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Emergency department (ED) practitioners commonly encounter patients with maxillofacial trauma. ED physicians must use all of their training and skills to provide the initial stabilization and make an accurate and timely diagnosis of the spectrum of injuries that commonly occur.

Following the initial assessment and stabilization, the ED physician must utilize the physical examination to direct the radiographic testing necessary to obtain a definitive diagnosis and provide care as mandated by the specific injury. Many injuries, such as facial lacerations, may receive definitive care from the ED practitioner. More complex and severe injuries may require further evaluation. Plain radiographs and/or computed tomography (CT) scanning of the injured structures frequently provide the required information to provide definitive patient care, appropriate referral and timely follow-up to minimize potential complications. Certain injuries that are identified,

(e.g., acute temporomandibular joint [TMJ] dislocation) may require specific treatment strategies in the ED whereas others may only require timely outpatient follow-up.

The authors discuss radiographic imaging, specific management of different types of commonly seen injuries, and appropriate consultation and disposition of patients who have sustained maxillofacial trauma. (See the May/June issue for a discussion of clinical characteristics and initial management of these injuries.)

— The Editor

Maxillofacial Injuries: Imaging, Management, and Disposition

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Introduction

Maxillofacial trauma is common with 5-10% of all patients presenting to the ED having an injury in this region. The first article on maxillofacial trauma discussed the recognition and initial stabilization of the patient who has sustained maxillofacial trauma. Focusing on anatomy and the mechanism of injury assists the ED physician in the early identification of potentially

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injured areas. The typical priorities for ED management apply: airway stabilization with cervical spine control, and early assessment, recognition and stabilization of breathing and circulatory complications. Following stabilization, the ED physician then faces the challenge of identifying specific injuries that the patient may have sustained. Maxillofacial trauma is particularly frightening to patients and their families because of the importance of the face and implications for long-term quality of life.

Diagnostic Studies

Radiographic assessment is one of the most important steps in the evaluation of the patient with maxillofacial trauma; however, it should be done only after the patient has been stabilized, the ABCs addressed, and the physical examination completed. The physical examination is important because it can focus the radiographic assessment to a specific bone or part of the face and allow for the identification of specific types of fractures. Focused radiography is much more efficient and allows for the appropriate use of the optimal technique and imaging strategy for each patient.

Radiologic assessment of maxillofacial trauma consists mainly of plain radiographs and CT imaging. Magnetic resonance imaging (MRI) and special procedures such as arteriography may be useful at times, but are modalities that are used rarely by the emergency physician (EP), and are reserved for complex cases typically not in the acute setting.

Standard Radiographic Facial Series. Before CT imaging

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became widely available in the 1980s, plain radiography and tomography were the mainstay of evaluation of the patient with maxillofacial trauma.¹ Plain radiographs continue to provide considerable information about the facial skeleton. Radiographic evidence of injury that can be detected includes cortical defects or overlap, bone displacement or rotation, and abnormal bone angulation.² Indirect signs of a fracture, (e.g., soft-tissue swelling, opacification or air-fluid levels in the sinuses and localized air collections) also may be detected on plain radiographs.

A standard radiographic facial series consists of four views: the Waters (occipitomental projection), Caldwell (occipitofrontal projection), lateral, and submentovertex views. Of these, the Waters view is the single most useful. In fact, some authors have suggested that it alone can identify accurately all midfacial fractures requiring treatment.^{1,3}

In a Waters view, the x-ray beam passes in a posterior-to-anterior direction, at an angle of 37° caudad to the canthomeatal line. (See Figure 1.)¹ The patient's face is placed against the x-ray plate, and thus, a prone position is necessary. Because of this patient positioning, the cervical spine must be cleared of injury before this view is taken. If this is not possible, a reverse Waters view can be used with the patient in the supine position; however, this method produces a poorer quality image because the beam travels in an anterior-to-posterior direction, which enlarges the facial structures.^{1,4}

The Waters view provides excellent visualization of the midfacial region, especially the anterior portion of the face. Features that are well demonstrated include the orbital rim and floor, nasal bones, zygoma, maxilla, and maxillary sinuses.^{2,1} The Waters view can be confusing to interpret, especially to the inexperienced physician because of the large overlap of bony structures; however, with experience and a systematic approach, the clinician will find it to be a very useful film in a search for asymmetry, abnormal contours, bony disruption, and opacified sinuses.¹

The Caldwell view utilizes a posterior-to-anterior x-ray beam angled 15° caudad to the canthomeatal line. This view allows visualization of the orbits, frontal bones and sinuses, and zygoma and is complementary to the Waters view.^{2,1}

The lateral view is obtained with the x-ray beam centered at the lateral canthus.¹ One option is to place the most severely injured side of the patient's face toward the film cassette, as that will give optimal imaging of the injured area. The presence of an air-fluid level in the spheroid sinus can indicate a basilar skull injury. The lateral view is useful to visualize the superior orbital rim, frontal and maxillary sinuses, and the pterygoid plate. The nasal bones can be visualized, preferably with the use of a coned-down lateral view.¹

The submentovertex view is taken with the patient prone and the neck hyperextended; thus, the same concerns about cervical spine clearance as with the Waters view apply here. This view gives the best visualization of the zygomatic arch and thus, is the view of choice when this fracture is suspected. It also allows visualization of the sphenoid sinuses and the anterior wall of the maxillary sinus.

Standard Radiographic Mandible Series. The unique shape

Figure 1. Facial Radiographs

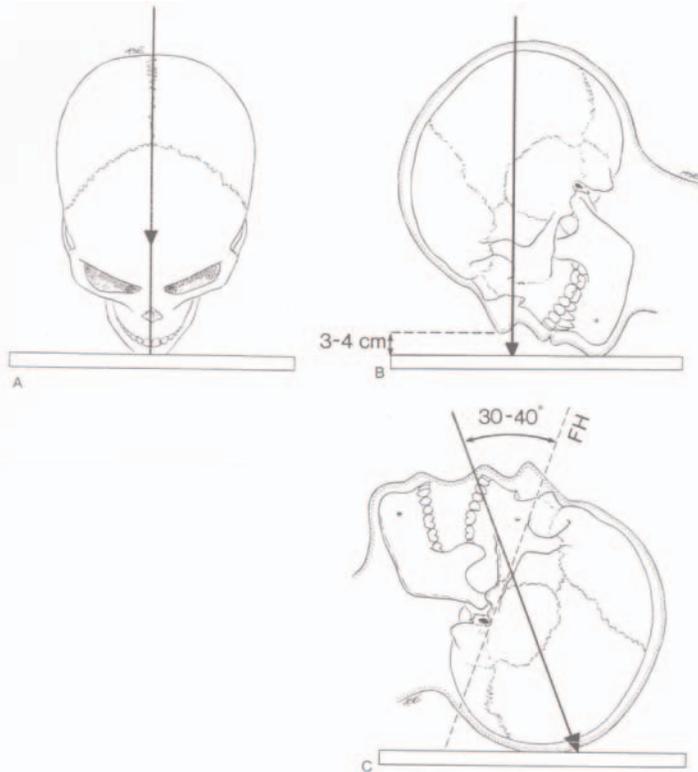


Figure 1. Facial radiographs. A and B, standard Waters (PA) view. C, reverse Waters view.

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of the mandible can make radiographic assessment challenging; however, plain radiographs can be very helpful. The standard radiographic mandible series consists of four views: posterior-anterior (PA), right lateral oblique, left lateral oblique, and the Townes view.¹ The combination of these four views allows adequate visualization of the majority of the mandible.

The patient is placed prone for the PA view, with the forehead and nose resting on the film cassette.¹ This positioning requires that the patient's cervical spine has been cleared. If this is not the case, the beam can be directed in the anteroposterior (AP) direction.¹ The PA view offers good visualization of the ramus, angle, and body of the mandible. It is suboptimal in its assessment of the condyles, coronoid processes, or symphysis.

For the two lateral oblique views, the patient's head is placed on a block inclined to 23°, and the x-ray beam is directed cephalad to the occlusal plane.¹ This view allows visualization of one side of the mandible without interference of the other side. As a result, the condyles, coronoid processes, ramus, angle, and body of the mandible are well visualized with these views.¹

The Townes view is taken with the patient supine, with the occiput resting on the film cassette. The x-ray beam is directed caudad through the frontal bone and the temporomandibular joints.¹ The condylar region is seen well on this view.

Figure 2. Penetrating Trauma to the Mandible



Figure 2. Three-dimensional reconstructed image demonstrating a comminuted fracture through the body of the mandible after a gunshot wound.

Image courtesy of the authors.

Although these four views compose the standard mandibular series, there are two other views that can be very useful and bear mention: the standard lateral and the panoramic views. The standard lateral view is not used often to evaluate the mandible, but it can provide some information about the subcondylar area, ramus, angle, and mandibular body.² It can be useful in assessing airway patency because the lingual, soft palate, retropharyngeal, and prevertebral soft tissues are seen well.

The panoramic (Panorex) view is considered the single best view for evaluation of the mandible, and when used in conjunction with the four-view plain film series, has the highest sensitivity for identification of mandibular fractures.¹ The view is taken with a dedicated x-ray machine in which the x-ray beam and plate rotate around the patient's head. As a result, the entire mandible is visualized. Unfortunately, the Panorex is not available in all emergency departments (EDs), and even in those in which it is available, there may be limitations in its hours of operation.

Computed Tomography Imaging. Because of the complex anatomy of the facial skeleton, high-resolution CT has become the imaging modality of choice for many patients with maxillofacial trauma.⁵ CT imaging reveals details of the complex facial anatomy not possible with standard radiography. In some cases, routine facial radiography will suffice if the injury is limited to a single structure; however, CT imaging is indicated when exten-

Figure 3. Coronal CT Image

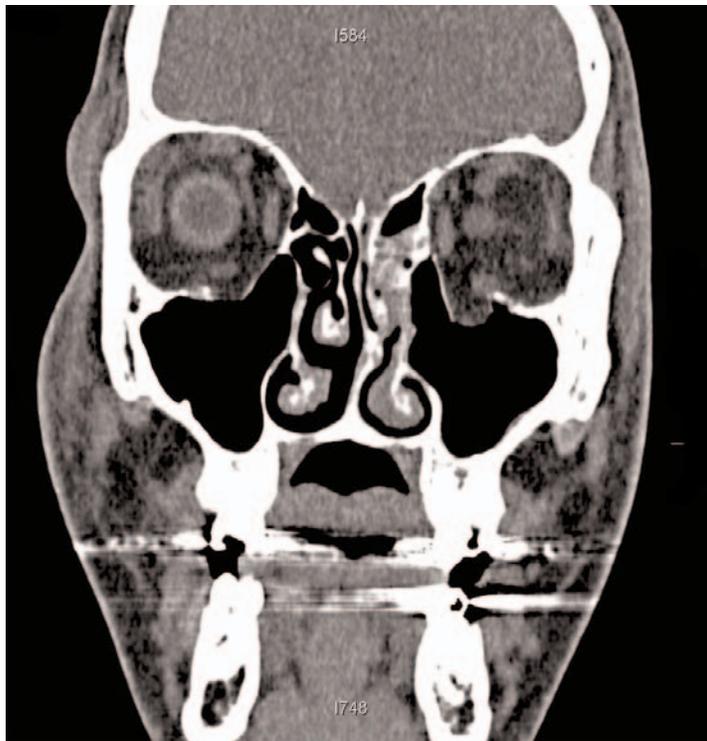


Figure 3. Coronal CT image demonstrating a left orbital floor fracture with fat herniation after an altercation.

Images courtesy of the authors.

sive osseous or soft-tissue injuries are apparent. Additionally, CT imaging is indicated for penetrating trauma (*Figure 2*) and all fractures that may involve the frontal sinuses, nasoethmoid complex, or orbits. Definitive surgical management almost always is based upon the results of CT imaging.³

CT imaging of the facial complex in two orthogonal planes, axial and coronal, allows accurate diagnosis and facilitates preoperative planning.⁵ Direct coronal images of the face require the patient to be in the prone position with extreme hyperextension of the cervical spine. Coronal imaging provides superior visualization of the cribriform plate, orbital roof, and orbital floor (*Figure 3*) because these structures are oriented predominantly in the axial plane. However, because of the high concurrence of cervical spine injury and facial fractures, direct coronal images often are unobtainable at the time of initial presentation to the ED. Standard imaging in the axial plane using 3-mm sections from the level of the mid-mandible through the frontal sinus performed on conventional helical CT scanners is rapid but provides poor quality, nondiagnostic, reformatted coronal images.⁶ Newer generation multidetector CT (MDCT) scanners and image reconstruction algorithms allow rapid acquisition of very thin (e.g., 0.5-mm) axial images, yielding high-resolution multiplanar reformatted images.⁵ This ability to obtain diagnostic-quality images at the time of initial presentation substantially improves

Table 1. Summary of Recommendations for Facial Wound Treatment

- Do not place staples on facial wounds—especially the forehead.
- Do not treat parotid gland/duct injury without evaluating for facial nerve injury (and vice versa).
- Do not assume patients with facial fractures from MVAs or assaults are isolated injuries without proving otherwise.
- Do not leave disfiguring facial bite wounds to heal by secondary intention.
- Do not forget to anesthetize wounds before cleaning them.
- Always align the vermilion lip border first.
- Try not to place absorbable sutures in ear cartilage.

Key: MVA = motor vehicle accident.

patient care, obviating the need for the patient to return to the radiology department for additional studies, lessening exposure to ionizing radiation, and ultimately reducing cost.⁶

Management of Specific Injuries

Lacerations. Management of facial lacerations begins with assessment of cranial nerve integrity and documentation of any deficits prior to administration of local anesthetic. Depending upon the location of the laceration, the temporal, zygomatic, or marginal mandibular branch of the facial nerve may have been injured (*Figure 4*). Lacerations located lateral to a vertical line running through the lateral canthus of the eye and involving any of the branches of the facial nerve generally are considered for microscopic repair of the transected nerve tissue with 8.0 or 9.0 nylon epineural simple suture. Nerve injuries that result from lacerations medial to this line generally are not considered repairable, owing to the small caliber of the nerve.

The surgical area may be anesthetized by local infiltration of the wound edges or by regional block. Common regional blocks useful for repair of facial lacerations include blocks of the supra-orbital, supratrochlear, infraorbital, and mental nerves. Complete instruction regarding these regional blocks is beyond the scope of this article; however, if they are used, the patient must be warned of the possibility of swelling and ecchymosis of the upper or lower eyelids.

After the laceration is anesthetized, the wound must be explored meticulously for the presence of foreign bodies. Removal of foreign material can be facilitated with the use of a surgical scrub brush or sharp excision. The skin surrounding the surgical site may be prepared using various surgical scrubs (e.g., povidine-iodine or chlorhexidine), exerting caution to avoid introduction of the cleaning agent into the wound. Following skin preparation, copious, pressurized irrigation with normal saline or sterile water using a 60-mL syringe affixed with an 18-gauge angiocatheter is performed. Conservative debridement of macerated or devitalized tissue is recommended. Repair proceeds with approximation of the deep tissues using buried, interrupted, fine-gauge absorbable sutures. Horizontal mattress sutures may

Figure 4. Facial Nerve and Parotid Gland

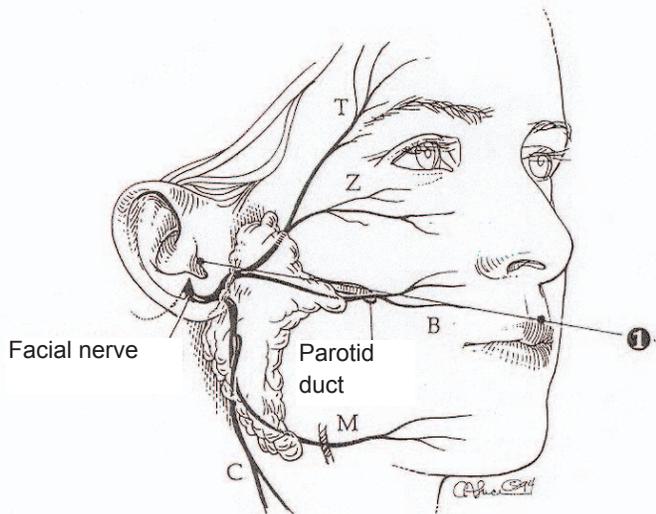


Figure 4. Note that the parotid duct lies roughly along a line drawn from the tragus to the mid upper lip. It enters the oral cavity along a line from the pupil to the mental nerve. The facial nerve divides into five main branches inside the parotid gland. Any laceration of the parotid gland or duct mandates an exam for facial nerve injury.

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Figure 5. Classification of Tooth Fractures

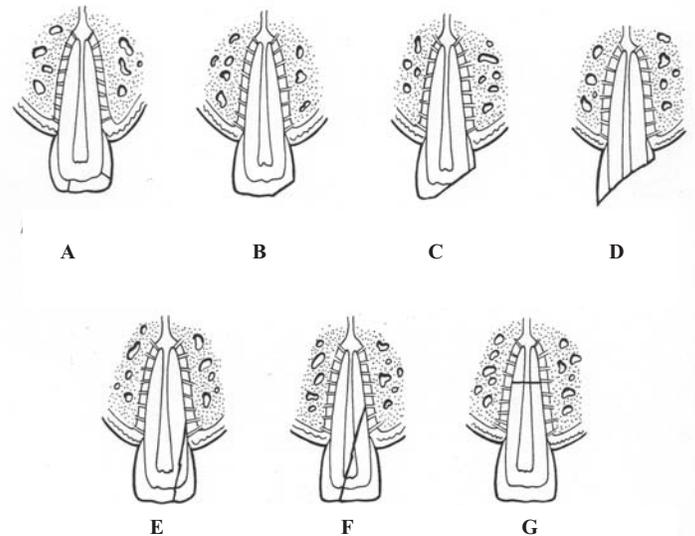


Figure 5. Dental injuries. A: crown infraction. B, uncomplicated crown fracture (Ellis I). C: uncomplicated crown fracture (Ellis II). D: complicated crown fracture (Ellis III). E: uncomplicated crown-root fracture. F: complicated crown-root fracture.

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be used to approximate the deepest portion of the dermis, relieving tension on the skin closure. Reduction of tension across the sutured wound is key to achieving an optimal cosmetic result. The epidermis is closed with 6-0 or 7-0 monofilament sutures. (See Table 1.)

General follow-up care of facial wounds consists of gently cleansing the affected area with soap and water at least six times daily beginning 24 hours after wound closure.⁷ Bacitracin ointment, applied in a thin layer, may be applied after each cleansing until sutures are removed. To minimize scarring, sutures should be removed no later than three to five days after initial closure in most patients. In patients with risk factors for impaired wound healing, sutures may be left in place for longer periods.⁸ Initiation of systemic antibiotics—most often penicillin G or penicillin VK, a cephalosporin, or amoxicillin/clavulanic acid—generally is recommended for any facial wound contaminated by oral, nasal, or skin flora.⁹⁻¹⁰ Sunscreens should be used for six months following repair. Finally, patients should be instructed to watch for signs of infection and reminded that generally it will take six to nine months before a final scar is formed. Seeking advice about potential revision prior to this time may be premature.

High-risk soft-tissue injuries involve areas associated with an increased incidence of late complications. These injuries include any laceration of the margin of the eyelid, the rim of the nostril, the vermilion border of the lip, and the helical rim of the

auricle.¹¹ Injuries involving these structures may warrant ophthalmology or plastic surgery consultation. Lacerations of the cheek may transect the parotid duct, which runs along a line connecting the tragus of the ear to the philtrum of the upper lip, and must be inspected carefully to exclude duct injury prior to closure. (Figure 4.)

Dentoalveolar Injuries

The main goal in the management of dentoalveolar injuries is restoration of aesthetic form and masticatory function. The prognosis depends largely upon the type of injury and the time elapsed from the injury to the completion of treatment. Ellis I and II fractures tend to be uncomplicated. Ellis I fracture of the enamel requires no emergent treatment. Ellis II fractures, involving the enamel and the dentin, should be treated within 48 hours to prevent bacterial migration into the pulp with ensuing pulpal inflammation. Complicated crown fractures, Ellis III, should be treated within a three-hour window when possible.¹³ Prompt treatment with calcium hydroxide and restoration within that timeframe can prevent pulpitis and the need for further endodontic therapy. (See Figure 5.)

Treatment of root fractures depends upon the location of the fracture. Apical root fractures often are stable and require referral to a dentist for periapical radiography and observation. Treatment of middle-third fractures consists of anesthetizing the area, reduction of the fracture, and rigid fixation of the injured tooth to adjacent teeth for six to eight weeks. With this treatment, the

Figure 6. Displaced Mandible Fracture

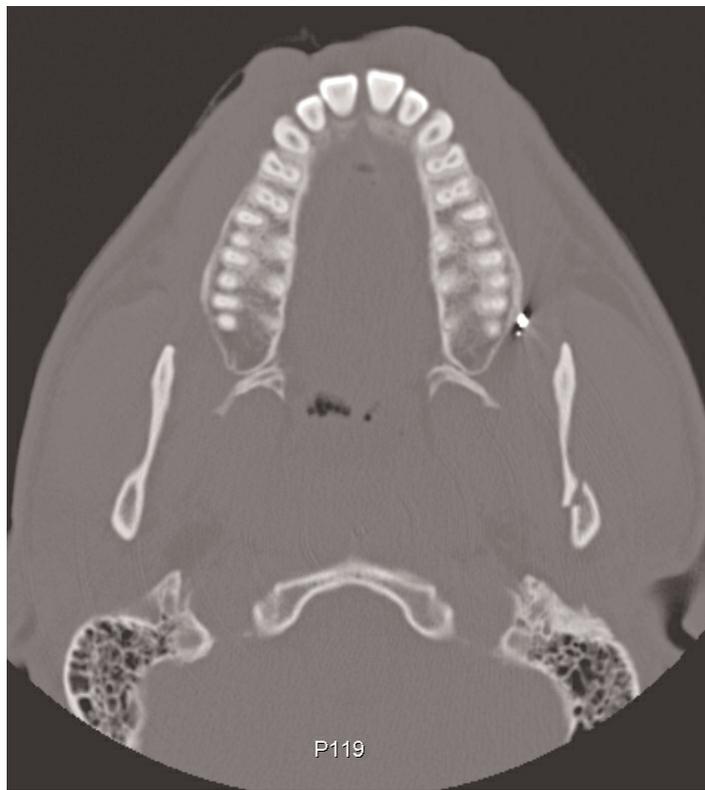


Figure 6. Non-contrast axial CT image demonstrating a displaced fracture through the ramus of the mandible.

Image courtesy of the authors.

Figure 7. Open Reduction and Internal Fixation of Mandible Fracture



Figure 7. Non-contrast axial CT image performed after open reduction and internal fixation of the mandible fracture utilizing miniplates.

Image courtesy of the authors.

tooth often will remain vital. Treatment of cervical root fractures requires extensive therapy; extraction and prosthodontic replacement are often necessary. Fractures through the middle third or cervical root are unstable and require immediate referral to the patient's dentist or an endodontist.¹²

Subluxation and concussive tooth injuries represent injury to the periodontal ligament, which is responsible for maintaining the teeth in their sockets. Immediate treatment is not necessary; however, patients should be referred to a dental practitioner because a small portion of these injuries results in pulpal necrosis within one year of the initial incident.

Luxation injuries are described according to the direction in which the tooth is displaced: extrusive luxation, lateral luxation, and intrusive luxation. Intraoral radiographs are necessary to evaluate for concomitant root fractures and alveolar process fractures. Treatment of extruded and laterally luxated permanent teeth consists of anesthetizing the area, manually repositioning the tooth, and nonrigid fixation with a monofilamentous nylon and composite resin splint left in place for two to three weeks. If root fracture or alveolar process fracture is identified on intraoral radiography, the tooth must be fixated rigidly for two to three months with orthodontic wire. Luxated primary teeth often are extracted to avoid risk of damage to the underlying permanent

tooth upon repositioning. Approximately 26% of extruded teeth and 58% of laterally luxated teeth develop pulpal necrosis, necessitating endodontic therapy.¹³

Intrusive luxation injuries are severe dental injuries in which the tooth has been forced into the alveolar process and the occlusal surface of the tooth is below that of the adjacent teeth. Severely intruded maxillary teeth can penetrate the floor of the nose and cause epistaxis. The alveolar process often sustains a severe crushing injury, resulting in comminution of the socket. Endodontic therapy almost always is required because of the high rates of pulp necrosis.

Complete avulsion of the tooth represents approximately 16% of dentoalveolar luxation injuries.¹³ Avulsed permanent teeth should be cleaned of debris and reimplanted immediately. If the tooth is not replanted immediately, it should be placed in a liquid storage medium such as Hank's Balanced Salt Solution, milk, saline, saliva, or water. The tooth should be handled carefully by the crown to avoid further damage to the periodontal ligament cells. The socket should be irrigated free of clot prior to reimplanting the tooth. Local anesthesia may be necessary for patient comfort. The tooth should be splinted for 10 to 14 days. Reimplantation of avulsed primary teeth is not recommended.

Fractures of the alveolar process are treated with manual

Figure 8. LeFort III Fracture

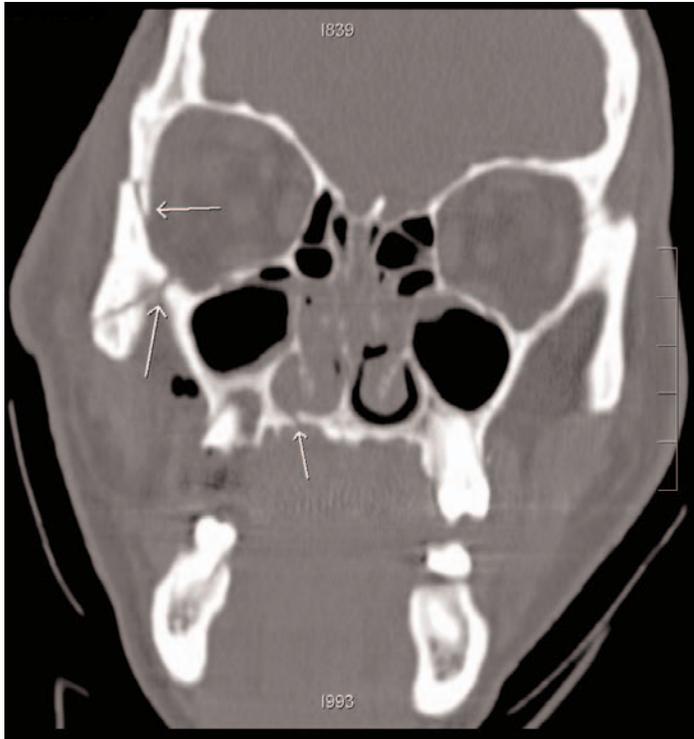


Figure 8. Reconstructed coronal CT image demonstrating multiple fractures consistent with a right hemi-LeFort III fracture.

Image courtesy of the authors.

repositioning and rigid fixation. Occasionally, surgical treatment is necessary. Early consultation with a dental practitioner is recommended, as complications are much more likely to develop if treatment is delayed beyond one hour from the time of injury.¹³

Antibiotics typically are recommended for dentoalveolar injuries. Tetanus immunization status should be evaluated and updated as needed. Opioid medication may be required for patient comfort.

Acute Temporomandibular Joint (TMJ) Dislocation. Acute temporomandibular joint (TMJ) dislocation is best managed with prompt manual reduction. Occasionally, manual reduction may be accomplished without the use of anesthetic or sedative medications; however, as dislocation is prolonged, spasm of the masseter muscles makes further reduction attempts more painful and less successful. In the cooperative patient, immediate manual reduction is best accomplished by positioning the patient in a chair, with the posterior occiput supported against a wall. The examiner places the gloved thumbs of both hands intraorally along the occlusal surface of the posterior mandibular molars, and positions the fingers extraorally along the inferior border of the mandible. Wrapping the thumbs in gauze may prevent injury by the molar cusps. Reduction of the condyle occurs with forceful inferior and posterior displacement of the mandible, allowing the condyle to slip into the glenoid fossa. If initial attempts are

unsuccessful, sedation with intravenous benzodiazepines—alone or in combination with an opioid—produces anxiolysis and may aid additional attempts. A panoramic radiograph should be taken after successful reduction to rule out condylar fractures.¹⁰ If repeated attempts at reduction are unsuccessful, subspecialty consultant manual reduction under general anesthesia or operative reduction may be necessary.

After successful reduction of an acute dislocation, patients should be instructed to eat a soft diet for one week and to limit oral opening for two to four weeks. Nonsteroidals and muscle relaxants facilitate patient comfort. Patients should be instructed that they are at increased risk for future dislocation due to ligamentous stretching.

Facial Fractures. Definitive management of facial fractures is highly specialized and requires early surgical consultation. Operative management depends greatly upon the degree of comminution and displacement of the bony segments and focuses largely on restoration of the anatomic buttresses of the face. High-resolution CT scans facilitate diagnosis and serve as the basis for perioperative planning.

Mandibular Fractures. Operative management of mandibular fractures has changed considerably during the past 10 years. Older methods of closed reduction within six weeks of maxillo-mandibular fixation (MMF) largely have been replaced by intraoral open reduction and internal fixation, using noncompression or compression bone plates or semirigid fixation with mini-plates.^{11,14} (See Figures 6 & 7.) When rigid internal fixation of the mandibular fracture is performed, the duration of MMF is reduced to several days to one to two weeks, permitting enhanced nutrition, oral hygiene, and comfort.^{12,14} Correct repair of mandibular fractures results in restoration of occlusion; mandibular function; and the anteroposterior, vertical, and lateral dimensions of the facial complex.

Midfacial and LeFort fractures. Initial surgical management of midfacial and LeFort fractures (Figure 8) involves restoration of the occlusal surface by first repairing any associated mandibular fractures. This approach provides the base upon which the midface is reconstructed. Skeletal repair is then accomplished by open reduction after wide exposure of the fragments with restoration of the facial buttresses using extensive miniplating in conjunction with bone grafts and, occasionally, wire osteosynthesis.¹⁰⁻¹² The administration of prophylactic antibiotics to cover for staphylococcal or anaerobic bacteria is recommended. Cerebrospinal fluid (CSF) rhinorrhea, if present, warrants neurosurgical consultation.

Orbital Fractures. Fractures of the orbital floor may result in serious consequences if not managed appropriately. The aim of initial management is to identify processes that may permanently compromise ocular function. One such process occurs when the ocular nerve is compressed by a retrobulbar hematoma. In this situation, an emergency lateral canthotomy can be sight saving. Further management aims to prevent long-term complications such as traumatic enophthalmos, which results from an increase in orbital volume associated with inadequate repair of the orbital floor. The globe is displaced posteriorly and inferiorly, prolaps-

ing into the maxillary sinus, creating a functional and cosmetic defect that may result in permanent diplopia. Surgical repair of an orbital floor fracture usually is accomplished through a transconjunctival or subciliary incision (immediately inferior to the lashes of the lower lid). Materials that commonly are employed to reconstruct the orbital floor include titanium mesh, silastic sheet, and cranial bone.¹⁴ Infections after orbital fractures are rare, therefore, routine antibiotic prophylaxis is not necessary.

Zygomatic Arch Fractures. Pure fracture of the zygomatic arch is rare, owing to the strength and thickness of the zygoma.⁹ Fractures tend to extend through adjacent weaker bones. Thus, the term zygomaticomaxillary complex (ZMC) fracture often is used when describing fractures involving the zygoma. ZMC fractures can be repaired using several approaches. The incisions can be made through the periorbital brow region, in a subciliary location, or posterior to the temporal hairline (Gillies incision). Internal fixation is accomplished with miniplates placed at the zygomatic frontal, infraorbital, and maxillary buttresses. Orbital floor fracture occurs commonly in association with ZMC fractures and must be repaired carefully, as above. There is no evidence supporting the use of prophylactic antibiotics for ZMC fractures.

Nasal Bone Fractures. Fractures of the nasal bones and septum are common and can result in nasal airway obstruction secondary to deviation of the nasal septum. Nondisplaced or minimally displaced nasal fractures can be treated with closed reduction and nasal splinting. Treatment of severe epistaxis includes meticulous repair of intranasal lacerations, followed by nasal packing. The nasal septum must be inspected carefully for the presence of a hematoma. If present, hematoma evacuation is accomplished through a small incision with subsequent drainage, then, the septal mucosa is reapproximated, and nasal packing is placed. Antistaphylococcal antibiotic prophylaxis is necessary while packing is in place.

Naso-orbital-ethmoidal (NOE) Fractures. More severe injury involving the nasal bones occurs with naso-orbital-ethmoidal (NOE) fracture. Typically, the result of high-energy impact, an NOE fracture involves the nasal bones, nasal processes of the frontal bone, frontal process of the maxilla, and the delicate lamina papyracea of the ethmoid bones. Any fluid draining from the nose must be evaluated for CSF rhinorrhea because NOE fracture can be associated with fracture of the cribriform plate and anterior cranial fossa. Surgical repair of an NOE fracture begins with evaluation for medial canthal ligament injury. The intercanthal distance should be measured; it averages 30-34 mm in adults. If canthal injury is suspected, careful repair of the medial canthal tendon with restoration of the medial orbital rim using autogenous bone grafts can prevent permanent traumatic telecanthus. Intraoperative stenting of the lacrimal system is performed, as duct injury may occur secondary to NOE fracture. Following medial canthal ligament repair, dental occlusion is reestablished through MMF with arch bars and rubber bands. Open reduction usually is accomplished via bicoronal and subciliary incisions, with internal fixation using miniplates and wires to stabilize the fractured bony segments.

Potential Complications of Maxillofacial Trauma

Auricular Hematoma. Much like a nasal septal hematoma, an auricular hematoma, if not treated promptly, may lead to permanent deformity. Hematoma of the auricle occurs when trauma causes shearing forces that separate the perichondrium from the underlying cartilage, leading to collection of blood between these two layers. As the hematoma expands, the increasing pressure leads to vascular compromise and cartilage death. Permanent deformity—commonly referred to as cauliflower ear—ensues as the auricular cartilage is replaced by fibrocartilaginous scar.

Treatment of an auricular hematoma incorporates principles of drainage and compression. Anesthesia is achieved by local infiltration of anesthetic into the subcutaneous tissue directly anterior and posterior to the auricle. Once adequate anesthesia is confirmed, the hematoma can be drained. Common methods of hematoma evacuation include aspiration with an 18-gauge needle or incision and drainage. Following evacuation, a compression dressing should be applied. An advanced compression method involves the use of thermoplastic silicone splints. A silicone splint is cut to cover the involved area of the inner auricle. A second splint, cut to match the first, is applied to the posterior pinna. The two splints are secured to each other with three to four interrupted mattress sutures (i.e., 3-0 nylon suture on a straightened needle) passed through the pinna along the outer edges of the splints. Antibiotic ointment is applied twice daily; systemic antibiotics (e.g., cephalexin or dicloxacillin) are recommended for five days to prevent infection. Silicone splints generally are left in place for 14 days; then the sutures may be removed. Regardless of the method of treatment, patients should follow-up with an otolaryngologist or plastic surgeon, because hematoma recurrence is not uncommon. Complications of auricular hematomas include fibrocartilaginous deformity of the ear, staphylococcal or streptococcal chondritis, and cartilage or skin necrosis.

Massive Bleeding Associated with Midfacial Fractures. Patients with massive bleeding following midfacial fracture must be managed aggressively to prevent the development of hemorrhagic shock or the need for massive transfusions. One standard approach to midfacial bleeding begins by passing 14-gauge Foley catheters through the nares into the posterior nasal pharynx. The correct position is confirmed by direct visualization of the catheter tips in the oropharynx. After balloon inflation with 5-10 mL of air, the catheters are withdrawn slightly and secured externally, allowing the inflated balloons to tamponade bleeding from the posterior nasopharynx. Following Foley catheter placement, posterior and anterior nasal packing with petroleum gauze is placed.

Occasionally, bleeding may continue and must be managed with more invasive techniques. Shimoyama and colleagues reported the use of temporary fracture reduction utilizing maxillomandibular fixation to restore occlusal relations.¹⁵ Additional invasive techniques include direct visualization and surgical ligation of arterial sources. A few authors have reported the successful use of transcatheter arterial embolization of the internal maxillary artery to control unstable epistaxis.^{16,17}

Disposition

Once the EP has assessed and stabilized the patient, obtained any needed radiographic studies, and reached a diagnosis, the disposition of the patient must be determined. Under the broad category of disposition are three distinct areas to be considered: consultation, admission/discharge decisions, and transfer.

Consultation. Decisions about consultation vary widely according to the type of injury, other patient injuries, and the type of hospital. Generalizations are presented here, but these practices can vary in different institutions and areas of the country.

The majority of soft-tissue injuries may be treated by the EP without the need for consultation. Examples in which a consultation is more likely to be obtained include unusually large, complex, or deep lacerations; lacerations that involve underlying structures (e.g., the facial nerve or parotid gland or duct); lacerations or abrasions with foreign bodies or debris that cannot be removed; and hematomas that involve the ear or nasal septum.²

Most dental injuries require urgent referral to a dentist. A special situation is avulsion of a permanent tooth. In this case, the time until re-implantation is very critical and affects the prognosis.¹³ Unless a dental consultant is available immediately to care for the avulsed tooth, the EP should perform this procedure.

A consultant is called for the majority of facial fractures. An exception would be a simple uncomplicated nasal fracture. Generally, this injury may be followed up by a consultant within 48-72 hours. However, patients with a significant deformity or obstruction need consultation in the ED, with manipulation to correct the deformity.² Patients without airway obstruction or a gross deformity may be advised to wait for the swelling to decrease before deciding about the cosmetic result. Some minor facial fractures (e.g., those involving only the body of the zygoma) may require only a telephone consultation and close follow-up.²

One issue concerning consultation involves the specialty of the consultant physician. Traditionally in the United States, three groups of specialists have cared for patients with maxillofacial trauma: plastic surgeons, otolaryngologists (ENTs), and oral and maxillofacial surgeons. A survey of U.S. teaching hospitals showed that the majority had a formal, documented referral pattern in place for patients with maxillofacial injuries.¹⁸ Most types of maxillofacial injuries were referred equally to all three specialties, with the exception of isolated mandibular fractures preferentially being referred to oral/maxillofacial surgeons.

One additional specialist that should be considered for the patient with maxillofacial injury is the ophthalmologist. This is especially important for patients with mid-face and orbital fractures, because a significant number of them will have injuries ranging from minor to severe.⁹ An ophthalmologist should be involved in the care of these patients whenever there is concern about possible eye injury.

Admission/Discharge. Most patients with isolated soft-tissue or dental injuries are discharged from the ED. In the past, the majority of patients with facial fracture were admitted to the hospital; however, in today's changing health care environment this necessarily may not be the case. One important factor in the decision process is the presence of other body system injuries that

require inpatient treatment. Other factors that should be considered are the availability and timing of planned surgical intervention and concerns for possible airway compromise. With the right combination of factors, many of these patients may be discharged from the ED.

Transfer. The issue of transfer generally arises because of the patient's need of a higher level of care, either for the maxillofacial injury itself or for associated injuries. In general, patients with minor facial injuries may be transferred if they have been stable in the ED. Patients with major maxillofacial injury potentially are unstable because of the possibility of airway compromise. In these patients, consideration should be given to pre-transfer intubation so that the airway will be protected during transfer.²

Additional Aspects

Pediatric Issues. Children may be especially susceptible to maxillofacial injury because of their greater cranial-mass-to-body ratio, yet facial fractures are relatively uncommon in children.¹⁹⁻²² This may be for a variety of reasons, including a flexible underdeveloped facial skeleton combined with unerupted dentition; in adults, mature teeth reinforce the maxilla and mandible.²² In addition, children are less likely to be exposed to the mechanisms of injury that cause facial fractures in adults. Pediatric facial fractures can be hard to diagnose, therefore, the EP must be diligent in searching for them. This fact is especially important because the growth and development of the facial bones can be affected by any fracture.

The developing pediatric facial skeleton is notable for incompletely calcified areas, ossification centers, underdeveloped sinuses, and tooth buds. Because of this, plain radiographs do not demonstrate fractures as well as in an adult.²⁹ Therefore, CT imaging is the modality of choice in the evaluation of the pediatric facial skeleton, even more so than in adults. CT also has the advantage of imaging the cartilaginous areas, which can be especially important in the pediatric maxillofacial region. With the high incidence of associated head injuries in the pediatric patient, it can be advantageous to perform a CT scan of the brain at the same time.

Further management of pediatric facial fractures differs in certain instances from adults because of the different stages of development of the pediatric facial skeleton; however, these issues of definitive treatment mainly concern the consulting specialist physician. Pediatric facial fractures are, in general, treated in a more conservative manner than adult fractures. Observation may be all that is required, especially in patients with minimally displaced fractures.

The evaluation and management of soft-tissue injuries in children largely mirrors that of adults. Children have immature collagen in their soft tissues, and their wounds generally heal with very good cosmetic results.¹⁹ Patient cooperation can be one of the most important aspects of obtaining an acceptable functional and cosmetic result in the child with a facial laceration.² A calming and reassuring atmosphere may be paramount, although at times sedation and/or restraint may be indicated. Topical anes-

thesia has been shown to be very effective for pediatric facial and scalp lacerations and should be considered.

One soft-tissue injury of particular concern in children is that of dog bites to the face. Most dog-bite victims are younger than 5 years, and the frequency of dog bites decreases with age.²³ The emergency practitioner must consider rabies and tetanus prophylaxis, antibiotic use, and the type of wound closure. Dog bites to the face can have important implications for cosmetic and functional sequelae, and consultants should be used liberally. Immediate surgical repair has been found to be safe and effective.²³

Sports-related maxillofacial trauma is an evolving pediatric issue. More and more children are participating in organized sports and starting at a younger age. Countering this fact is the increased development of more and better safety equipment along with rules mandating its use.^{12,24,25} Equipment specifically designed to protect the maxillofacial area are mouthguards, helmets, and face masks.

Nasal and mandibular fractures are the most common sports-related facial fractures in children.^{24,25} Dental injuries are also common sports injuries, and their incidence is inversely related to mouthguard and face mask use. Dental injuries are found less frequently in football players, and more commonly in sports in which the mouth is not protected (e.g., basketball, baseball, and softball).²⁵

Public Health. Several public health initiatives established to reduce motor-vehicle-collision (MVC) associated mortality have led to significant reductions in the incidence of severe maxillofacial injury. Enforcement of seat belt laws has reduced MVC-related mortality, and many states have adopted helmet laws for the protection of motorcycle riders. It is well documented that helmet use by motorcycle riders significantly reduces the risk of severe traumatic brain injury (TBI).²⁶ Additional reduction in the incidence of facial fractures and soft-tissue injury has been observed in helmeted riders versus non-helmeted riders.²⁷ Full-face model helmets offer the greatest rates of reduction of all injuries.

The protective effects of helmets also are seen among injured bicycle riders. More than 500,000 bicyclists are treated annually in EDs in the United States.²⁸ Although the mortality rate associated with bicycle accidents is low, head injury accounts for three-quarters of bicycle-related deaths.²⁸ In one meta-analysis of seven case-control trials of bicycle riders with maxillofacial injuries, helmet use was associated with a 65-88% reduction in the risk of TBI and a 65% reduction in the risk of middle and upper facial injuries.²⁹

A major role of the emergency practitioner is to educate patients to prevent future injuries. The effect of physician intervention on behavior patterns should not be underestimated. Physicians and nurses must educate their patients regarding the beneficial effects of helmet and seat belt use.

Domestic Violence. Domestic violence is a widespread problem in the United States and has far-reaching physical, emotional, and social consequences.^{30,31} Victims of abuse may not, for a variety of reasons, initially seek treatment for their injuries; however, when they do, they usually come to the ED. Therefore, ED

nurses and physicians are frequently responsible for diagnosing and treating these patients. This responsibility extends beyond the immediate medical concerns to include counseling, ensuring a patient's safety, referrals, and legally mandated reporting. Because most injuries arising from domestic violence involve the face, certain facts bear mention here.³⁰

In a study of 236 female victims of domestic violence, Le and colleagues documented that 81% had maxillofacial injuries.³⁰ The most common type of maxillofacial injury resulting from domestic violence is soft-tissue injury, (i.e., contusions and lacerations). Thirty percent of the patients in this study had facial fractures, with nasal fractures being the most common. Injuries most commonly were caused by a blunt mechanism such as the use of a fist or weapon. Other injuries that may be markers of domestic violence include hair loss from pulling, fractured anterior teeth, dislocated jaw, and suborbital ecchymosis.³¹ Suspicion of abuse should be aroused when the patient's presentation is inconsistent with the initially offered mechanism of injury, when the clinician observes old injuries in multiple stages of healing, and when the patient has delayed seeking treatment.³¹

Child and elderly abuse are two specific categories of domestic violence. Patients in these situations can present with the same type of maxillofacial injuries already described, including soft tissue injuries, facial fractures, and dental trauma.³¹

Summary

Maxillofacial trauma evokes strong emotional responses for both patients and health professionals. A common injury, maxillofacial trauma accounts for 5-10% of patients presenting to trauma centers. All ages, genders, and ethnic groups are affected. The most common causes of maxillofacial injuries remain MVCs and assault; however, increased participation in competitive sports has increased the incidence of maxillofacial injuries among children. Falls and abuse remain significant causes of maxillofacial trauma among the elderly.

Cervical spine fracture and traumatic brain injury are common in patients with maxillofacial fractures and must be ruled out. Early aggressive airway management with orotracheal intubation is recommended for all patients at risk for airway decompensation. CT has emerged as the imaging modality of choice for many patients. High-resolution multiplanar reformatted images aid diagnosis and preoperative planning.

Current surgical management of maxillofacial fractures more commonly involves open reduction and internal fixation than in the past. Early involvement of surgical consultants facilitates patient evaluation and reduces complications from delayed diagnosis and treatment.

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CE/CME Instructions

Physicians and nurses participate in this continuing medical education/continuing education program by reading the article, using the provided references for further research, and studying the questions at the end of the article. Participants should select what they believe to be the correct answers, then refer to the list of correct answers to test their knowledge. To clarify confusion surrounding any questions answered incorrectly, please consult the source material. **After completing this activity, you must complete the evaluation form provided and return it in the reply envelope provided in order to receive a certificate of completion.** When your evaluation is received, a certificate will be mailed to you.

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CE/CME Questions

1. Which of the following standard radiographs is the single most useful view for a patient with maxillofacial trauma?
 - A. Caldwell view
 - B. Lateral view
 - C. Submentovertex view
 - D. Waters view

CE/CME Objectives

- Upon completing this program, the participants will be able to:
- a.) discuss conditions that should increase suspicion for traumatic injuries;
 - b.) describe the various modalities used to identify different traumatic conditions;
 - c.) cite methods of quickly stabilizing and managing patients; and
 - d.) identify possible complications that may occur with traumatic injuries.

2. Which dental injury requires the most urgent, timely management?
 - A. Avulsed permanent tooth
 - B. Avulsed primary tooth
 - C. Ellis class I fracture
 - D. Ellis class II fracture

3. Which of the following views is considered the single best one for evaluation of the mandible?
 - A. Standard lateral view
 - B. Panoramic view
 - C. Posterior-anterior view
 - D. Townes view

4. A nasal septal hematoma is treated with:
 - A. warm compresses and observation.
 - B. nasal fracture reduction and splinting.
 - C. incision, drainage, and nasal packing.
 - D. elective outpatient management.

5. Children are especially susceptible to maxillofacial injury because:
 - A. they are more likely to intend to hurt themselves.
 - B. they have a disproportionate cranial/body mass ratio.
 - C. the anatomic structures are different than the adult.
 - D. the relative size of their head is smaller than the adult.

6. Which of the following lacerations is *not* a high-risk soft-tissue injury that is associated with an increased incidence of late complications?
 - A. Laceration of the margin of the eyelid
 - B. Laceration of the rim of the nostril
 - C. Laceration of the inner aspect of the lip that does not involve the vermilion border
 - D. Laceration that involves the vermilion border of the lip
 - E. Laceration of the helical rim of the auricle

7. Which of the following statements is true regarding naso-orbital-ethmoidal (NOE) fractures?
 - A. Typically, they are the result of high-energy impact.
 - B. An NOE fracture involves the nasal bones, nasal processes of the frontal bone, frontal process of the maxilla, and the delicate lamina papyracea of the ethmoid bones.
 - C. Any fluid draining from the nose must be evaluated for cerebrospinal fluid rhinorrhea because NOE fracture can be associated with fracture of the cribriform plate and anterior cranial fossa.
 - D. All of the above statements are true.

8. Which of the following management strategies would be appropriate for a simple uncomplicated nasal fracture?
 - A. Generally, this injury may be followed up by a consultant within 48 to 72 hours.
 - B. Patients with a significant deformity or obstruction need consul-

- tation in the ED, with manipulation to correct the deformity.
 - C. Patients without airway obstruction or a gross deformity may be advised to wait for the swelling to decrease before deciding about the cosmetic result.
 - D. All of the above
9. Which of the following statements is true regarding pediatric dog-bite injuries?
 - A. Most dog-bite victims are older than 5 years.
 - B. The emergency practitioner must consider rabies and tetanus prophylaxis for the patient.
 - C. Antibiotic use is never appropriate.
 - D. Dog bites to the face usually have no significant complications.
 - E. Immediate surgical repair is *not* safe nor effective.

 10. Which of the following statements is *not* true regarding sports-related maxillofacial trauma?
 - A. More and more children are participating in organized sports and starting at a younger age.
 - B. More and better safety equipment along with rules mandating its use are mandated in many sports.
 - C. Zygomatic arch fractures are the most common sports-related facial fracture in children.
 - D. Equipment specifically designed to protect the maxillofacial area are mouthguards, helmets, and face masks.

Answer Key:

1. D
2. A
3. B
4. C
5. B
6. C
7. D
8. D
9. B
10. C

In Future Issues:

Pelvic Fractures

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