures do not fall within this criteria, they can be treated with closed reduction for a period of 2-3 weeks to allow for initial fibrous union of the fracture segments. If the condylar fracture is in association with another fracture of the mandible, treat the noncondylar fracture with ORIF, and treat the condylar fracture with closed reduction.
Indications for open reduction

- Displaced unfavorable fractures through the angle of the mandible: Often, the proximal segment is displaced superiorly and medially and requires an open technique for proper reduction.\textsuperscript{43}
- Severely atrophic edentulous mandibles: These have little cancellous bone remaining and minimal osteogenic potential, and fracture healing may be delayed. Ellis and Price advocate an aggressive protocol of ORIF with rigid fixation and acute bone grafts.\textsuperscript{42} They demonstrated no complications with this approach, despite the advanced age and medical comorbidities of this patient population.\textsuperscript{42}
- Complex facial fractures: Such fractures can be reconstructed best after open reduction and fixation of the mandibular segments to provide a stable base for restoration.
- Condylar fractures: Although strong evidence supporting open reduction of condylar fractures is lacking, a specific group of individuals benefit from surgical intervention. The classic article by Zide and Kent lists absolute and relative indications for open reduction of the fractured mandibular condyle.\textsuperscript{43} Palmieri et al\textsuperscript{44} and De Riu et al\textsuperscript{45} demonstrated better long-term range of motion and occlusion in patients with condylar fractures treated with ORIF versus closed reduction and MMF.
  - Absolute indications
    1. Displacement of the condyle into the middle cranial fossa
    2. Inability to obtain adequate occlusion by closed techniques\textsuperscript{46}
    3. Lateral extracapsular dislocation of the condyle
  - Relative indications
    1. Bilateral condylar fractures in an edentulous patient when splints are unavailable or impossible because of severe ridge atrophy

Mandibular fracture. Coronal CT scan demonstrating bilateral high condylar fractures.

2. Unilateral or bilateral condylar fractures when splinting is not recommended because of concomitant medical conditions or when physiotherapy is not possible
   3. Bilateral fractures associated with comminuted midfacial fractures
- Mandibular nonunions require open access for debridement and subsequent reduction.\textsuperscript{47}
- Malunions after improper reduction often require osteotomies through open surgical approaches to correct mandibular discrepancies.\textsuperscript{48}

Relevant Anatomy

The mandible is a U-shaped bone; the middle portion is termed the symphysis. The horizontal body of the mandible bears the tooth-bearing alveolar process. Distally, the horizontal body of the mandible joins the vertical ramus at the angle. The ramus has both the coronoid and condylar processes. The coronoid is the site of insertion for the temporalis muscle, while the condylar process articulates with the mandibular fossae of the temporal bone.
Contraindications

Contraindications to closed reduction include the following (these patients benefit from open reduction and rigid internal fixation [ORIF]):

- Patients with poorly controlled seizure history
- Patients with compromised pulmonary function (ie, moderate-to-severe asthma, chronic obstructive pulmonary disease)
- Patients with psychiatric or neurologic problems
- Patients with eating or GI disorders

Workup

Imaging Studies

- The following types of radiographs are helpful in diagnosis of mandibular fractures:
  - Panoramic radiograph

Mandibular fracture. Postoperative pantomogram.

Mandibular fracture. Close-up view of postoperative pantomogram.
Mandibular fracture. Postoperative pantomogram.

- Lateral oblique radiographs

Mandibular fracture. Lateral view.

- Posteroanterior (PA) mandibular view

Mandibular fracture. Infection treated with incision and drainage and intravenous antibiotics. Hardware was removed and site debrided. Postoperative posteroanterior cephalometric view demonstrating reconstruction plate in place.

- Reverse Towne view
- Mandibular occlusal view
- Periapical radiographs
- Temporomandibular joint views including tomography
- CT scan
Axial CT scan demonstrating multiple fractures of the mandible.

Axial CT scan demonstrating severe displacement.

- Initial screening of patients is most effective with a panoramic radiograph, since it shows the entire mandible including the condyles.
- Standard mandibular series should consist of at least a panoramic radiograph, a PA view, and a reverse Towne view.
- Since an accurate panoramic radiograph requires that the patient is able to stand upright and without any motion, achieving good quality films with severely traumatized patients may be difficult. Traditional lateral oblique views of the mandible can be used when obtaining a panoramic radiograph is not possible.
- The reverse Towne view is the plain film of choice for excluding condylar and subcondylar fractures. Transcranial temporomandibular radiographs also may be helpful in detecting condylar fractures and anterior displacement of the condylar head. If visualization of the condylar head is difficult with plain films, obtain a CT scan. Although high cost and radiation exposure limit its use, CT scan is ideal for intracapsular and high neck condylar fractures.
- Occlusal views are helpful for accurate assessment of symphyseal fractures.
- Obtain periapical radiographs of the teeth on either side of a fracture to assess root fractures.

Diagnostic Procedures

- For cases where the preinjury occlusion is difficult to determine, particularly in partially dentate and edentulous patients, the use of study models is very helpful. Model surgery on the study models can be performed and acrylic splints fabricated to the new arch form. These splints may include a lingual, palatal, or labial splint that will be secured in place during surgery. The splints may be secured with the use of circummandibular wires for the mandible or with circumzygomatic or piriform wires for the maxilla. A maxillary splint also may be secured with palatal screws.
- For fully edentulous patients, dentures can be secured to the maxilla and mandible and used for splints. If dentures are not available, impressions are taken of the jaws, and acrylic baseplates are processed and used as dentures. These are known as Gunning splints. An arch bar also can be processed into the dentures, or holes can be placed into the flange of the denture for intermaxillary wires. Prosthetic incisor teeth can be removed for existing dentures, and space can be made in the acrylic to allow food intake.
Treatment

Medical Therapy

The use of preoperative and perioperative antibiotics in the treatment of mandible fractures, especially in the dentate portion is well established to reduce the risk of infection. Abubaker and Rollert and Miles et al demonstrated that continuing this antibiotic regimen into the postoperative period did not further improve the infection rate.

Surgical Therapy

Closed Reduction of Dentate Patients

Erich arch bars

- Initially, use a bar of sufficient length to accommodate the maxillary and mandibular arches from first molar to contralateral first molar.
- Next, use 24-gauge stainless steel circumdental wires at the first bicuspid positions, one on each side of the arch to secure the arch bar.
- At this point, tightly place circumdental wires along the greater segment of the fracture. The greater segment is the fracture segment; that is the most tooth-bearing segment.
- Loosely place circumdental wires along the lesser segment of the fracture. The lesser segment is the fracture segment that bears the least amount of teeth.
- Then tightly place circumdental wires along the opposing arch.
- Place the patient into his or her preinjury occlusion. With the patient held into occlusion, tighten the looser segment circumdental wires. This prevents arch bar placement from interfering with proper occlusion.
- Place interarch 25-gauge stainless steel box wires along the molar/premolar region and the premolar/canine region bilaterally.

Bridle wire

- Bridle wire is used for temporary stabilization of a fractured segment. This provides some patient comfort by minimizing mobility of the fracture segments.
Mandibular fracture. Patient presents with occlusal step off between right mandibular central and lateral incisors.

- Manually reduce the segments with the use of local anesthesia.
- Loop two teeth (if available) with 24-gauge wire anterior and posterior to the fracture segment. The closest stable teeth can be used if the adjacent dentition is poor or missing.
- Tighten the wire in a clockwise fashion while manually reducing the segments.

Mandibular fracture. View of occlusal step off.

Mandibular fracture. Bridle wire used to decrease mobility and provide patient comfort.

Ivy loops

- Ivy loops are used for intermaxillary fixation when full dentition is present in good condition and the fracture is displaced minimally.
- Construct a loop in the middle of a 24-gauge wire.
- Pass the loose ends of the wire interproximal to two stable teeth.
- Loop the wire ends around the mesial and distal sides of the teeth.
- Pass the distal wire under or through the loop and then tighten it to the mesial wire in an apical direction.
- Accomplish the same procedure on the opposite arch directly opposing the first wire.
- The loops need to be short enough to allow for an interarch wire to be tightened.
Pass a 25-gauge interarch wire through the two opposing loops and tighten it in a clockwise fashion.

At least one ivy loop on each side is necessary.

A variety of wiring techniques (e.g., Essig wire, continuous-loop [Stout] wiring) besides those mentioned above has been used for closed reduction and intermaxillary fixation.

Closed Reduction of Partially Edentulous Patients

If a patient is partially dentate, the existing partial denture can be used for intermaxillary fixation. The partial dentures can be secured to either jaw using circummandibular or circumzygomatic wiring techniques. If the patient has no existing partial denture, acrylic blocks also can be fabricated with an incorporated arch bar and secured with circummandibular or circumzygomatic wires.

Closed Reduction of Edentulous Patients

- If dentures are available, they can be secured with circummandibular wires, circumzygomatic wires, or palatal screws.
- Dentures also can be fabricated with incorporated arch bars as well as a space in the anterior for feeding (Gunning splint). They are secured in the same fashion with circummandibular wires, circumzygomatic wires, or palatal screws.
- Biphasic pin fixation (external pin fixation or Joe Hall Morris appliance) also is used for edentulous patients. Its indications for use are as follows:
  1. In edentulous patients with a discontinuity defect because of either severe trauma or resection
  2. In severely comminuted fractures
  3. When intermaxillary or rigid fixation cannot be used
- Biphasic pin fixation using two pins on both the proximal and distal fragments: Use a transbuccal trocar approach to place two bicortical screws on either side of the fracture. Secure a series of locking plates and bars to the 4 or more pins and then construct a self-curing acrylic secondary splint.

Open Reduction

Wire osteosynthesis

This is rarely used for definitive fixation since the advent of rigid fixation. However, it may be useful for help in alignment of fractured segments prior to rigid fixation.

- This can be placed either by an intraoral or extraoral route. The wire should be a prestretched soft stainless steel.
- A straight wire can be used across the fracture site. This is placed so the direction of pull of the wire is perpendicular to the fracture site. This can be placed as a monocortical or bicortical wire.
- A figure-of-8 wire can provide increased strength at the superior and inferior borders compared to the straight wire.

Intraoral approach

- Advantages over the extraoral approach are that it is quicker to perform, results in no extraoral scar and no damage to the facial nerve, and can be performed under local anesthesia.
- Complication rates and infection rates appear to be similar between the intraoral and extraoral approaches when large numbers of patients are studied.
- Symphysis and parasymphysis fractures can be accessed through a genioplasty-type incision. Identification of the mental neurovascular bundle is important to preserve its integrity.
- Body, angle, and ramus fractures can be accessed through a vestibular incision that may extend onto the external oblique ridge as high as the mandibular occlusal plane. Extending the incision higher predisposes the buccal fat pad to prolapsing onto the surgical field. The entire surface of the ramus and the subcondylar region can be exposed.
by stripping the buccinator and temporal tendon with a notched ramus retractor and periosteal elevator. Bauer retractors placed in the sigmoid and antegonial notch can help in gaining access to the subcondylar and ramus regions.

Submandibular approach

- The submandibular approach often is referred to as the Risdon approach since he first described it in 1934.\textsuperscript{57}
- Make the skin incision approximately 2 cm below the angle of the mandible in a natural skin crease.\textsuperscript{58}
- Dissect the subcutaneous fat and superficial cervical fasciae to reach the platysma muscle.
- Sharply dissect the platysma to reach the superficial layer of the deep cervical fascia. The marginal mandibular nerve runs just deep to this layer.\textsuperscript{59}
- Carry dissection to bone through the deep cervical fascia with the aid of a nerve stimulator. Carry the dissection down to the level of the pterygomasseteric sling.
- Sharply divide the sling to expose the bone.

Mandibular fracture. Intraoperative view demonstrating fixation of mandibular segments.

Mandibular fracture. Left lateral view.

Mandibular fracture. Right lateral view.
Mandibular fracture. Open reduction rigid internal fixation of left mandibular body fracture.

Mandibular fracture. Postoperative radiograph demonstrating reduction and fixation.

Retromandibular approach

- Hinds first described this approach in 1958. 60,61
- Make the incision approximately 0.5 cm below the lobe of the ear and continue it inferiorly 3-3.5 cm. Place it just behind the posterior border of the mandible; it may extend below the level of the mandibular angle.
- Carry the dissection through the scant platysma, superficial musculoaponeurotic layer (SMAS), and parotid capsule.

Retromandibular approach to right mandibular condylar fracture.

- The marginal mandibular branch and the cervical branch of the facial nerve may be encountered.62
- The retromandibular vein runs vertically in this region and commonly is exposed. This vein rarely requires ligation unless it has been transected inadvertently.
- Carry out sharp incision through the pterygomasseteric sling.
- Strip the muscle off the lateral surface of the mandible superiorly, which gives access to the ramus and subcondylar region of the mandible.
Preauricular approach

- This approach is excellent for exposure to the temporomandibular joint. Make the incision sharply in the preauricular folds, approximately 2.5-3.5 cm in length as described by Thoma and Rowe.
- Take care not to extend the incision inferiorly, since it may encounter the facial nerve as it enters the posterior border of the parotid gland.
- Carry the incision and dissection along the perichondrium of the tragal cartilage. Some surgeons advocate making the incision through the tragus.
- The temporal fascia is encountered along the superior portion of the incision. Take care to be sure one is deep to the superficial temporal fascia or the temporoparietal fascia.
- Make an incision through the superficial (outer) layer of the temporalis fascia beginning from the root of the zygomatic arch just in front of the tragus anterosuperiorly toward the upper corner of the retracted flap.
- Insert the sharp end of a periosteal elevator in the fascial incision, deep to the superficial layer of temporalis fascia, and sweep it back and forth.
- Once the periosteal elevator dissection is approximately 1 cm below the arch, sharply release the intervening tissue posteriorly along the plane of the initial incision.
- Retract the entire flap anteriorly, exposing the joint capsule. Fracture location dictates whether the capsule is opened.

Intraoperative Details

Concomitant dentoalveolar injuries should be evaluated and treated concurrently with treatment of mandibular fractures. Teeth in the line of fracture should be evaluated and if necessary, extracted. Whether teeth in the line of mandibular fractures are associated with increased morbidity is a controversial subject. Neal, Wagner, and Alpert reported that there was no statistical difference whether teeth in the line of fracture were removed or retained when examining 257 fractures with teeth in the line of fracture (molars, premolars, anteriors). Amaratunga looked at 191 patients with 226 fractures and used the following criteria for removal of teeth in the line of fracture:

- Excessive mobility
- Root exposure due to distraction of the fracture
- Tooth fracture with pulp exposure
- Caries with pulp exposure

Fractures were treated with maxillomandibular fixation (MMF) for 4 weeks or open reduction. He found that 13.7% of teeth removed in the line of fracture had complications and that 16.1% of teeth retained in the line of fracture had complications. He concluded that there was no significant difference between the number of complications in the teeth removed and teeth retained groups, which indicates that noninfected teeth in the line of fracture can be preserved when antibiotics are used. After a review of the literature, Shetty and Freymiller made the following recommendations concerning teeth in the line of mandibular fracture:
- Intact teeth in the fracture line should be left if they show no evidence of severe loosening or inflammatory change.
- Impacted molars, especially full bony impactions, should be left in place to provide a larger repositioning surface. Exceptions are partially erupted molars with pericoronitis or those associated with a follicular cyst.

Left mandibular angle fracture involving tooth #17. Right mandibular body fracture.

- Teeth that prevent reduction of fractures should be removed.
- Teeth with crown fractures may be retained provided emergency endodontics is performed.
- Teeth with fractured roots must be removed.

Right mandibular body fracture. Left mandibular angle fracture going through tooth #17.
Right mandibular body and left mandibular angle fractures status post fixation. Tooth #17 was extracted.

- Teeth with exposed root apices tend to develop pulpal or periodontal complications.
- Teeth that appear nonvital at time of injury should be treated conservatively due to potential for recovery.
- Perform primary extraction when there is extensive periodontal damage.
- Timing of the fracture is important; less complications occur when reduction and adequate fixation is instituted as soon as possible.

**Outcome and Prognosis**

- A higher prognosis is achieved with removal of grossly carious and periodontally involved teeth.
- Treatment should occur as soon as possible. Prolonged delay in treatment contributes to infection.
- Immobilization of the fracture segments is perhaps the most important aspect in avoiding delayed union, nonunion, and infection.
- Little difference seems to exist between the infection rates of intraoral and extraoral open reduction procedures.
- Alcohol abuse plays a major role in the etiology of mandibular fractures. It results in a higher rate of complications either secondary to noncompliance or as a result of metabolic dysfunction.

**Future and Controversies**

- The advent of resorbable plates and screws opens a new arena for the treatment of mandible fractures in the pediatric population. More controlled prospective studies on the use of resorbable plates are necessary prior to their use for pediatric and adult patients with mandible fractures.
- Rigid fixation techniques have evolved from larger, thicker plates to smaller, low-profile plates while maintaining adequate fixation.
- The use of endoscopic techniques may broaden the indications for open reduction of condylar fractures.