Trauma Series: FACIAL INJURIES

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ABSTRACT

Physical trauma to the face can range from a simple bruise to large and painful lacerations, fractures, and trauma to the eyes, teeth, and nerves. Facial injuries have the potential to disfigure and cause significant loss of function, such as the sense of sight or smell, or even the ability to speak. Proper diagnosis and rapid treatment can minimize and prevent these effects.
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Statement of Need

Individuals with facial injuries often have other injuries in the setting of trauma, which require timely, coordinated, care between trauma and surgical specialists trained to manage maxillofacial and multisystem injuries. Additionally, in cases where there has been high impact and severe facial injuries, ongoing physical and emotional support are needed during all phases of care. Nurses need to have the necessary knowledge and an understanding of future trends in facial reconstruction while caring for individuals with traumatic injuries to the face during all phases of medical intervention and recovery.

Course Purpose

This course will provide advanced learning for nurses interested in the management of the trauma patient with a facial injury.
Learning Objectives

1. List the three types of facial trauma.
2. Identify common facial bone fractures.
3. Describe Le Fort fractures.
4. Explain common causes of facial trauma.
5. Describe the relationship between nosebleeds and facial trauma.
6. Describe common diagnostic tools for facial injuries.
7. Identify the purpose of angiography for a facial trauma patient.
8. Describe the types of airway protection that may be used with facial trauma.
9. Explain when antibiotics are used to treat facial trauma.
10. Identify when bone grafting would be appropriate treatment for a facial trauma patient.

Target Audience

Advanced Practice Registered Nurses, Registered Nurses, Licensed Practical Nurses, and Associates

Course Author & Director Disclosures

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Please take time to complete the self-assessment Knowledge Questions before reading the article. Opportunity to complete a self-assessment of knowledge learned will be provided at the end of the course.
1. The submandibular and sublingual salivary glands are _______________ injured because of their anatomical location.
   a. Less commonly
   b. More commonly
   c. Rarely
   d. None of the above

2. True or False. The orbital rim must be inspected carefully since injury to the area may involve an underlying fracture.
   a. True
   b. False

3. _______ percent of burn injuries reported in the U.S. involve the head and neck region.
   a. 25 %
   b. 33 %
   c. 50%
   d. 63 %

4. In children, dental trauma to the primary teeth most commonly occurs between the ages of__________.
   a. 1 to 2 years
   b. 2 to 3 years
   c. 4 to 5 years
   d. 7 to 10 years

5. The establishment of a patent airway is the first priority in patients with severe facial injuries. The mouth needs to be cleared of:
   a. knocked out teeth
   b. foreign debris
   c. blood
   d. all of the above
6. True or False. Both muscle and nerve entrapment are *less frequently* reported among children because their bones are still growing and more flexible.
   a. True
   b. False

7. Pluridirectional (complex motion) tomography is the imaging study of choice in the evaluation of facial injury. It has the advantage of:
   a. showing the injury with detailed clarity
   b. determining the extent of facial injury
   c. helping to diagnose facial multiple facial trauma where routine radiography studies will not suffice
   d. all of the above

8. CT imaging has a distinct advantage over other imaging studies:
   a. It can demonstrate both bone and soft tissue involvement
   b. it can demonstrate both bone and vascular involvement
   c. it is less invasive
   d. none of the above

9. Since the ethmoid sinuses are anatomically positioned close to the skull base, it is not uncommon for facial trauma patients with nasal fractures to report ______________________________.
   a. Profuse blood loss
   b. Cerebrospinal fluid (CSF) leakage
   c. Dizziness
   d. Vomiting

10. Mandibular fracture requires:
    a. fixation in the hospital
    b. antibiotics prior to surgery
    c. surgical repair of the jaw in 7 – 10 days after the injury
    d. all of the above
INTRODUCTION

Facial trauma or maxillofacial injuries, refers to injuries to the mouth, face, and jaw. These types of injuries are commonly encountered in emergency rooms across the country as a result of assault, vehicular and industrial accidents, and sports mishap. An estimated three million emergency department visits are made per year for facial trauma (1).

Facial injuries can interfere with a patient's ability to eat, speak, breathe, listen, see, and perform other important routine sensory and physiological functions. Moreover, studies on trauma survivors found that disfiguring facial injuries can have debilitating psychological and social consequences (2, 3). Therefore, the initial focus of the treatment of facial injuries should be on patient stabilization followed closely by functional restoration and lastly, long-term cosmesis.

Nurses are among the first medical personnel that trauma patients encounter upon arrival at the emergency department. Their role in the assessment, critical care and management of the patient is crucial to the survival of the trauma patient. This course is designed to equip nursing staff with the necessary knowledge and basic skills to deliver optimum performance in emergency room settings. The basic anatomy, clinical manifestations, work-up and the acute management of facial trauma involving soft tissue injuries and fractures in adults are all reviewed in this course.

Definition of terms

Maxillofacial injury is another term for facial trauma. It refers to injuries to any of the bony or fleshy structures of the face, including the mouth, face, and jaw.

Epidemiology

There are approximately three million emergency cases of facial trauma reported in the United States each year. Most facial injuries in preschoolers and children between the ages of six and fifteen are due to accidental falls and account for about 78 percent and
47 percent of the cases, respectively. Approximately 10 percent of school-aged children attribute their facial injuries to parental abuse (4).

In older teenagers and young adults, violent crime or other personal assaults account for approximately 50 percent of facial injuries, followed by automobile accidents and sports mishaps, which account for 29 percent and 11 percent, respectively. Moreover, facial trauma in patients between the ages of 17 and 30 are more likely the result of gunshot wounds, while older adults attribute their injuries to violent attacks with blunt objects (4).

FACIAL ANATOMY

The face is a complex anatomical structure. It is made up of the anterior surface of the body that is bordered inferiorly by the chin and underside of the jaw and extends upward all the way to the frontal bone. Laterally, it also encompasses all the structures from the temporomandibular joint and the lateral edges of the right and left orbits (5). It does not include the temporal bones or other bones of the skull, such as those of the inner ears. Yet, inspection of drainage from the ears is an essential part of facial trauma assessment.

In order to understand the magnitude of facial trauma and the treatment required, nurses need to understand the basic anatomy of the structures involved. This type of injury involves the soft tissue structures such as skin, nerves, muscles, blood vessels, and glands, sensory organs such as eyes, nose, sinuses, ears, mouth, cheeks, as well as teeth and the bones of the face.

**Bones**

Underneath the thin layer of skin lies a complex array of facial bones. The maxillofacial area consists of three major parts, namely (4):
• The upper third of the face (upper face)
• The middle third of the face (mid face)
• The lower third of the face (lower face)

Each part houses various bone structures, as listed below in Table 1.

**Table 1: Facial Bone Structure**

<table>
<thead>
<tr>
<th>Maxillofacial area</th>
<th>Bone structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper face</td>
<td>Frontal (forehead), frontal sinus</td>
</tr>
<tr>
<td>Mid face</td>
<td>Nasal, ethmoid, zygomatic (cheekbone) and maxillary</td>
</tr>
<tr>
<td>Lower face</td>
<td>Mandible (jaw)</td>
</tr>
</tbody>
</table>

**Orbital region**

The superior orbital margin is composed of the frontal bone. The frontal process of the zygoma, the zygomatic process of the frontal bone, and the greater wing of the sphenoid form the lateral orbital margin. The inferior orbital margin is formed by the zygoma and maxilla. The zygomatic bones or cheekbones are connected to the maxillary and frontal bones. They form the zygomatic arch, which is the attachment point for the masseter muscle responsible for chewing and talking. The orbital apex is formed by the lesser and greater wings of the sphenoid, palatine, and part of the ethmoid (4).

The frontal bone or forehead is located anteriorly and forms the upper portion of the orbits and nose. It is fused with the zygomatic bones, maxillary bone near the midline and the nasal bones. The mid face is
the site of maxillary LeFort II and LeFort III fractures as well as fractures of the nasal bones, nasoethmoidal complex (NOE) or zygomaticomaxillary complex (ZMC), and the orbital floor. The frontal process of the maxilla, lacrimal bone, the angular and orbital process of the frontal bone, and the ethmoid bone form the medial orbital margin. The roof of the maxillary sinus forms the orbital floor. The maxillary bones do not move and are fused to other facial bones that make up the middle third of the face (4).

Facial bones have numerous functions, namely to (4):

- Protect the brain;
- House vital sensory organs such as the eyes, tongue, and nose;
- Provide the initial point of entry of the respiratory system;
- Support facial structures that perform the initial digestive process (mastication); and,
- Create the basis for communication through facial expressions.

The major palpable facial bones are the mandible, maxillary, nasal, zygomatic and frontal bones. The mandible or the jaw is the only movable bone of the face (6). It moves in multiple planes to assist in mastication and speech. This is particularly useful in the airway management of trauma patients with cervical spinal injury. Its manipulation in this type of patient is called the jaw-thrust maneuver. It involves the displacement of the tongue to prevent it from blocking the entrance to the trachea, thus ensuring a secure airway.

Light facial trauma only causes superficial injuries such as lacerations, abrasions, bruises and swelling. Severe trauma, on the other hand, can result in significant physical and functional damage if it also involves:

- Damage to underlying bone structures
- Traumatic brain injury
- Subdural or epidural bleeding
- Intracranial hemorrhage
- Brain herniation
- Cervical spine injury
- Airway compromise

For example, facial trauma involving the mandible and maxillary bones, which form the oropharynx can cause airway problems. A thorough initial assessment, detailed secondary assessment and ongoing monitoring are crucial to the identification of traumatic facial injuries, as well as any other injuries which may be life-threatening such as a compromised airway, breathing, and circulation (ABC).

**Sinuses**

The sinuses are the hollow cavities found inside the various facial bones that are connected to the nasal cavity through short ducts, which act as channels that facilitates the drainage of mucus. They consist of the following:

- Frontal sinus;
- Maxillary sinus;
- Ethmoid sinus; and
- Sphenoid sinus.

They are believed to help in warming and moistening of inhaled air as well as giving vocal resonance. Sinus congestion due to cold or allergic reaction results in vocal tone changes and sinus pressure alterations (7).

**Nerves**

There are various nerves innervating the facial region. The ophthalmic nerve is the first division of the trigeminal nerve and functions as a sensory nerve innervating the skin of the forehead, the upper eyelid, and conjunctiva. Its branches are the lacrimal,
supraorbital, supratrochlear, infratrochlear, external nasal, nasociliary, and frontal nerves (8).

The maxillary nerve is the second division of the trigeminal nerve. It also functions as a sensory nerve innervating the skin on the posterior part of the side of the nose, lower eyelid, cheek, and upper lip. Its branches are the anterior and posterior superior alveolar, infraorbital, zygomaticofacial, and zygomaticotemporal nerves (8).

The mandibular nerve is the third division of the trigeminal nerve. It is both a sensory and motor nerve innervating the masseter muscles and skin of the lower lip, chin, temporal region, and part of the auricle. Its branches are the lingual, inferior alveolar, dental, mental, buccal, and auriculotemporal nerves (8).

The facial nerve or cranial nerve (CN) VII innervates all of the muscles of facial expression. Its branches include the temporal, zygomatic, buccal, mandibular, and cervical nerves. The greater auricular nerve, a branch of the cervical plexus, innervates the angle of the mandible and skin over the parotid gland and mastoid process.

The other cranial nerves are listed below (8):

- CN I (olfactory) - Smell
- CN II (optic) - Vision
- CN III (oculomotor) - Eye movement; innervation of superior, medial, and inferior recti, inferior oblique, levator palpebrae, and smooth muscle pupilloconstrictor and ciliary muscle
- CN IV (trochlear) - Eye movement and innervation of the superior oblique
- CN VI (abducens) - Eye movement, innervation of the lateral rectus muscle
- CN VIII (vestibulocochlear) - Equilibrium and hearing
- CN IX (glossopharyngeal) - Taste, salivation, and swallowing
- CN X (vagus) - Taste, swallowing, palate elevation, and phonics
- CN XI (spinal accessory) - Head rotation and shrugging of shoulders
- CN XII (hypoglossal) - Tongue movement

**Vasculature**

The face is highly vascular. Primarily the external carotid artery supplies it. Among its branches are the lingual, facial, internal maxillary, and superficial temporal arteries.

Venous drainage is made possible by the superficial temporal, pterygoid venous plexus, retromandibular, lingual, facial, and external jugular veins. They empty into a common trunk to the internal jugular vein (9).
Injuries and fractures involving blood vessels may cause large hematomas or even exsanguination in severe cases. Despite the vulnerable position and anatomical make up of the face, it has extensive arterial anastomoses, including some that cross the face’s midline, which prevents ischemia in cases where circulation is disrupted or major blood vessels are ligated (9).

**Skin**

Skin is the largest organ of the body, comprising an area of between 16.1 ft² and 21.6 ft². Its average thickness is 0.1 mm and accounts for approximately 15% and 18% of the total body weight. It is made up of three major layers, namely:

- Epidermis (the outer shell);
- Dermis (the middle layer); and
- Subcutaneous (the lower layer).

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Its primary function is protection of the sensitive internal organs. It is the boundary between the internal system and harsh external environment. Because of its sustained contact with the outside environment, it is not surprising that it is the most injured human organ.

**Glands**

The parotid glands lie anterior to the auricle and posterior to the ramus of the mandible. The anterior path of the parotid duct opens into the internal wall of the cheek opposite the second upper molar. The submandibular and sublingual salivary glands are less commonly injured because their anatomical location provides them better protection (9).
**Muscles**

The face is also provided with a complex system of muscles. Injury of the extraocular muscles and those surrounding the mouth during trauma can have devastating consequences.

![Muscles of the face](image)

Similarly, fractures of the orbital floor can lead to entrapment of the inferior rectus, which is the muscle primarily responsible for rotating the eye downward. The orbicularis oris, which surrounds the mouth, frequently requires repair following complete perioral lacerations (9).

**SOFT TISSUE INJURIES**

Isolated soft injuries and those that are part of multilevel injuries are both among the most common traumatic craniofacial injuries encountered by emergency department personnel, and plastic surgeons. Soft tissue injuries are responsible for about 10% of all emergency department visits (10, 11, 12).

Soft tissue injuries are generally apparent upon initial physical examination. They do not pose life-threatening consequences to the trauma patient, though they pose the risk of permanent disfigurement and sensory impairment.
Soft tissue injuries to the face can involve the following:

- Eyebrows
- Eyelids
- Eyes
- Ears
- Nose
- Mouth/lips
- Tongue
- Face

**Skin injuries**

The most common traumatic injuries sustained to the skin are generally classified as:

- Abrasions
- Cuts
- Lacerations
- Avulsion
- Contusions

Nurses need to be able to discern characteristic patterns of these injuries and match them to their most likely cause. (See Table 2) (13).

### Table 2: Characteristics and Causes of Skin Injuries

<table>
<thead>
<tr>
<th>Characteristic pattern</th>
<th>Most likely cause</th>
</tr>
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<tbody>
<tr>
<td>Fingertip-like contusions</td>
<td>Forceful grabbing</td>
</tr>
<tr>
<td>Cord-like contusions/abrasions</td>
<td>Whipping</td>
</tr>
<tr>
<td>Fingernail, scratchy abrasions</td>
<td>Strangulation</td>
</tr>
</tbody>
</table>

Each injury may be isolated or part of a multisystem injury. Generally, the terms abrasions and cuts are less serious forms of skin injury and are mostly confined to the superficial layers. Lacerations, on the other hand, are medically regarded as a more serious wound, requiring immediate medical attention because of its threat to the underlying structures, usually nerves and blood vessels, beneath the superficial skin layer. The depth of each injury is the chief distinction between each term. Each skin injury is discussed in detail below.
**Abrasions**

An abrasion refers to a superficial damage to the surface of the skin. The injury is penetrating but usually does not penetrate deeper than the epidermis, the skin’s outer layer. An abrasion results in a roughened texture of the skin, accompanied by inflammatory manifestations such as the skin taking on reddish color, and being warm to touch (14).

Abrasions are not limited to the skin. In fact, it can occur to the cornea, which is the clear surface of the eye that covers the iris.

This type of injury usually happens when a sharp object such as a fingernail scrapes the corneal surface (e.g. during violent personal assaults) (14). Abrasions, being superficial wounds, heal quickly. They generally heal within a few days of the incident. Trapped foreign particles lodged in the surface of the skin are commonly removed with tweezers. The risk of infection is decreased with the use of topical antibiotics applied to the injured area (14).

**Cuts**

A cut is a neat and asymmetrical penetrating wound to the skin, which typically results in the puncture of the epidermis, and damage to the underlying vasculature, with blood being drawn into the opening. Sometimes, it may be deep and long enough to require stitches to close the opening. A cut is often caused by contact with a sharp object, such as a stick or the edge of a puck in ice hockey (14).
The healing time of a cut primarily depends on the extent of the skin damage. Generally, a period of 5 to 14 days is sufficient for the wound to close and heal (14).

**Lacerations**

A laceration is a serious injury characterized by the tearing of the skin, its fatty tissues or muscles beneath it. This type of skin injury is often associated with a significant blood flow from the opening in the skin, as well as damage to the underlying structures. It differs from a cut in that it is asymmetrical, and results in the affected skin appearing with jagged edges. Moreover, it penetrates deep into the tissues, resulting in heavy blood flow from the opening. It generally results in a permanent scar (14).

Lacerations expose the underlying structures beneath the skin to significant risk of infection, as foreign particles of all types have access to the tissues and the bloodstream. Tetanus, a serious disease of the central nervous system caused by the bacteria, *Clostridium tetani*, is a prime concern in treating a laceration. To avoid infection by this microorganism, a tetanus injection is often administered as a prophylactic measure. The nature and the depth of the laceration will almost always require stitches to close the wound (14).

**Avulsion**

Avulsion is a type of soft tissue injury characterized by surface trauma that results in the skin being torn away and the underlying structures (i.e.—subcutaneous tissue, muscle, tendons, or bone) beneath it exposed. It is similar to an abrasion but more severe, as body parts, such as an eyelid or an ear, can be partially or fully detached from the body; as demonstrated below (15).
Avulsions can occur with any soft tissue, such as (15):

- Skin
- Ear
- Eyelid
- Nail
- Nerve (brachial plexus)
- Tooth
- Periosteal

The most commonly encountered avulsion injury involves the skin. Skin avulsion usually occurs during motor vehicle accidents. Its severity can range from minor skin flaps to moderate degloving and the most severe form, amputation of a finger or limb. It is of two types (15):

- Suprafascial
- Subfascial

Suprafascial avulsions are characterized by deep skin removal, usually reaching the subcutaneous tissue layer. Suturing can repair small suprafascial avulsions, but most avulsions require skin grafts or reconstructive surgery. Subfascial avulsions, on the other hand, are more severe and involve the removal of structures found below the subcutaneous layer (15).
Skin avulsion injuries are common among rock climbers. They usually occur when climbers slip off holds, creating friction between their fingers and the holds. The skin injury in this sport is often referred to as a "flapper", its name derived from the appearance of loose skin flap on the fingers.

The ear is another soft tissue that is particularly vulnerable to avulsion injuries because of its vulnerable anatomical position (15). This type of injury is usually associated with human bites, falls, motor vehicle collisions, and dog bites (15).

A partially avulsed ear can be reattached via sutures or microvascular surgery, depending on the severity of the injury (17, 18). Microvascular surgery can also be used to reattach a completely avulsed ear (19, 20, 21). The ear can also be reconstructed with cartilage and skin grafts.

Eyelid avulsions are less common than skin and ear avulsion injuries (22). They are often caused by motor vehicle collisions (23), dog bites (24, 25), or human bites (24). Eyelid avulsions are sutured following a CT scan that determines the location of the damage to the muscles, nerves, and vasculature (23). Severe eyelid avulsion injuries may need reconstruction, however, this usually results in some loss of function and subsequent surgeries may be necessary to improve structure and function (25). Microvascular surgery is also used to repair the eyelid but is rarely used (26). Sometimes botulinum toxin is injected into the eyelid to paralyze the muscles while the eyelid heals (23).

Nail avulsions are another uncommon soft tissue avulsion injury. They occur when the nail plate is torn away from the nail bed due to trauma. Their management generally does not require sutures or surgery because the nail bed forms a germinal layer, which hardens as the cells acquire keratin and becomes a new nail (27).
Avulsion injuries can also occur with nerves. The brachial plexus, a network of nerves that communicates signals between the spine and the arms, shoulders, and hands, is particularly vulnerable to this type of injury.

Brachial plexus avulsion occurs when nerves are torn from their attachment to the spinal cord. It can occur during motor vehicle accidents and delivery. Trauma to the shoulder during motor vehicle collisions results in the detachment of certain nerves, causing neuropathic and intractable pain and loss of function in the arms, shoulders, and hands. Neuropathic pain may be managed with medication while the intractable pain may be managed with a procedure called dorsal root entry zone (DREZ) lesioning. Functional restoration can only be achieved through surgical reattachment or nerve grafts (30). Babies may also sustain brachial plexus avulsions during birth when their shoulders rotate in the birth canal causing the brachial plexus to stretch and tear (28). It is relatively uncommon and occurs in 1-2 out of every 1,000 births (29).

Tooth avulsion injuries occur when a tooth is either completely or partially dislodged from the socket and results in the exposure of the dental pulp. It can result in hypoxia and necrosis of the pulp.

Periosteal avulsions occur when the periosteum, a fibrous layer that surrounds a bone, detaches from the bone’s surface following trauma. An example of a periosteal avulsion is an ALPSA (anterior labral periosteal sleeve avulsion).
**Contusions**

Contusions or bruises occur following heavy, repeated or direct blows to the skin from blunt objects. In the case of muscle contusions, the trauma crushes the underlying muscle fibers and connective tissue without breaking the skin. It may be the result of accidents (e.g. motor vehicle), contact sports, or violent attacks on the person. It is important to note that an inconsistent history of the injury supplied by the patient and by family members are strong indicators of child abuse.

Sometimes, the trauma causes rupture of tiny blood vessels underneath the skin, pouring blood out, and accumulating within the damaged tissue. This is called a hematoma (31). In severe cases, swelling and bleeding beneath the skin may cause a shock. In case of extensive injuries, it maybe accompanied by a fractured bone, dislocated joint, sprain, torn muscle, or other injuries. The severity of contusions ranges from simple skin contusions to muscle and bone contusions to internal organ contusions.

**Burns**

Facial burns vary in severity from minor trauma to severe debilitating injuries. It has been estimated that more than 50% of burn injuries reported in the US involve the head and neck region. Usually, these injuries tend to be caused by flame, electrical current, steam, hot substances and chemicals (32).

A burn may solely involve the skin cells, although severe burns can involve the destruction of underlying structures such as fascia, bone and muscle. Normally, these structures allow the dissipation of heat and maintain their structural and functional integrity. However, this capacity is limited to mild temperatures. Exposure to high heat results in these structures absorbing it, resulting in their injury. This, in turn, triggers a series of inflammatory responses such as the rapid accumulation of extravascular fluid facilitated by cytokines (32).
Burn injuries may require multiple specialties in a burn center (33). Some of the goals of facial reconstruction following an injury include the restoration of function, comfort, and appearance. Some of the functional concerns in these patients include airway patency, protection of the cornea, oral continence, and neck mobility. Burn patients may experience sensory loss to the face, imparting a tight masklike sensation, distorting features and facial expression. Contractures, scarring, and pigmentary changes alter the burn patient’s appearance.

Burns are classified based on the severity (degree) of injury, namely (33):

- First-degree burn
- Second-degree burn
- Third-degree burn

A first-degree burn is also called a superficial burn. It only involves minimal tissue damage that is usually confined to the epidermis. Some of its most common causes are sunburn, scald, or flash flame. The appearance is dry and without blisters, with a pink color that is usually painful. Healing occurs over 5-10 days. Usually, no permanent scar occurs, but the tissue may discolor (33).

A second-degree burn involves the destruction of the epidermis and partial damage to the dermis. This type of burn is typically painful. Some of its most common causes are contact with hot liquids or solids, flash flame, or chemicals.

It typically manifests as a hyperemic, (sometimes pale), and moist skin with blisters. This type of burn usually results in loss of a variable depth of skin, although if treated appropriately, the epithelial cells undergo spontaneous re-epithelialization. This type
of burn typically heals within 10-14 days. Because the layer lost is capable of regeneration, no grafting is required. A deeper second-degree burn may take more than 30 days to heal and can become a full-thickness injury if it develops an infection (33).

Third-degree burns involve the destruction of both the epidermis and the entire dermis. Patients with third-degree burns usually do not feel pain at the site of injury because of the sensory loss due to damage to the nerve endings. Some of the most common causes are contact with hot liquids/solids, flames, chemicals or electricity. It is characterized by dry and leathery skin, which is grayish-white or translucent color and turns to brown or black color that is characteristic of an eschar. These burns do not usually heal spontaneously unless they are very small. The resulting scars can be disfiguring. Surgical intervention is usually indicated in this type of burn injury (33).

**EYE TRAUMA**

The eyes are very sensitive to injuries. Eye trauma refers to the general damage to the organ as a result of a direct blow to the eye. It is a leading cause of significant visual impairment (54).

An injury to the eye not only affects the organ itself, but can also extend to areas surrounding the eye such as adjacent tissues and bone structures. A blunt force hitting the eye that causes compression and retraction can lead to accumulation of blood below the injured area and other symptoms of eye trauma (50).

Eye injury is a common result of domestic or industrial accidents, assault, car battery explosions, sports injuries, and motor vehicle collisions. Other causes include strong
ultraviolet light, which can cause injury to the cornea (51). Occupational eye injuries are also fairly common but highly preventable, given their predictable nature and associated risk (52).

**Causes of eye trauma**

It must be mentioned here that eye injuries are sometimes superficial while some of the injuries are serious enough to result in vision loss. Chemical burns, retrobulbar hemorrhage and open globe injuries (including intraocular foreign bodies) are some of the most common and urgent eye injuries (53). The most common causes of eye injuries or eye trauma are listed below (55):

1. Entry of a small particle in the eye which damages the cornea, known as a corneal abrasion;
2. A foreign body stuck in the eye;
3. A sudden blow to the eye during sports activities or due to some other reason may cause the uvea to become inflamed and this is known as traumatic uveitis;
4. Exposure to dangerous and destructive chemicals which cause ocular chemical burn;
5. A cut in the eye, which may bleed.

**Chemical injury**

Chemical injury to the eyes may sometimes be very severe, causing a penetrating eye injury. Acids like sulfuric acid, sulfurous acid, hydrofluoric acid, acetic acid, chromic acid and hydrochloric acid and alkalis like ammonia, sodium hydroxide and lime may cause chemical burns in the eye. The symptoms resulting from this eye injury are pain, blurred vision, photophobia foreign body sensation, and blepharospasm red eye cloudy cornea (55).

**Retrobulbar hemorrhage**

Retrobulbar hemorrhage is an ocular emergency resulting from trauma to the orbital area. Bleeding within the orbital cavity results in compression of
orbital structures which, when left untreated, can ultimately lead to ischemia of the eye and optic nerve damage.

The main symptoms of this type of eye injury are eye pain, progressive visual loss, progressive ophthalmoplegia, and proptosis. Eyelid bruising, reduced pupillary response, a tense eyeball, and pallor or venous dilation of the optic disc, may also occur (55).

**Open globe (penetrating) eye injury**

Open globe eye injury refers to a penetrating trauma extending into the cornea or sclera. Clinicians need to remember that this type of eye injury may not always be visible (55).

**Blunt injuries to the globe**

Sports injuries, elastics snapping back or champagne corks are few of the causes of blunt injuries to the globe. The injury results in the compression of the globe in the anteroposterior direction and stretching of the globe equatorially which, in turn, affects the lens and iris along, causing damage at the posterior side of the pole of the eyes.

The resulting damage includes (55):

- Corneal abrasion
- Acute corneal edema
- Hyphaema
- Pupillary damage
- Iris damage
- Ciliary body damage
- Lens damage
- Posterior vitreous attachment
- Retinal damage
- Optic nerve damage
- Rupture of the globe

Some of the other injuries, which may occur, are orbital fractures, lid injuries, superficial conjunctival and corneal injuries, deterrent spray injuries, pepper spray exposure, super glue exposure, and certain non-accidental injuries (55).
DENTAL TRAUMA

Facial trauma often results in fractured, displaced, or lost teeth, which carry substantial negative impact on functional, esthetic, and psychological wellbeing of adults and children. In children, dental trauma to the primary teeth most commonly occurs between the ages of 2 to 3 years. Injuries on permanent teeth are usually attributed to falls, collisions, and contact with hard surfaces (57).

Classification of dental injuries
Dental trauma includes injuries to the teeth, supporting structures, gingiva and oral mucosa. The World Health Organization (WHO) has comprehensively classified dental trauma as injuries to the internal structures of the mouth. These are:

- Fracture of enamel of tooth
- Fracture of crown without pulpal involvement
- Fracture of root of tooth
- Fracture of crown and root of tooth
- Fracture of tooth which is not specified
- Luxation of tooth
- Intrusion or extrusion of tooth
- Avulsion of tooth
- Other injuries which may include laceration of oral soft tissues

Causes of dental injuries
Home accidents are cited as one of the most commonly reported causes of dental injuries to the primary dentition. Accidents at school and other places are also commonly attributed to this type of injury. Sport injuries, accidents due to violence and road traffic accidents are the other common causes of dental trauma (56).

A large maxillary overjet and incomplete lip closure is an important predisposing risk factor of dental trauma. The severity of the dental injuries will increase in the presence of such predisposing factors. It is also important to mention here that when an injury to a
primary tooth takes place, there may be possible complications such as the appearance of a vestibular sinus tract and color change of the crown.

**Fracture of the enamel**
Tufts initiate a fracture to the tooth enamel; and, hypocalcified defects at the junction of enamel and dentin followed by a growing longitudinal fracture around the enamel coat (58).

**Fracture of crown without pulpal involvement**
This type of fracture is also known as enamel–dentin fracture. It does not involve the pulp.

**Fracture of the root**
This is a dentin and cementum fracture, which involves the pulp. A succedaneous tooth may hide a root fracture in a primary tooth.

**Fracture of the crown and root**
This is an enamel-dentin and cementum fracture with or without pulp exposure.

**Luxation**
Subluxation is defined as an injury to the tooth supporting structures accompanied by an abnormal loosening of the tooth but no apparent displacement. Lateral luxation occurs when tooth is displaced in a direction, which is not axial. In this case, a periodontal ligament tear and contusion or fracture of the supporting alveolar bone is seen.

**Intrusion or extrusion**
An intrusion of tooth is an apical displacement of tooth into the alveolar tissue. The tooth impinges upon the periodontal ligament once it forces itself inside the alveolar bone and results in a crushing fracture of the alveolar socket.
Extrusion may be defined as a partial displacement of the tooth axially from the socket. In this case, a torn periodontal ligament is usually seen. Extrusion is also termed as partial avulsion.

*Avulsion of tooth*

Avulsion is the complete displacement of tooth out of its socket. The periodontal ligament is broken and fracture of the alveolus can occur. This was discussed in the subsection, “avulsion”.

**FRACTURES**

Facial and skull bones are composed of an intricate network of bones that function to protect the body’s control center, the brain. In order to assess the severity of facial fractures, healthcare professionals need to understand both the facial anatomy as well as the common fracture patterns of the face.

Facial fracture or maxillofacial fracture is an injury that is most often attributed to broken bones in the face. Due to the presence of elaborate network of nerves and vascular tissues in the facial region, facial trauma such as fractures is characterized by contusion, pain and inflammation (36).

Facial fractures are attributed to impact forces, which produces trauma upon collision with the facial region. High-velocity and low-velocity forces are those that are greater and lesser than 50 times the force of gravity, respectively. Some facial regions such as the zygoma and nasal bone only require a low-velocity force to be fractured, while the supraorbital rim, the maxilla and the mandible (symphysis and angle), and frontal bones are stronger and require a high-velocity force to be damaged.

*Maxilla*

Maxillary fractures involve the mid face; specifically, the two maxillae forming the upper jaw, the anterior portion of the hard palate, the lateral walls of the nasal cavities and floor of the orbital cavities. These fractures are generally a result of trauma from high-
velocity impact such as seen in motor vehicle accidents. The most common symptoms of maxillary fractures include (40):

- Changes in the dental occlusion or misalignment of the teeth
- Visual problems
- Clear nasal discharge

Early in the 20th century, René Le Fort mapped distinct locations for the maxillary facial fractures, which came to be known as Le Fort I, Le Fort II and Le Fort III fractures. Le Fort fractures comprise almost 10% to 20% of the total facial fractures, and these are frequently linked with serious injuries. For a long period of time, this system was used to categorize injuries. The common feature of the Le Fort fracture is the extension of the fracture through the pterygoid plates (44).

Falls, assaults, sports injuries, vehicle crashes, blunt assaults, gunshots and blasts, animal attack, occupational hazards and vehicular trauma can all lead to Le Fort fractures. Sometimes, Le Fort fractures cause the mid face to move in comparison with the rest of the face or the skull (42).

A Le Fort fracture is defined as a fracture of the mid face bones, cheekbones, and the bones under the eye. Injuries to the eye and brain commonly occur with these types of fractures.

**Le Fort I**

Le Fort I is also termed as Guérin fracture or horizontal maxillary fracture.

Le Fort I is a fracture of the maxilla just above the teeth in a transverse plane. It extends horizontally over the inferior portion of the
maxilla. It is a result of a direct downward blow on the maxillary alveolar rim, causing the segregation of the alveolar process and the hard palate from the rest of the maxilla. The fracture may reach up to the nasal septum, lateral maxillary sinus wall, and inside the palatine bones and pterygoid plates. This type of fracture may cause facial edema, loose teeth, and a mobile hard palate (40).

The symptoms of Le Fort I fracture are inflammation of the upper lip, ecchymosis in the buccal sulcus below the zygomatic arch, malocclusion, and increased mobility of teeth. The characteristic ecchymosis in the greater palatine vessels shows the presence of Guerin’s sign.

**Le Fort II**
Le Fort II is a fracture of the apex of the maxilla located above the bridge of the nose in a pyramid and draws out in a lateral and inferior plane through the infraorbital rims. It is shaped like a pyramid and generally occurs due to a blow to the lower or mid-maxilla. It covers the nasal bridge up to the frontal process of the maxilla to the lacrimal bones and inferior orbital floor and rim, up to or close to the inferior orbital foramen and through the anterior wall of the maxillary sinus.

It may cause facial edema, epistaxis, sub conjunctival hemorrhage, cerebro spinal fluid rhinorrhea, mobile maxilla or a broadening of the nasal bridge (40).

**Le Fort III**
These types of fractures are commonly termed as craniofacial disjunction and transverse facial fractures. It crosses the front of the maxilla and involves the
lacrimal bone, the lamina papyracea, orbital floor and the ethmoid bone. These fractures are the most serious type of all Le Fort fractures.

Le Fort III is a total disruption of the craniofacial structure involving the fracture of zygoma, infraorbital rims, and maxilla. The main cause of this type of fracture is a serious forceful injury that is usually attributed to contact sports. The injury may result from a hockey puck, baseball pitch, or baseball bat. Patients with this type of fracture may complain of diplopia, malocclusion or numbness.

The symptoms seen with Le Fort III fracture are gross edema of the soft tissue above the region of the middle face, bilateral circumorbital ecchymosis, bilateral subconjunctival hemorrhage, epistaxis, cerebrospinal fluid rhinorhea, dish face deformity, diplopia, enophthalmos, a "cracked pot" sound, tenderness and segregation at the frontozygomatic suture, lengthening of the face, depression of the ocular levels, hooding of the eyes, and slanting of the occlusal plane with gagging on one side.

Except for the Le Fort I fracture, "pure" Le Fort fractures are not generally seen. They mostly occur as variants of the Le Fort classification. One common example is the Le Fort II - tripod fracture complex. This type of Le Fort variant fracture is primarily attributed to large forces encountered in a motor vehicle accident. When describing these injuries, one should potentially give a separate diagnosis to each half of the face. Other complex variants of the Le Fort fracture may be encountered such as a mixed LeFort II/LeFort III complex or a LeFort III/LeFort II/tripod complex.

**Mandible**

Maxillofacial trauma often leads to mandible fracture. Broken noses usually accompany it. Often the jaw is fractured in more than one place. The most common symptoms of jawbone fracture include:

- Pain and tenderness in the jaw
- Inability to bring teeth together
- Bruising below the tongue
- Numbness of the chin

A trauma to the mandible results in a fracture, which is generally accompanied by other injuries such as ipsilateral body fracture and contralateral subcondylar fracture. A dense blow to the symphysis often results in a symphyseal fracture and bilateral subcondylar fractures. Mandible fractures are often the result of road traffic accidents, assault, falls, and industrial injuries or sports injuries (39).

**Nasal bone**

Due to its prominent location on the face, the nose and subsequently, the nasal bone, is the most injured facial structure. Despite its common occurrence, it is an often-missed diagnosis. It is sometimes visible when viewed on a standard lateral skull film, although it is viewed more clearly when the film is shot with special low kVp nasal bone technique (essentially, a soft tissue technique).

The clinician must always look at the nasal spine (part of the maxilla) as well for subtle fractures. One common mistake that many clinicians make is viewing the normal sutures lining the nasal bone, as well as the linear channel for the nasociliary nerve and mistaking them for a fracture. To avoid this, the clinician must do well to remember that this channel runs parallel to the bridge of the nose, while most nasal bone fractures will run *perpendicular* to the bridge. Additionally, clinicians need to remember that nasal fractures almost always occur with more extensive injuries, such as those to the orbital rim or floor and the ethmoid or frontal sinuses.
The manifestations of nasal bone fractures are (34):

- Inflammation
- Epistaxis
- Tenderness
- Deformity
- Crepitus
- Periorbital ecchymosis
- Injury and trauma to the bridge of the nose causing fracture of the ethmoid bones
- Clear fluid discharge from the nose or a persistent bleeding in the nose

Septal deviation or septal hematoma may also be present. The nasoethmoid fractures are those that involve the nose and extend down to the ethmoid bones. This type of fracture may lead to damage or destruction of the lacrimal apparatus, canthus, nasofrontal duct or dural tear at the cribiform plate.

**Zygoma**

The most significant cause of this type of facial fracture is motor vehicle accidents and violent assaults. The blow delivered from slightly above and anterolaterally displaces the cheekbone. Fractures may also occur at the zygomatic arch in which case, the depressed temporal arch can impinge on the coronoid process of the mandible (34).

One of the characteristic manifestations of the zygomatic fractures is diplopia, which in some cases, may be persistent in nature. The other common symptoms associated this type of fracture are (36):

- Flattened cheeks
Zygomatic fractures occur in 2 to 3 places on the zygomatic arch. Two breaks commonly occur; one at the end of the arch and the other one in the middle resulting in a fracture which may be seen as a “V”. It impinges on the temporalis muscle leading to a condition known as trismus.

**Frontal bone**
A severe blow to the forehead usually causes frontal bone fractures. If the posterior wall of the frontal sinus is also broken or injured, a dural tear may occur. The frontal bone fracture may be diagnosed by tenderness, a disruption of the supraorbital rim, subcutaneous emphysema and decreased sensitivity of the supraorbital, and supratrochlear nerves (40).

Fractures involving the frontal bone occur at the junction of the zygoma between the frontal maxilla and the zygomatic arch, which extend upward to the orbital floor. In this case, the infraorbital nerve can be damaged leading to hypoesthesia of the area (38).

**Frontal sinus fractures**
A severe blow to the frontal or supraorbital region, which can lead to fracture of the anterior and/or posterior wall, causes frontal sinus fractures. The patient may experience numbness in the distribution of the supraorbital nerve.

WORK UP: PHYSICAL EXAM AND TESTS

**Physical exam for soft tissue injury**
Patients with apparent facial trauma must have their airway, breathing, and circulation (ABCs) thoroughly evaluated. Because of the close proximity of the face to the neck and
upper spine, cervical spine injury must also be considered based on the mechanism of injury, and the appropriate precautions taken accordingly. Additionally, the physical exam must also focus on the specific injury site (46).

As mentioned previously, the facial region is highly vascular, prone to copious bleeding even with minor injuries. Nurses and first aid responders need to irrigate these wounds thoroughly to clean and accurately assess the injury. They should follow this up with visual inspection and palpation to evaluate changes in facial symmetry; and, may proceed as follows (46):

1. Begin superiorly at the scalp and frontal bones.
2. Then, proceed inferiorly and laterally.
3. Examine the oral cavity for avulsed tooth or lacerations. Check for redness and swelling since their presence is indicative of a possible greater significant underlying injury.
4. Pay attention to the location, size, shape, and depth of any lacerations, and check wounds for tell-tale signs of lodged foreign bodies.
5. Palpate for areas of crepitus or bony step-off.
6. Perform a neurologic assessment and check the gross asymmetry to uncover any underlying nerve damage.

**Orbital rim**

The orbital rim must be inspected carefully since injury to the area may involve an underlying fracture. Follow the procedure below (46):

1. Palpate the rim around its circumference. During this aspect of the exam, the clinician may note subtle displacement of the rim by placing an index finger on each infraorbital rim, and viewing from above or below with the patient’s head tilted back.
2. Pay close attention to sensory and motor deficits in the area.
3. During repair, the clinician must be careful not to alter the alignment of the brow borders.
4. Additionally, during repair, the eyebrow must not be shaved since it can lead to significant cosmetic deformity. This is because injuries to the brow may cause the hair to either not grow back at all or to grow back abnormally. For example, the brow may grow back with an abnormal pattern or color.

**Eyelids**

Eye lacerations that do not involve the margins may be treated as simple wounds that do not require concern for underlying eye injury. However, if the lacerations are severe and the eyelid’s protective function is compromised, further examination and medical intervention is necessary. In this case, the clinician needs to check for the presence of foreign bodies by flipping the eyelids over and examining the tarsal plate.

Any damage to the tarsal plate needs an immediate referral to an ophthalmologist for repair. In another note, the presence of ptosis is indicative of injury to the levator aponeurosis, which must also be referred to an ophthalmologist. Other injuries that may also require ophthalmological referrals are injuries involving the canthi, lacrimal system, or lid margin (46).

**Eyes**

When examining the eye, check for the following:

1. Gross injury or global asymmetry (59, 60).
2. Papillary responses to direct or indirect light. Also, check for blood, iris rupture, or asymmetry.
3. Foreign bodies, abrasions, tears or laceration. Examine the cornea for such injuries, and if needed, use fluorescein
dye and tetracaine (or other topical ocular anesthetic) to help ensure an adequate eye exam.

4. An impaired movement is indicative of nerve entrapment, injury to one of the extraocular muscles or any of the nerves innervating the globe (e.g. cranial nerves III, IV, and VI). The conjugate gaze and smooth pursuit must be evaluated, as illustrated below.

5. During sporting events wherein athletes present with this type of injury, a hand-held eye chart is used for gross investigation of visual acuity. Massive loss of visual acuity is indicative of global, retinal, nerve, or central injury. Therefore, such injury must be referred urgently to further ophthalmologic care.

**Ears**

A direct trauma to the ear can lead to torn blood vessels at the perichondrium level and cause a condition known as subperichondrial hematoma. This type of injury may lead to substantial cosmetic deformity if undiagnosed or fails to receive adequate
and immediate treatment. Within two weeks following the trauma, the development of fibrosis is seen, with the patient manifesting with abnormally shaped pinnae, a condition also known as cauliflower ear.

Blunt injury may also lead to perforation of the tympanic membrane. This is why an otoscope is necessary to visualize the defect and check for abnormal discharges (e.g. blood). Clinicians need to remember that this type of injuries is usually asymptomatic which is why they need to examine the ear structures carefully to avoid permanent damage. General symptoms such as vertigo and otalgia may be present (46).

**Nose**

Nasal fractures are apparent to the eye because of the visual deformity they cause (61). However, this is not always the case since epistaxis in the absence of obvious nasal deformity may be the only outward manifestation in some nasal fractures.

This is why it is still important to perform an adequate and thorough nasal examination, including palpation, after epistaxis has been put under control. The origin of most nasal bleeding can usually be traced back to the highly vascular area on the anterior septum (Kiesselbach area).

Following control of epistaxis, a thorough examination of the nasal structures using a nasal speculum must be performed, with the clinician noting the position and structural integrity of the nasal septum. The turbinates and inferior meatus need to be checked bilaterally, and the septum inspected for the presence of a septal hematoma. Soft tissue injuries to the mucosal area (e.g. lacerations) must be noted because of their close association with underlying nasal bone fractures (46).
**Mouth and lips**

Clinicians should visually check the lips closely and look if there’s a disruption to the vermillion border. If this injury remains unchecked and subsequently unrepaired, it can result in permanent cosmetic deformity. It should be noted that even a tiny disruption (such as 1 mm) to the vermillion border is visible to the naked eye at a normal face-to-face distance (46).

After the examination of the vermillion border, the clinician can proceed to examine the internal side of the lip and cheeks for penetrating wounds. The area surrounding the parotid gland must be checked carefully. The clinician can check its function and patency by milking it observing the flow of saliva from the Stensen duct. A suspected injury to this area must be further evaluated to arrange for possible stenting and repair. Other signs to look for during intraoral examination are disrupted teeth and hematoma (46).

**Tongue**

Another part to be examined during intraoral examination is the tongue. Clinicians need to check it for lacerations. Usually, tongue lacerations do not warrant surgical repair except in cases where there is a complete anterior laceration. If left untreated, this type of laceration can lead to a bifid tongue. Penetrating and deep lacerations have to be inspected carefully for the presence of lodged foreign bodies and the potential need for repair (46).

**Facial nerve**

Clinicians also must examine the sensory perception for each of the three branches of the trigeminal nerve (CN V). Neurological deficits in any area must be investigated further. In the illustration below, nerve damage can result in facial asymmetry. Injuries
along a topographic line extending from the tragus to the base of the nose, and lateral to the lateral canthus, are indicative of a parotid duct injury \(^{46}\).

**Physical exam for facial fractures**

Like the physical examination of soft tissue injuries, the approach to facial fractures follows in the same manner – thorough and step-by-step. For example, the clinician may choose to proceed with the examination by starting with the internal anatomy followed by the external structures. Each area examined should incorporate inspection, palpation, and sensory and motor testing \(^{47}\).

The examination may begin with the oral pharynx. Check this area for lacerations, evidence of tooth avulsion, or the presence of foreign bodies. Clinicians need to carefully examine the dentition for obvious tooth mobility, which is highly suggestive of underlying bone fractures. This is to be followed by the assessment of each facial region including the mandibular, maxillary, zygomal, nasal, orbital, and frontal bones. Apparent signs of injury must be inspected carefully. The mandible must be assessed for trismus and mobility while the mid face checked for stability and depression of the bones \(^{47}\). Lastly, the clinician needs to test the motor and sensory function of the facial nerves and muscles following inspection and palpation.
There are four general points to remember about the findings of this physical exam, namely:

1. Hypoesthesia in the infraorbital or supraorbital nerve areas is indicative of an orbital fracture;
2. Reduced sensation of the chin is suggestive of inferior alveolar nerve compression from a mandibular fracture;
3. Trismus, spasm of the muscles of the jaw is usually found secondary to mandibular or zygomatic fractures; and
4. Nasal fluid discharge should be investigated further for possible cerebrospinal fluid rhinorrhea, which is indicative of anterior cranial base disruption.

The physical findings of each of the facial fractures are further discussed in detail below.

**General facial region**

Facial trauma is rarely a one-area injury. Several bones and soft tissues are usually involved. Some of these lead to facial asymmetry. This is why clinicians need to palpate all of the bones, including the temporomandibular joint.

**Frontal sinus fractures**

When frontal fractures are suspected, check for a visible or palpable depression in the frontal sinus area. A fracture of the posterior wall is highly suggestive of dura fracture, which can manifest as CNS depression, CSF rhinorrhea, or finding of visible brain matter (47).

**Orbital fractures**

The clinical manifestations of orbital fractures are ecchymosis and edema of the eyelids, subconjunctival hemorrhage, diplopia with limitations in upgaze or downgaze, enophthalmos, infraorbital nerve anesthesia, or emphysema of the orbits/eyelids. Clinicians will do well to remember that the single most significant clinical feature of orbital floor fracture is entrapment of the inferior rectus muscle, resulting in impaired upward gaze on the affected side. Additionally, this is usually accompanied by
entrapment of the inferior orbital nerve, which manifests as decreased sensation to the cheek, upper lip, and upper gingival region on the affected side (47).

Both muscle and nerve entrapment are more frequently reported among children because their bones are still growing, more flexible, and show a linear outline that goes back to create a "trap-door" fracture. The same cannot be said for adults because adult bones are more likely to be thinner, and thus have greater chance of shattering completely. Other clinical findings associated with orbital fractures are enophthalmos, a condition wherein the eye appears to recede into the orbit; and orbital dystopia, a condition wherein the injured eye appears lower in the horizontal plane relative to the uninjured side (62).

**Nasal fractures**

Nasal fractures usually manifest as epistaxis, swelling, tenderness, deformity, crepitus, nasal airway obstruction, and periorbital ecchymosis. The image to the right depicts a testing of the nasal airway passage, a simple method to gather information on the function of the internal patency of the nose.

As mentioned previously, clinicians need to evaluate for septal deviation or septal hematoma. A bulging, bluish, tender septal mass requires evacuation. Failure to do so can result in necrosis of the nasal septum. Widening of the intercanthal distance is indicative of a nasoorbitoethmoid fracture.

**Zygomatic fractures**

Zygomatic fractures can result in temporalis muscle impingement. These can manifest as trismus, however, this is not always evident.
Other clinical findings of zygomatic fractures are inferior orbital rim depression and paresthesia in the distribution of the infraorbital nerve. The finding of diplopia indicates a fracture that extends into the orbit or maxilla.

**Maxillary (Le Fort) fractures**

Maxillary fractures are usually seen manifesting as distorted facial features. Patients usually present with an elongated face, a mobile maxilla, or mid face instability and malocclusion.

Grasping the anterior alveolar arch and pulling forward while stabilizing the patient with the other hand may test mobility of the mid face. The level of a Le Fort fracture I, II, III is often determined by noting the structures of the mid face that move in conjunction with the anterior maxilla.

A study by Schwab et al explored the physical examination characteristics that predicted a mandibular fracture. The tongue blade test assesses the ability of patients to grasp a tongue depressor in between the teeth and the patients' ability to hold the blade against mild resistance by the examiner on each hemimandible.
The result of the study found that inability to hold the tongue depressor had a negative predictive value (NPV) of 96%, whereas malocclusion had an NPV of 87%; facial asymmetry, 76% and trismus, 75% (63).

**Lab studies**

Following physical examination of facial injuries, clinicians should order a series of lab studies. The labs consist of:

- Primary survey level
- Initial imaging tests
- Secondary survey level
- Tertiary survey level

Each test is required to determine the priorities of care for the trauma patient.

Laboratory tests are required for the injuries to the face especially those incurred to the soft tissue. The laboratory studies, which are recommended for the patients of facial trauma, are (64):

- Complete blood count (CBC) every 4 hours to keep track of hemoglobin and hematocrit in case of excessive bleeding;
- Sequential multiple analysis of 20 chemical constituents;
- Blood type and cross match;
- Coagulation studies; and
- Beta human chorionic gonadotropin (bhCG) studies.

Complete blood count (CBC) is important since it helps in evaluating blood volume from traumatic loss. The values of acute measures, if normal, may also be deceiving since third space fluid volumes are not yet mobilized to the endovascular space (67).

The secondary level of examination is also important. The patient’s cardiac rhythm with pulse oximetry, frequent blood pressure measurements, mental status exam, and
clinical assessments of peripheral perfusion needs careful monitoring. End tidal carbon dioxide monitoring is also considered to be useful (66).

The tertiary level needs a new lab panel in patients with multiple injuries. These lab tests are comprised of a complete blood count, coagulation panel, arterial blood gas, and serum lactate (66).

**Chemistry**

It is important to assess overall fluid states and renal function especially in cases where general anesthesia may be required during treatment or surgery. Blood sugar level elevation is also significant in severe trauma. This factor is of importance in wound healing and risk of infection (67).

**Toxicology**

Toxicology is necessary to identify increased blood alcohol levels, the presence (or absence) of narcotic drugs, or any prescription medicine, which may affect the patient’s sensory responses and contribute to cardiovascular or neurologic side effects. Toxicological assessment is also important in those cases that may require anesthesia (67). Patients who are intoxicated with alcohol or other chemicals are sometimes unable to cooperate with diagnosis and management of their potential injuries and may need rapid sequence induction and endotracheal intubation to allow for their secondary survey and diagnostic imaging as well (66).

**Imaging studies**

Magnetic resonance imaging is ideal for detecting soft-tissue injuries such as:
- Optic nerve edema or hematoma;
- Ocular muscle disorders (incarceration, hematoma, disruption);
- Intraocular disorders (hematoma); and
- Foreign bodies in the orbit.

**Radiography**

Radiography is required for patients with facial injury for two primary reasons, namely:
1. To provide the surgeon with information about the major fractures and disruption of the facial skeleton, and;
2. To demonstrate any type of displacement of the fracture fragments which may be present.

The information provided by radiographic study forms the basis for the selection of surgical techniques to repair, manage, and stabilize fractures.

**Plain radiograph**

Plain radiographs are more commonly referred to as x-rays. Initial portable radiographs and other procedures are indicated to assess and determine the bone condition of the trauma patient. Conventional radiography, together with computed tomography (CT) and MRI, is needed in detecting facial fractures and determining their direction, extent, and displacement.\(^{68}\)

Plain film radiographs are generally useful for the evaluation of the status of the cervical spine, especially to check whether the trauma extends to the spine or not. Primary emergency medicine or trauma service management protocols usually include the radiographic exams, however, their usefulness is limited in the assessment of craniofacial traumatic injuries.\(^{67}\)

**Pluridirectional tomography**

Pluridirectional (complex motion) tomography is the imaging study of choice in the evaluation of facial injury. It has the advantage of showing the injury with such detailed clarity including the obscure or ‘only suspected’ injuries on plain radiographs. It is especially of great importance in determining the extent of facial injury in patients whose multiple injuries make them poor candidates for routine radiography studies.\(^{65}\)

**Computed tomography (CT)**

Computed tomography (CT) is important in evaluating facial injuries which are otherwise
not possible or hard to detect by conventional radiography methods. These injuries include intraorbital and retrobulbar hematomas. The details of the bone and its displacement are also demonstrated with clarity while performing computed tomography in "bone mode." The image to the right shows a Le Fort III fracture.

The images captured by CT may also be adjusted to optimize bone images. The coronal and sagittal images are easily seen using CT. One disadvantage of CT is it is hard to capture images in patients who are seriously injured and cannot lie still for long periods of time to allow for the collection of trans-axial data necessary for reconstruction (65).

CT allows for the accurate reconstruction of the facial fractures in detailed 3-dimensional images. It provides excellent depiction of the bony architecture. Additionally, it can also demonstrate the presence of radiopaque foreign bodies, which may have embedded in the soft tissue, as well as damage to underlying vascular structures of the face. Lastly, it allows for the visualization of soft tissue fluid accumulation (67).

Generally, CT has one distinct advantage over other imaging studies, i.e., it can demonstrate both bone and soft tissue involvement. As such, it is considered to be far superior to pluridirectional tomography in the assessment of facial injuries. Therefore, plain radiography should be followed by computed tomography in facial trauma, unless strong evidence indicates the need for pluridirectional tomography (69).

Computed tomography is also helpful in pointing out the exact location of neural injury and fractures. In addition, it may also demonstrate cerebrospinal fluid (CSF) leaks, which occur in fractures of the frontal and ethmoidal bones, and sphenoidal sinus walls.

**Angiography**

Compelling results from research studies have found that injury to the carotid and vertebral arteries following a blunt high-energy cranio-cervical trauma is a risk factor for
thromboembolic stroke. Consequently, it is important to identify such risks early on to enable clinicians and other members of the healthcare team to prevent their occurrence.

Angiography is used to determine the features and extent of arterial injury. Selective cerebral angiography is an angiographic technique used in high-risk trauma patients. Patients with skull-base or facial fractures are the best candidates for angiographic studies. These studies form the basis for the clinical management of such injuries (70). Angiography is also indicated in cases of Le Fort fractures, especially when injury to the carotid artery or internal maxillary artery is strongly suspected. In this case, angiography is used to identify the site of arterial bleeding before embolization (71). Selective angiography may also be needed in case of bleeding from the posterior superior alveolar artery (72).

Bleeding following facial fractures may have life threatening consequences, especially when they are difficult to bring under control by traditional means. It is in cases like these that super selective arteriography is needed to allow for accurate localization of the bleeding site and immediate embolization of the offending vessel (73).

Most studies that assess the role of CT angiography in blunt neck trauma patients have found its accuracy equivalent to catheter angiography. CT angiography is capable of visualizing cervical subluxations-dislocations, fracture lines reaching an arterial structure, and high-impact mechanisms of injury. It is the most frequently used modality in the evaluation of patients who are suspected of having a blunt vascular injury in case of facial fractures (74).

The indications for multidetector CT angiography include screening, which are (75):

- Minimal intimal injury
- Raised intimal flap
- Dissection with intramural hematoma
- Pseudoaneurysm
- Occlusion
• Transection, and
• Arteriovenous fistula

**Initial evaluation using imaging studies**

There are a variety of imaging study techniques the radiographer can choose from for each region of the face. (See Table 3) (64).

**Table 3: Imaging Techniques**

<table>
<thead>
<tr>
<th>Region of the face</th>
<th>Imaging technique of choice</th>
<th>Alternative technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper face</td>
<td>Axial and corona CT scan</td>
<td>Skull series, Waters view radiograph</td>
</tr>
<tr>
<td>Mid face</td>
<td>Axial and coronal CT scan</td>
<td>Waters view radiograph and posteroanterior, submental vertex (jug-handle), and occlusal views</td>
</tr>
<tr>
<td>Lower face</td>
<td>Panoramic radiograph</td>
<td>Axial and coronal CT scan, posteroanterior view, right and left lateral oblique view of the mandible, elongated Townes projection radiograph, and occlusal views</td>
</tr>
</tbody>
</table>

A CT scan of the condyle is indicated if a fracture is strongly suspected and the accompanying radiographic findings are negative.

**TREATMENT, MANAGEMENT AND PROGNOSIS**

**Pre-hospital care**

Maxillofacial trauma is commonly associated with many head injuries. The outcome of such injuries largely depends on the pre-hospital care and subsequent emergency room treatment provided to the patient. Timely resuscitation and surgical intervention are considered to be of prime importance for better prognosis.

Emergency department nurses are considered to be at the front line of patient care. This is because, on a typical day, they are responsible for resuscitating patients, triaging and treating less urgent patients, providing care and treatment of their injuries, and
providing the evaluation and support needed for a patient to return home. Because of the critical nature of their work, they need to act with a high degree of autonomy and have the ability to initiate treatment with limited direction while at the same time educating and supporting the patient and their family.

There are several clinical challenges faced by nurses and other health professionals at this critical time of their patients’ lives, including (76):

- Airway management
- Circulation
- Intubation
- Neurologic assessment and management
- Exposure control

Airway management is of primary importance in patients with facial fractures since oronasal bleed and disruption of the facial structure is a grave challenge in maintaining airway access. Support for the circulatory system is also critical since facial trauma patients most likely have associated circulatory shock. Respiratory distress, deteriorating clinical condition, intra-oral bleed and progressive decrease in the Glasgow Coma Scale (GCS) score (shown in the representative table, below) present a huge clinical challenge to emergency care personnel (76).
Airway management

The timely and appropriate management of airway in patients with facial injuries is of high significance because a compromised airway can very well lead to death. The main goal in the early management of the severely injured patient is the provision of sufficient oxygen to the tissues so that any organ failure or secondary central nervous system damage can be prevented (84).

Hemorrhage, tissue prolapse, and edema can all cause airway obstruction, which may require emergent intervention such as intubations. Patients with maxillofacial trauma are faced with a unique set of challenges in developing, operative and post-operative stages.

The establishment of a patent airway is the first priority in patients with severe facial injuries. The mouth needs to be cleared of any obstruction such as knocked out teeth and foreign debris. Blood should be suctioned out to clear the oral cavity. The administration of a high concentration of oxygen allows for sufficient tissue perfusion.

Table 4: The Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Eyes Opening</th>
<th>Verbal response</th>
<th>Motor response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - none</td>
<td>1 - none</td>
<td>1 - none</td>
</tr>
<tr>
<td>2 - to pain</td>
<td>2 - incomprehensible sounds</td>
<td>2 - abnormal extension</td>
</tr>
<tr>
<td>3 - to voice</td>
<td>3 - inappropriate words</td>
<td>3 - abnormal flexion</td>
</tr>
<tr>
<td>4 - spontaneously</td>
<td>4 - confused</td>
<td>4 - withdraws from pain</td>
</tr>
<tr>
<td></td>
<td>5 - orientated</td>
<td>5 - localises to pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 - obeys commands</td>
</tr>
</tbody>
</table>
An oropharyngeal airway may also be used to maintain airway patency while at the same time, exerting lesser force on the vertebrae.

A nasopharyngeal intubation can improve the airway function in cases where an oropharyngeal airway is not tolerated.

The patient’s ability or lack thereof to breathe is the basis for allowing spontaneous breathing or provision of assisted ventilation. Assisted ventilation, with the use of facemask and reservoir bag, is considered to be extremely important in pre-hospital airway management, even more so than intubation (79).

Once the safety of the patient has been secured, the second concern is the establishment of manual in-line stabilization of the cervical spine. In unconscious patients, head and neck should be maintained in neutral alignment. Alternatively, a correctly sized hard cervical collar, lateral blocks and straps across the forehead, and chin piece of collar can be used. A jaw thrust may be delivered to effectively relieve airway obstruction with reduced consciousness.

**Intubation**

Tracheal intubation is needed in those cases listed below (79):

- Life threatening hypoxemia which is imminent and cannot be relieved by simple airway management;
- Aspiration threats posed by blood or stomach contents; and,
- Anticipated occlusion by edema, hematoma, or displacement of a laryngotracheal fracture to preserve the airway.

Normally, intubation also requires drug assistance. If intubation can be successfully achieved without the use of drug, it is reflective of a poor prognosis. There is no strong evidence that indicates pre-hospital intubation to be beneficial since intubation is accompanied by various risks such as unrecognized esophageal intubation, epistaxis, laryngospasm, and vomiting (79).

A supra glottis device is used to create an airway and to assist in securing ventilation. The classic laryngeal mask airway, Combitube and laryngeal tube, have proven to be very useful in pre-hospital airway management (76). Tracheal intubation should be done immediately in case of cervical spine injury, severe cognitive impairment, severe neck injury, severe maxillofacial injury and smoke inhalation, since these are all potential reasons for airway obstruction. Patients who show cognitive impairment or a Glasgow Coma Scale less than 8 are also strong candidates for tracheal intubation.

In cases of maxillofacial trauma, airway obstruction is directly related to tongue base or maxillary prolapse, pharyngeal edema or hematoma, and severe hemorrhage. Patients with bilateral mandibular body fractures are also at greater risk for tongue base prolapse; tongue retraction with a heavy suture or towel clamp is used to allow for oxygenation until such time that a clearly defined airway can be found and maintained. Le Fort fractures can also compromise the airway through maxillary prolapse, edema or hemorrhage. This is why an emergency airway has to be maintained in patients with known Le Fort fractures. The more severe the Le Fort fracture is, the greater is the need for intubation (83).
The various techniques used for intubation are rapid sequence induction, manual inline stabilization of the head, and orotracheal intubation through direct laryngoscopy. While using manual inline stabilization, the head of the patient is kept in a neutral position with the mastoid process held in a position that limits head movement during direct laryngoscopy.

Other intubation methods limiting the cervical motion are with the use of the Bullard laryngoscope and flexible fiber optic endoscope. There is a consensus regarding the fact that disregarding the associated injuries, the primary means of securing the airway in a wide range of acutely desaturating patients with maxillofacial trauma is orotracheal intubation via direct laryngoscopy. This technique is used successfully since these methods can improve the success of orotracheal intubations. Retrograde intubation is also successful in cases where other methods of intubation have failed. Unsuccessful intubation or ventilation is replaced with cricothyroidectomy, considered to be the procedure of choice. It is indicated in cases of excessive emesis or hemorrhage, known cervical spine fracture, and inability to visualize the vocal cords (83).

Breathing
As part of the initial management of patients with facial trauma, it is important to provide consistent and high oxygen flow through a re-breather mask if the patient is not intubated and ventilated. Breathing should be evaluated through an examination of lungs, chest wall, and diaphragm. Any chest movement or lesions if present may impair ventilation. Examples include (81):

- Tension pneumothorax: requires needle thoracostomy followed by drainage
- Flail chest: management involving ventilation
- Hemothorax: which will require intercostal drain insertion
- Pneumothorax: requiring intercostal drain insertion

Determining the respiratory rate of the patient, the depth and effort of inspiration, are part of the breathing assessment. Pulse oximetry and end-tidal carbon dioxide are considered to be useful in the breathing management of trauma patients. Other
conditions which require a breathing assessment and management prior to the initiation of treatment of facial fractures include: rapid respiratory effort, the use of accessory muscles of respiration, hypoxia, hypercapnia, asymmetric chest wall excursions and the reduced or absence of breath sounds (77).

Trauma patients with elevated intracranial pressure and cerebral perfusion pressure require close monitoring as well as prompt neurological examination in order for clinicians to correctly choose the method for controlled ventilation. Assisted ventilation may be required to secure adequate breathing in patients with severe facial trauma (78).

Respiratory distress in trauma patients is frequently seen. It is caused by open or closed pneumothorax, pulmonary contusions, airway obstruction, flail chest, tension pneumothorax, hemothorax and diaphragmatic hernia (80).

**Circulation**

In cases of severe trauma to the face, significant external hemorrhage can occur from major blood vessels. High volume of hemorrhage only occurs when severe trauma is directed at specific sites of the body including chest, abdomen, and soft tissues of the pelvis and thigh (82).

The mental status, skin color, and skin temperature provide significant clues to the circulation status of the trauma patient. Severe hemorrhagic shock may progress from anxiety to agitation, and finally to coma, in case blood loss is not controlled. Blood loss compounded with shock lead to tachycardia and hypotension, pain and anxiety. Pulse and blood pressure should be assessed along with signs of hypovolemic shock such as tachypnea, dusky color, diaphoresis, and altered mental status (81).

Direct pressure to open wounds or major blood vessels must be applied to minimize rapid external bleeding. Adequate venous access may be obtained for a complete survey of circulation. The fluids needed for resuscitation include crystalloid, colloid, and blood products. Patients who do not respond to crystalloid resuscitation need to be
transfused with type O uncross-matched blood. Shock therapy should be started and external bleeding controlled. Lastly, the source of internal hemorrhage needs assessment. Patients with hypovolemic shock accompanied by circulatory collapse who do not respond to fluid resuscitation are strong candidates for ED thoracotomy (81).

In cases where serious intra-abdominal hemorrhage is suspected, immediate laparotomy must be initiated as soon as possible. Patients with large intrathoracic hemorrhage also need immediate thoracotomy and probably autotransfusion of blood through thoracostomy (82).

Mental and neurologic disability management
Neurologic function should also be assessed to determine brain and spinal cord involvement. Patients with Glasgow Coma Scale less than 9 need endotracheal intubation for airway protection, brain imaging, and neurological evaluation and therapy to prevent secondary brain injury (82).

Once airway, circulation, and breathing have been established, trauma patients should also be assessed for disability during the pre-hospital management to determine neurologic deficits prior to the administration of intravenous sedation or paralytics. The Glasgow Coma Scale and gross motor and sensory status of all four extremities has to be determined and recorded. Aggressive hyperventilation should not be done since it lowers the intracranial pressure too rapidly, potentially injuring the brain (81).

Exposure
The final part of pre-hospital care and management is exposure and environmental control. In facial trauma, exposure assessment is considered to be significant since the missed or late finding of second or third injuries can lead to inaccurate clinical assessment. The entire body of the trauma patient has to be examined for the presence of any signs of hidden trauma (82). To achieve this, all clothing and accessories need to be removed. Additionally, all avulsed hard and soft tissue, need to be recovered and transported in damp gauze with no ice and very little manual manipulation (64).
Environmental control is also important in the assessment of core body temperature and prevention of hypothermia. Patients need to be kept warm. The infusion of fluids should be done through a fluid warmer. Patients with hypovolemic shock especially require active warming during the resuscitation phase \(^{(81)}\).

**HOSPITAL CARE**

Once, the patient arrives in the emergency room, the definitive diagnosis and management of the facial trauma can begin. In cases of complex facial trauma, the skills of many surgical specialties including plastic surgery, maxillofacial surgery, otorhinolaryngology and ophthalmology may be needed \(^{(91)}\). This is because facial trauma is a complex combination of bony and soft tissue injuries. The facial trauma may arise as a result of an isolated injury or may be associated with significant injuries elsewhere in the body.

Once the airway and breathing have been established, blood loss stopped and a wide bore intravenous access is in place, fluids and medications can then be administered to the patient. If there is a continuing rapid decline of blood pressure despite fluid resuscitation, there’s a high probability of internal bleeding which must be visualized, located and stopped.

Hemorrhage from open wounds and fractures can be controlled by appropriate pressure or splinting. It is also recommended that patients be given smaller aliquots of fluids with frequent evaluation. The systolic blood pressure should be maintained at a pressure of 80 mmHg. External bleeding can also be controlled through the use of clips, sutures or direct pressure. To control oral bleeding, local gauze packs may be used as well as manual reduction of any displaced fracture in the dental arches. Epistaxis, which may either occur alone or in conjunction with mid face fractures, can be controlled with the help of nasal balloons, or packs.
Catheters may also be used to contain bleeding. Temporary stabilization of the reduced fractures using a mouth prop may also be necessary. Additional stabilization may be attempted in case of a fractured mandible. Antibiotics should be administered as prophylaxis against infections and their ensuing complications such as sinusitis, meningitis and brain abscess (89).

If the hemorrhage is persistent then surgical interventions may be needed. After intubation and anesthesia, manual reduction of facial fractures is carried out. The cervical spine must be kept immobilized during this time. The sooner the manual reduction of the facial fracture is carried out, the better the outcome of the injury. A tracheostomy may also be required at the end of the surgery.

In the case of major facial injuries a delay may be tolerated before surgery to allow for the swelling to resolve; in addition, for further imaging, investigations and assessment, planning and for informed consent to be taken. Different interventions such as wires, splints, or plating techniques are used to stabilize facial fractures. External fixation of fracture may also be done to provide rapid first aid stabilization in a patient who has suffered multiple injuries (89).

The ligation of the external carotid artery and ethmoidal arteries through the neck and orbit may be needed if bleeding continues. Alternatively, supralselective embolization can also be done as an alternative to surgical ligation. Catheter-guided angiography and embolization may also be used to stabilize the patient (89). The hospital treatment of each type of facial soft tissue injury is discussed below.

**Lacerations**

Facial lacerations require extensive wound assessment. The emergency clinician needs to be familiar with the significant tension lines and boundaries of the face. These facial boundaries must be followed when attempting to realign any apparent deformity. Doing so will result in better aesthetic prognosis, particularly when minimal tension is placed on the wound edges at the time of repair. This is why lacerations consisting of
elongated axis running parallel to the natural skin tension lines offer better cosmetic prognosis.

The amount of tension on the wound edges may be calculated by measuring the distance that the wound edges draws back from the center of the lesion. A significant retraction indicates a strong skin tension. Such wounds may need dermal sutures placed in a 2-layer closure (46).

**Anesthesia**

Anesthesia may be given via topical, local, or regional block. A regional block in the face is advantageous because it eliminates the administration of local anesthetic, which may distort the wound edges. Anesthetics made up primarily of amide compounds such as lidocaine, bupivacaine, mepivacaine are usually used. Allergic reactions are rare. When administering anesthetics in conjunction with epinephrine, nurses need to avoid facial regions with end arteries such as the nose (46). The regional block and the area of anesthesia are listed in Table 5 (46):

**Table 5: Regional Blocks**

<table>
<thead>
<tr>
<th>Type of regional block</th>
<th>Facial region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraorbital and supratrochlear blocks</td>
<td>Forehead, anterior one third of the scalp</td>
</tr>
<tr>
<td>Infraorbital block</td>
<td>Lower lid, upper lid, lateral aspect of the nose</td>
</tr>
<tr>
<td>Mental nerve block</td>
<td>Lower lip, chin</td>
</tr>
</tbody>
</table>

Lacerations, as with other open wounds, need to be thoroughly explored, irrigated, cleaned, and debrided of necrotic tissue prior to closure. Generally, irrigating the open wound reduces the risk of infection, although this is not always the case. Sometimes, in spite of irrigation, non-contaminated wounds closed and repaired within six hours of trauma develop infections. Gentle cleansing of the wound with dilute povidone-iodine solution should follow wound irrigation. The wound edge consisting of necrotic tissue
may then be removed. When doing this, care must be used to make sure that its removal follows a perpendicular pattern with the skin surface to obtain a smoother and less noticeable scar (46).

**Repair**

The repair of deep wounds needs to be done layer by layer. Muscles must be repaired prior to closure of the wound to avoid obvious scars. A 2-layer closure of the deep layers must be performed using minimal absorbable suture since a more subcutaneous suture is associated with greater risk of infection. Finally, a non-absorbable monofilament suture is ideal for superficial closure. Monofilament sutures are less likely to get infected compared to a polyfilament suture (46).

The type of suture technique depends on the location of the laceration and the amount of tension on the wound edges. A simple interrupted technique may be used in areas of low tension or lacerations with tension decreased by the use of a layer of subcutaneous sutures. The same technique should be used in realigning wounds with irregular wound edges. On the other hand, regions of high tension are ideally closed using a vertical mattress technique, a single, interrupted suture approach that allows for both deep and superficial layers to be approximated. All facial wounds need to be closed in less then 24 hours of injury to minimize risk of infection and obtain optimum cosmetic results. In the case that a delay in closure is unavoidable, wounds must be covered with saline-moistened gauze pending the repair (46).

Dermal adhesives, such as 2-octyl cyanoacrylate, are found to be as effective as sutures for the repair of simple, clean wounds in areas of low tension (92). These adhesives are placed to the wound edges. It has several advantages, namely:

- Shorter repair time
- Fewer supplies
- Less pain during repair, and
- Elimination of the need to remove sutures or staples at a follow-up visit.
Despite its many advantages, dermal adhesives must never be used on the lips or the mucous membranes. Additionally, it is contraindicated in patients with poor circulation or who are more likely to develop keloids. Table 6 enumerates the various facial laceration sites and their corresponding recommended suture size and removal times:

**Table 6: Suture Recommendations**

<table>
<thead>
<tr>
<th>Facial laceration sites</th>
<th>Recommended suture size</th>
<th>Recommended removal time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forehead</td>
<td>5-0/6-0 sutures</td>
<td>5 days</td>
</tr>
<tr>
<td>Eyebrow</td>
<td>5-0/6-0 sutures</td>
<td>3-5 days</td>
</tr>
<tr>
<td>Face</td>
<td>6-0 sutures</td>
<td>5 days</td>
</tr>
<tr>
<td>Eyelid</td>
<td>6-0/7-0 sutures</td>
<td>3 days</td>
</tr>
<tr>
<td>Nose</td>
<td>5-0 sutures</td>
<td>3-5 days</td>
</tr>
<tr>
<td>Ears</td>
<td>6-0 sutures</td>
<td>10-14 days</td>
</tr>
<tr>
<td>Lips</td>
<td>6-0 sutures</td>
<td>3-5 days</td>
</tr>
</tbody>
</table>

**Septal hematoma**

A septal hematoma is a bruise or bleeding in the nasal septum. If left undetected and untreated, the septal cartilage is put under continuous pressure by the hematoma, which can eventually lead to necrosis of the underlying cartilaginous support. This will, in turn, develop into a saddle deformity of the septum that will require surgical repair.

Sometimes, the trapped blood develops infection, and necrosis ensues, as the picture below shows.
The primary management method of septal hematoma is decompression either by needle aspiration with a large-gauge (≥ 18-gauge) needle, or by incision and drainage using a no. 11 scalpel. This is usually followed by placement of bilateral nasal packing to prevent re-accumulation of fluid. Some clinicians administer antibiotics to prevent the onset of infection, although this practice remains controversial. Referral to otolaryngologist is warranted for close follow-up (46).

**Cauliflower ear**

Cauliflower ear is also a result of delayed treatment of hematoma at the level of the perichondrium following injury to the auricle. If left untreated early on (i.e. if blood is not evacuated), the blood begins to fibrose over a number of weeks. Finally, the fibrotic mass with new cartilage develops within 2-3 months, leading to the defect that resembles a cauliflower. Although treatable, it is best treated early on to avoid complications such as disruption of the ear canal. It is therefore advisable to treat it immediately after injury (46).

Aspiration needs to be done with a large-gauge (≥ 18-gauge) needle. This should be followed by the application of an external compression dressing to prevent reaccumulation of fluid. Silicone ear splints may be molded to the front and back of the earlobe and secured in place with a head wrap, sutures, or both. When splints are unavailable, compression may be done by suturing a button or piece of nasal packing to the front and back of the auricle. Compressive dressing must be held in place for 3-5 days (46).
**Contusions**
Contusions are very common in sports medicine practice. They are usually treated with ice for a period of 10-20 minutes following blunt trauma to reduce the acute inflammatory response. Ice may be applied for the next 48-72 hours to reduce inflammation and swelling. Over-the-counter (OTC) nonsteroidal anti-inflammatory medications (NSAIDs) such as ibuprofen and meloxicam can provide symptomatic relief (46).

**Abrasions**
Abrasions require gentle cleansing to rid them of all debris. Failure to do this can lead to "tattooing" of the skin and disfiguring cosmetic results. Local or regional anesthetic may be needed to ease the patient’s discomfort long enough to clean the wound thoroughly. Finally, this may be followed by lubrication with an antibiotic ointment and covering with sterile bandage to promote faster healing (46).

**Corneal abrasion**
Corneal abrasions are a delicate matter and its successful treatment requires the administration of ophthalmic topical antibiotics. Symptomatic pain relief may be achieved by topical analgesics in the beginning although this shouldn’t be prescribed for home use since it can very well delay re-epithelialization and further suppress the normal blink reflex (46). In case of suspected debris retained in the cornea, an emergent consultation with an ophthalmologist should be sought (46).

**Epistaxis**
Epistaxis or nosebleed usually does not need surgical intervention since maintaining continuous pressure for 10 minutes can mostly control it. If the patient is conscious, the clinician can ask the patient to grasp and pinch the nose while tilting the head forward to prevent bleeding into the pharynx, which can result in blood aspiration. The direct pressure needs to be maintained for at least 5 minutes and up to 20 minutes. If this does not control the bleeding, a second attempt should be made (46).
Applying gauze soaked in topical decongestant directly to the bleeding nostril is helpful in obtaining hemostasis. In cases where the source of bleeding is clearly observed, chemical cautery may be done using silver nitrate applied directly to the area. However, if bleeding continues, the nasal cavity must be packed from posterior to anterior with ribbon gauze impregnated with petroleum jelly. Nasal tampons are also effective. For particularly resistant cases, referral to an otolaryngologist should be sought (46).

**Antibiotics**

Generally speaking, antibiotics are not part of the routine wound care because of the rapidly growing resistance of bacterial strains to some of the commonly used antimicrobials. However, empiric treatment is still recommended for wounds that are at significantly greater risk of infection. Large intraoral wounds may need to be treated with penicillin. Bite injuries from a cat, dog, or human must be treated with amoxicillin/clavulanate combination or doxycycline and/or cefuroxime (46).

As mentioned previously, the growing bacterial resistance to antibiotics has made their use somewhat limited to certain cases. Antibiotics such as cefalexin and dicloxacillin are no longer recommended for empiric treatment in the US. Methicillin-resistant *Staphylococcus aureus* (MRSA) is also fast becoming a cause for concern especially in community-acquired infections such as community-acquired pneumonia (CAP). Because of these, antibiotic treatment must be based on the community resistance pattern.

When organism sensitivities have not been determined, vancomycin is the drug of choice in such infections until culture and sensitivity testing have been performed and the causative agent identified (46).

Some of the other common antibiotics used in the emergency room in patients with facial soft tissue injuries are enumerated in Table 7 (46).
Table 7: Antibiotics

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Mechanism of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin G benzathine</td>
<td>Interferes with synthesis of cell wall mucopeptide during active multiplication, resulting in bactericidal activity against susceptible microorganisms.</td>
</tr>
<tr>
<td>Penicillin VK</td>
<td>Inhibits biosynthesis of cell wall mucopeptide. Bactericidal against sensitive organisms when adequate concentrations are achieved and most effective during the stage of active multiplication. Inadequate concentrations may produce only bacteriostatic effects.</td>
</tr>
<tr>
<td>Amoxicillin/Clavulanate</td>
<td>Drug combination treats bacteria that are resistant to beta-lactam antibiotics.</td>
</tr>
<tr>
<td>Doxycycline</td>
<td>Broad-spectrum, synthetically derived bacteriostatic antibiotic in the tetracycline class. Almost completely absorbed, concentrates in bile, and is excreted in urine and feces as a biologically active metabolite in high concentrations. Inhibits protein synthesis and, thus, bacterial growth by binding to 30S and possibly the 50S ribosomal subunits of susceptible bacteria. May block dissociation of peptidyl t-RNA from ribosomes, causing RNA-dependent protein synthesis to arrest.</td>
</tr>
</tbody>
</table>
| Cefuroxime          | Second-generation cephalosporin that maintains gram-positive activity of first-generation cephalosporins; adds activity against *Proteus mirabilis*, *Haemophilus influenzae*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Moraxella catarrhalis*.

Binds to penicillin-binding proteins and inhibits final transpeptidation step of peptidoglycan synthesis, resulting in cell wall death. The condition of the patient, severity of the infection, and susceptibility of the microorganism determine the proper dose and route of administration. Resists degradation by beta-lactamase. |
| Vancomycin          | Potent antibiotic directed against gram-positive organisms and active against *Enterococcus* species. Useful in the treatment of septicemia and skin structure infections. Indicated for patients who are unable to receive or whose infections have not responded to penicillins and cephalosporins or for infections with resistant staphylococci. Use CrCl to adjust the dose in patients diagnosed with renal impairment. |

**Immunotherapy**

Because of the risk of infection, especially in cases where wounds are deep and extensive, clinicians administer toxoids and immunoglobulins, in addition to or without antibiotics, as a prophylactic measure (46).
Toxoids are used to stimulate active immunity, especially against tetanus infections in select patients. The immunizing agents of choice for most adults and children 7 years and older are the tetanus and diphtheria toxoids. Clinicians need to be especially careful not to administer diphtheria antigen–containing toxoids to pregnant patients since these can harm the fetus. The tetanus toxoid is generally injected into the deltoid or midlateral thigh muscles of children and adult trauma patients (46).

Usually, the dose is 0.5 mL dT administered intramuscularly to patients aged more than 7 years of age who have not been immunized within the last five years. Alternatively, a dose of tetanus IgG 250 U at a different site is given to patients with an incomplete immunization history (46).

Immunoglobulins provide passive immunization. It is usually obtained from a pool of serum of immunized subjects. Tetanus immune globulin (TIG) provides passive immunization in any person with a wound potentially contaminated with tetanus spores (46).

**Fractures**

Fractures require clinicians to use individualized strategies. After the facial fractures have been successfully visualized and identified, and the extent of involvement of the underlying structures has been assessed, surgeons and specialists such as plastic surgeon, ophthalmologist, ENT specialist, oral-maxillofacial surgeon or neurosurgeon, should be consulted for definitive care (90).

**Frontal fractures**

Frontal fractures require immediate neurosurgical evaluation, especially in cases of posterior wall involvement, although repair to the structure may be delayed.

Frontal sinus fractures, on the other hand, may require endoscopic management, a type of surgical intervention. Generally, frontal sinus fractures are repaired 1-10 days
following the injury. The endoscopic approach is applicable for isolated anterior table frontal sinus fractures that do not displace the superior orbital rim (85).

This surgical approach has a distinct advantage over the traditional open reduction in that it produces a more favorable cosmetic result. The procedure allows the surgeon to access isolated anterior table fractures through two scalp incisions, which is analogous to an endoscopic browlift approach. The repair is intentionally performed in a delayed fashion using porous polyethylene sheeting (Medpor, Porex Surgical Inc, Newnan, Ga) or one of the many available cements (generally some form of hydroxyapatite [HA] cement) to hide the bony defect. The delay allows for the alleviation of the need to manipulate unstable bone fragments endoscopically. Additionally, the delay allows for the proper determination of the injury and its subsequent aesthetic deformity (85).

**Orbital fractures**
The initial treatment of an orbital fracture involves elevation of the head, cold compressions, and analgesics to reduce pain. In case of persisting diplopia lasting over two weeks, surgery may be required. Surgery is mostly needed in case of large fractures and enophthalmos. If there is accompanying inferior rectus muscle entrapment, inferior orbital nerve entrapment, enophthalmus or orbital dystopia, then it may lead to cosmetic impairment and functional disability. An orbital fracture, therefore, has to be assessed within 24 hours of injury by a specialist, such as an ophthalmologist, oral-maxillofacial surgeon or plastic surgeon, to ensure prompt resolution and treatment (90). Antibiotic prophylaxis is needed in case of fractures involving the sinuses (93).

Because orbital fractures do not always warrant surgical intervention, surgeons are more likely to recommend surgery only if one or more of the following are reported (90):

- Compromised vision, or
- Eyeball sagging into the socket resulting in a sunken appearance, which is not always apparent due to the general swelling.
Surgical repairs, when they are performed, are typically performed about 1-2 weeks following the injury. The lag time allows for the swelling to resolve, allowing for better inspection and evaluation of the fracture. The incisions made vary on a case-to-case basis. They are generally placed inside the eyelid to be hidden. Successful surgery means reduction of the fracture, or reinstatement of the affected bones in their normal anatomical positions. During the healing process, the broken bones can be supported using a titanium plate or other similar material (90).

Orbital blowout fractures (OBFs), is a type of orbital fracture involving the orbital floor or medial orbital wall. They are the result of traumatic force applied to the globe or bony orbit. A fractured bony orbit can lead to prolapse and strangulation of the orbital contents, manifesting as diplopia, enophthalmos, and even visual loss. Such fractures are currently managed by transconjunctival and subciliary incisions. These surgical techniques allow direct visualization of the defect and reconstruction of the premorbid bony architecture. Although these techniques enjoy high success rates, they also risk certain complications ranging from transient scleral show to severe lid malposition. Another disadvantage of these techniques is the inability to easily visualize the posterior bony shelf via transconjunctival or subciliary incisions. The angle of attack is oblique, and prolapsing orbital fat usually hinders the surgeon’s view (85).

The endoscopic repair of an OBF involves a sublabial (Caldwell-Luc) incision and exposure of the orbital floor defect from below. The eyelid structure remains unscathed and the risk of postsurgical eyelid complications is eliminated. The angle of attack is much more favorable for the visualization of the posterior bone shelf. The orbital floor defect is then reconstructed in a similar fashion to that of the open approach (85). Blowout fractures of the medial orbital wall, on the other hand, are a distinct type of orbital blowout fracture, which also benefits from endoscopic management. The technique involves a transnasal, transethmoid approach to the medial orbital wall comparable to that utilized in endoscopic decompression of a periorbital abscess. However, with blowout fractures of the medial orbital wall, there are the herniated orbital...
contents found in the ethmoid sinus to consider. If the slippage is undetected, the orbital contents are at risk (85).

The herniated orbital contents must be visualized properly through ethmoidectomy around these tissues. The procedure allows the surgeon to evaluate the degree of disruption and the best approach for repair. If the herniated medial orbital wall is 'egg-shelled' (multiple, yet interconnected, hairline fractures) but continuous, then gentle pressure may result in adequate repositioning.

Once repositioning is achieved, a temporary stent may be enough to secure the fractured fragments in place for healing. The most commonly used technique makes use of a sheet of thick silicon sheeting rolled and placed into the ethmoid as a stent. This technique also applies the right amount of pressure when unrolled, supporting the medial orbital wall for healing. The stent may be removed in the outpatient setting after 2-6 weeks of implantation, depending on the surgeon’s advice (85).

**Nasal fractures**

A modified nasal fracture is managed with the application of manual pressure through the thumb and fingers. A soft probe is also inserted in the nose to raise the depressed septum back to its normal anatomic position. Epistaxis control and pain relief are the main goals of management of this fracture. If surgery is needed, it should be done quite early, ideally within a period of 1 to 2 hours following the injury or within 10 to 14 days after the injury, following symptom resolution such as swelling and edema. If there are any open wounds, use of prophylactic antibiotics is also recommended (90).

Since the ethmoid sinuses are anatomically positioned close to the skull base, it is not uncommon for facial trauma patients with nasal fractures to report cerebrospinal fluid (CSF) leakage. In cases like these, a neurosurgical consultation is warranted (90). Surgical repair is performed to reinstate the proper distance between the eyes. The procedure makes use of plates and wires to hold together the fractured bones (90).
Zygomatic or zygomaticomaxillary fractures
This type of fracture is managed by the reduction and fixation to repair the normal contour (90).

Le Fort (maxillary) fractures
A Le Fort fracture is usually managed by open reduction with internal fixation. If it is accompanied by CSF rhinorrhea, neurosurgical intervention may be needed. The primary aim of surgery is to reinstate the normal contour of the facial skeleton and its functional status, i.e., repair the face so that the bite functions as normally as possible. There are several surgical techniques for accessing the fractures. For one, the surgeon may make incisions through the mouth or gums, or another way is to make incisions in the hairline. Once fractured bones have been restored to their normal anatomical positions and stabilized, plates and screws may be used to secure the bones in place and prevent them from moving again (90).

When the fracture extends through the tooth-bearing region or through the nasal or sinus mucosa, the use of prophylactic antibiotics should seriously be considered to prevent the onset of infection (90).

Mandibular fractures
Mandibular fracture requires fixation in the hospital. Antibiotics are needed especially prior to surgery when a tooth or teeth is/are affected, indicating involvement of internal oral structures. Ideally, the time needed to surgically repair jaw fractures is 7-10 days following the injury (90).

Similar to other types of facial fractures, the selection of treatment and management choices are based on the individual and the severity of the fracture. The primary goal of surgery is to reinstate the teeth to their pre-injury position. Surgeons may opt to do maxillomandibular fixation (MMF), which fixes the upper teeth to the lower teeth for an extended period of time while the fracture heals. Patients who have undergone this procedure are usually advised to keep a liquid diet during this time. Another surgical
option is called open rigid fixation, which stabilizes the fracture with titanium plates and screws. The incisions can be made either through the mouth or hidden in a jaw or neck crease (90).

Post surgical management includes antibiotic therapy, oral rinse, and soft diet while the fracture heals (90).

Medication
The primary targets of pharmacotherapy in the management of facial soft tissue injuries and fractures are to prevent complications, reduce morbidity, manage pain, and prophylaxis (90).

Pain management
The management and control of pain is a very important aspect of patient care in trauma patients. Analgesics reduce the pain and inflammatory symptoms and ease the patient’s discomfort. The different drugs used for pain relief in patients of trauma are discussed below (90):

- **Ibuprofen**, which is used for patients with mild to moderate pain. It is a non-steroidal anti-inflammatory drug (NSAID) that inhibits the inflammatory responses and reduces pain by decreasing prostaglandin synthesis.
- **Acetaminophen** or **paracetamol**, which is specifically used in patients who are allergic to aspirin or other NSAIDs, with upper gastrointestinal disease, or who are on oral anticoagulants such as warfarin.
- A combination of **acetaminophen** and **hydrocodone**, which is particularly useful in patients with moderate to severe pain.
- **Toradol**, which is also an NSAID. NSAIDs are believed to be prostaglandin synthetase inhibitors.
- **Morphine**, which is a staple opioid pain reliever in emergency medicine. It is a potent analgesic that provides a safe, reliable, and predictable pain relief. It is usually administered intravenously.
**Antiemetics**

Antiemetics such as promethazine and ondansetron are used to treat symptoms of nausea (90).

**Antibiotics**

Antibiotics are primarily used prophylactically in cranio-facial trauma to prevent the risk of meningitis and the growth of the colonies and infections due to the use of invasive devices. These are especially useful in the following conditions (90):

- Intracranial pressure monitors and ventriculostomies;
- Leakage of cerebrospinal fluid;
- Pneumocephaly;
- Open facial fractures;
- Closed facial fractures; and
- Repair of facial fractures.

There are several randomized clinical trials that have found evidence of the utility of antibiotics in the successful reduction of infection risks following facial fractures. Among the antibiotics investigated was the cephalosporin derivative, cefazolin (87).

The additional use of antibiotics is also recommended in cases of severe facial trauma with multiple open fracture wounds (88). As mentioned previously, they are often used prophylactically to prevent surgical wound infection during the management of maxillofacial fractures (86).

In case of orbital floor fracture repair, the combination of amoxicillin-clavulanate has been reported to be of some benefit, although its effect was not clearly observed and quantified. Broad-spectrum antibiotics are recommended for short term prophylaxis. However, many of such antibiotics have poor penetrative power, especially when used to prevent infection in cases of hematoma and accumulation of sinus fluid. Additionally, the emergence of resistant strains of bacteria targeted by these antibiotics has caused many clinicians to doubt the clinical benefits of their prophylactic use (88).
**Prognosis**

The prognosis for many facial soft-tissue injuries is good because such injuries usually heal quickly. In cases of sports injuries, it allows the athlete to return to their normal pre-injury levels (46).

Prognosis of facial fractures varies on a case-by-case basis. It largely depends on the severity of the fractures, prompt treatment, and the comorbidities involved (90).

**Nasal fractures**

Patients with nasal fractures usually need follow-up care in 5-7 days for re-evaluation after the resolution of the swelling. If the patient's nose requires adjustment, it may be done at the follow-up visit. Since nasal fractures heal quickly and do not pose life-threatening complications when caught in time, the prognosis is usually good (90).

**Mandibular fractures**

The prognosis for mandibular fractures is usually good (90).

**Le Fort (maxillary) fractures**

Le Fort fractures have a poorer prognosis because of other injuries suffered concomitantly. A high incidence of blindness is reported in Le Fort I fractures following osteotomies. This is usually attributed to optic nerve or optic canal injuries. However, it should be noted that it is an uncommon complication of facial trauma, with a reported incidence of only 3 to 5 percent.

This incidence becomes even lower when fractures are performed in the controlled situation of orthognathic surgery. Because of the rare incidence of ophthalmic complications following traumatic Le Fort I injuries, it is not surprising that few cases have been reported after orthognathic surgery (94).
**Zygomatic fracture**

Zygomatic fractures as an isolated injury that is not considered serious and at the most only poses cosmetic problems (90).

**SUMMARY**

Facial trauma is a commonly encountered set of complex medical conditions seen by emergency room nurses, doctors, and first aid responders. They are frequently caused by motor vehicular accidents (MVAs), domestic violence, personal assaults, and sports-related activities.

Because these injuries are often part of a set of multiple injuries, rapid assessment and on-the-scene management measures are essential and must be made to improve patient prognosis.

Facial injury may be divided into soft tissue injuries and fractures, and as such, their corresponding management and treatment approaches vary. Facial injuries with apparent deformity require imaging studies to evaluate for fractures and the presence of foreign bodies and debris. Clinicians usually start with plain films of the face, including Water, Caldwell, and lateral views. In the event that the images produce inconclusive results or suspicions of fractures are high, computed tomography (CT) scans is the next logical step to take, as far as imaging studies are concerned. When necessary, a 3D reconstruction can be made to allow an extensive detailed analysis.

Facial soft tissue injuries involve the eyes, eyelids, orbital rim, ears, nose, mouth, tongue, and lips. The general area of the face is highly vascular, which is why copious bleeding is seen even with relatively minor injuries such as lacerations and abrasions. These soft tissue injuries will initially require irrigation, cleansing, debridement, and sometimes sutures. Prophylaxis against infection is achieved through the administration
of antibiotics. Other pharmacotherapy measures used in wound treatment are analgesics, anesthesia, and immunotherapy.

Facial soft tissue injuries have very good prognosis, with cosmetic defects such as scar and keloid formation being the primary limitation when choosing methods of repair. Nerve injuries and their functional restoration are also another cause for concern.

Facial fractures, on the other hand, often require extensive imaging studies to determine the extent of injury and involvement of the underlying structures. They may require surgical interventions such as endoscopic management, internal fixation, and open reduction. As with any open wound, antibiotic prophylaxis is also used to combat the risk of infection.

Bone fractures are painful; therefore, most of the pharmacotherapeutic measures are directed at pain reduction. NSAIDs such as ibuprofen, acetaminophen and ketorolac are primarily used for mild to moderate pain. Moderate to severe pain is usually managed with intravenous administration of morphine. Facial fractures, when repaired in a timely manner have very good prognosis.

Please take time to help the NURSECE4LESS.COM course planners evaluate nursing knowledge needs met following completion of this course by completing the self-assessment Knowledge Questions after reading the article. Correct Answers, page 78.
1. The submandibular and sublingual salivary glands are ____________ injured because of their anatomical location.
   a. Less commonly
   b. More commonly
   c. Rarely
   d. None of the above

2. True or False. The orbital rim must be inspected carefully since injury to the area may involve an underlying fracture.
   a. True
   b. False

3. ________ percent of burn injuries reported in the U.S. involve the head and neck region.
   a. 25 %
   b. 33 %
   c. 50%
   d. 63 %

4. In children, dental trauma to the primary teeth most commonly occurs between the ages of ________.
   a. 1 to 2 years
   b. 2 to 3 years
   c. 4 to 5 years
   d. 7 to 10 years

5. The establishment of a patent airway is the first priority in patients with severe facial injuries. The mouth needs to be cleared of:
   a. knocked out teeth
   b. foreign debris
   c. blood
   d. all of the above
6. True or False. Both muscle and nerve entrapment are *less frequently* reported among children because their bones are still growing and more flexible.
   a. True
   b. False

7. Pluridirectional (complex motion) tomography is the imaging study of choice in the evaluation of facial injury. It has the advantage of:
   a. showing the injury with detailed clarity
   b. determining the extent of facial injury
   c. helping to diagnose facial multiple facial trauma where routine radiography studies will not suffice
   d. all of the above

8. CT imaging has a distinct advantage over other imaging studies:
   a. It can demonstrate both bone and soft tissue involvement
   b. it can demonstrate both bone and vascular involvement
   c. it is less invasive
   d. none of the above

9. Since the ethmoid sinuses are anatomically positioned close to the skull base, it is not uncommon for facial trauma patients with nasal fractures to report ________________________.
   a. Profuse blood loss
   b. Cerebrospinal fluid (CSF) leakage
   c. Dizziness
   d. Vomiting

10. Mandibular fracture requires:
    a. fixation in the hospital
    b. antibiotics prior to surgery
    c. surgical repair of the jaw in 7 – 10 days after the injury
    d. all of the above
Correct Answers:
1. a
2. a
3. c
4. b
5. d
6. b
7. d
8. a
9. b
10. d

Footnotes:


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