# Basic Athletic Training
# Course Pack C

# Conditions to the Axial Region

SECTION

VI

CHAPTER

20

# Head and Facial Conditions

## STUDENT OUTCOMES

1. Locate the major bony and soft-tissue structures of the head and facial region.
2. Explain the importance of wearing protective equipment to prevent injury to the head and facial region.
3. Describe the forces responsible for cranial injuries.
4. Identify the signs and symptoms associated with a possible skull fracture.
5. Recognize the critical signs and symptoms that indicate a focal or diffuse cranial injury.
6. Describe how the evaluation and management of a focal cranial injury differs from how a diffuse cranial injury

is managed.

7. Explain why baseline concussion testing is important for making an accurate and efficient diagnosis in an acute situation.
8. List the components of the baseline concussion testing protocol.
9. Explain how to use the Sport Concussion Assessment Tool 3 (SCAT3), Vestibular/Ocular Motor/Reflex Screening (VOMS/VORS), and cranial nerve assessments.
10. Summarize the steps of the graduated return to play protocols for patients recovering from concussion and explain the value of using this protocol.
11. Identify the signs and symptoms associated with a possible facial fracture.
12. Describe the signs and symptoms of epistaxis, deviated septum, and fractured nose.
13. Describe the differences in managing a loose versus a fractured or dislocated tooth.
14. Recognize common external and internal ear conditions and explain their management.
15. Describe the use of an otoscope to assess nose and ear conditions.
16. Identify the signs and symptoms of serious nasal, ear, or eye injuries that warrant immediate referral to a physician.
17. Describe the evaluation of an eye injury and the use of an ophthalmoscope.

# INTRODUCTION

The head and facial area are frequent sites for minor injuries, including

lacerations, contusions, and mild concussions. However, the incidence of facial injuries, eye, ear, and dental injuries are significantly decreased when protective equipment is worn. Although intracranial injuries have been associated with sport-related fatalities, increased standards for protective equipment and rule changes that prohibit leading with the head for contact as well as the development and use of the face mask have significantly decreased the incidence of injuries since the mid-1970s. Although face masks, properly fitting helmets, and mouth guards may decrease the incidence of catastrophic brain injury, there is little evidence to support that protective equipment decreases the risk of concussion.[1]

This chapter begins with a general anatomical review of the head and facial region. Discussion concerning preventive measures is followed by information regarding the mechanisms of injury most commonly linked to cranial injuries. The signs, symptoms, and management of the more common focal and diffuse cranial injuries are discussed, followed by steps to include in a thorough assessment of a head injury. Within the discussion on the importance of conducting baseline concussion assessments, information is presented on the Sport Concussion Assessment Tool 3 (SCAT3), cranial nerve assessment, vital sign assessment, mental status assessment, and the value of comparing pre- and postinjury assessment findings to make decisions regarding management and return to participation decisions. The final section discusses the more common facial, nasal, ear, and eye injuries and their management.

## ANATOMY OF THE HEAD AND FACIAL REGION

While playing racquetball, a 40-year-old man collides with the back wall of the court and hits his head. He sustains a superficial cut to the back of the head that is bleeding profusely. What anatomical structures are likely to have been injured, and is this a potentially serious injury?

This review focuses on the brain and its coverings; the facial area, including

the eyes, ears, and nose; and the nerve and blood supply to the region. Although the numerous muscles of the face and jaw enable speaking, chewing, and facial expression, these muscles are not commonly involved in injuries attributed to participation in sport and physical activity and, therefore, are not discussed.

## Bones of the Skull

The skull is composed primarily of flat bones that interlock at immovable joints called sutures (**Fig. 20.1**). The bones that form the portion of the skull referred to as the cranium protect the brain. The thin bones of the cranium include the frontal, occipital, sphenoid, and ethmoid bones as well as two parietal and two temporal bones. The material properties and thickness of the cranial bones vary, with the strongest being the occipital bone and the weakest being the temporal bones. The facial bones provide the structure of the face and form the sinuses, orbits of the eyes, the nasal cavity, and the mouth; these bones include the paired maxilla, zygomatic, palatine, nasal, lacrimal, vomer, and inferior nasal concha bones, along with the bridge and mandible. The large opening at the base of the skull that sits atop the spinal column is called the foramen magnum.

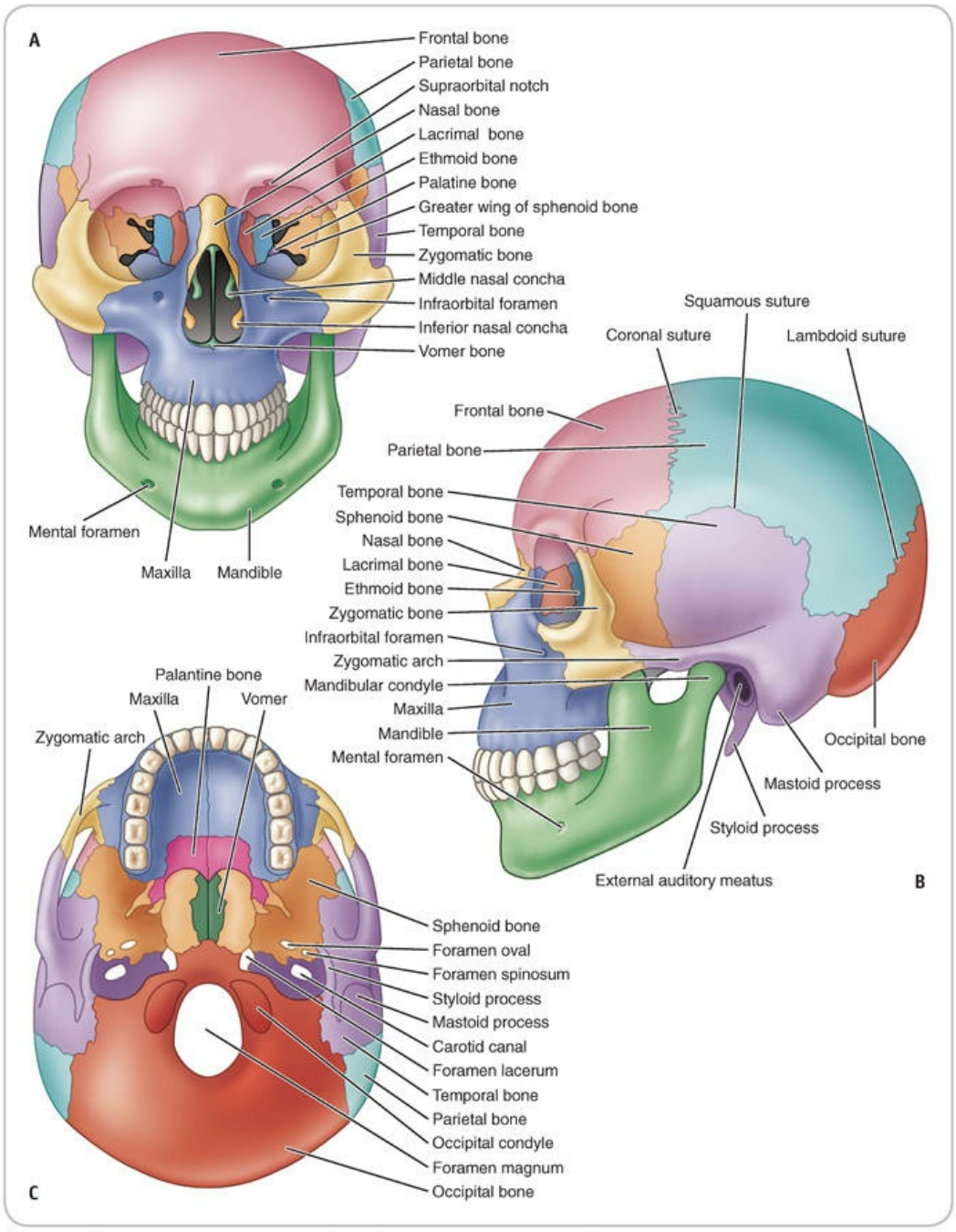



**Figure 20.1. The bones of the skull. A,** Frontal view. **B,** Lateral view. **C,** Inferior view.

## The Scalp

The scalp is composed of three layers: the skin, the subcutaneous connective tissue, and the pericranium. The protective function of these tissues is enhanced by the hair and by the looseness of the scalp, which enable some dissipation of force when the head sustains a glancing blow. The scalp and

face have an extensive blood supply; as a result, superficial lacerations tend to bleed profusely.

## The Brain

The four major regions of the brain are the cerebral hemispheres, diencephalon, the brainstem, and the cerebellum. The entire brain and spinal cord are enclosed in three layers of protective tissue known collectively as the meninges (**Fig. 20.2**). The outermost membrane is the dura mater, which is a thick, fibrous tissue containing the dural sinuses that act as veins to transport blood from the brain to the jugular veins of the neck. The arachnoid mater is a thin membrane internal to the dura mater; it is separated from the dura mater by the subdural space. Beneath the arachnoid mater is the subarachnoid space, which is filled with cerebrospinal fluid (CSF) and contains the largest of the blood vessels supplying the brain. The arachnoid mater is connected to the inner pia mater by web-like strands of connective tissue. The dura mater and arachnoid mater are rather loose membranes; in comparison, the pia mater is in direct contact with the cerebral cortex and contains numerous small blood vessels.

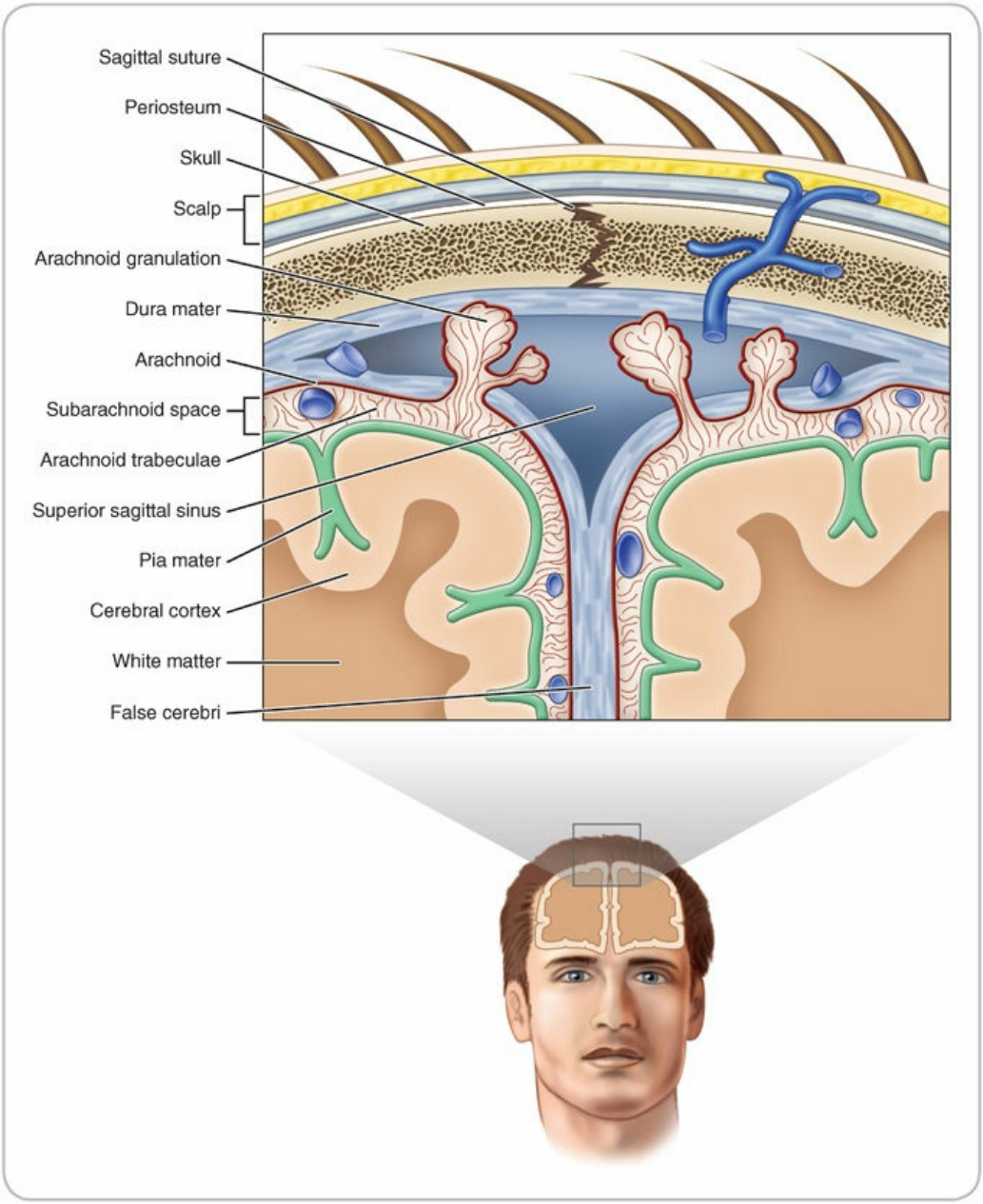



**Figure 20.2. The meninges.** Three layers of protective tissue, known as the meninges, enclose the brain and spinal cord.

## The Eyes

The eye is a hollow sphere, approximately 2.5 cm (1 in) in diameter in adults (Fig. 20.3). The anterior eye surface receives protection from the eyelids, eyelashes, and the attached conjunctiva. The conjunctiva lines the eyelid and the external surface of the eye and secretes mucus to lubricate the external eye.

The lacrimal glands, which are located above the lateral ends of the eyes, continually release tears across the eye surface through several small ducts. The lacrimal ducts, which are located at the medial corners of the eyes, serve as drains for the moisture. These ducts funnel the moisture into the lacrimal sac and, eventually, into the nasal cavity.

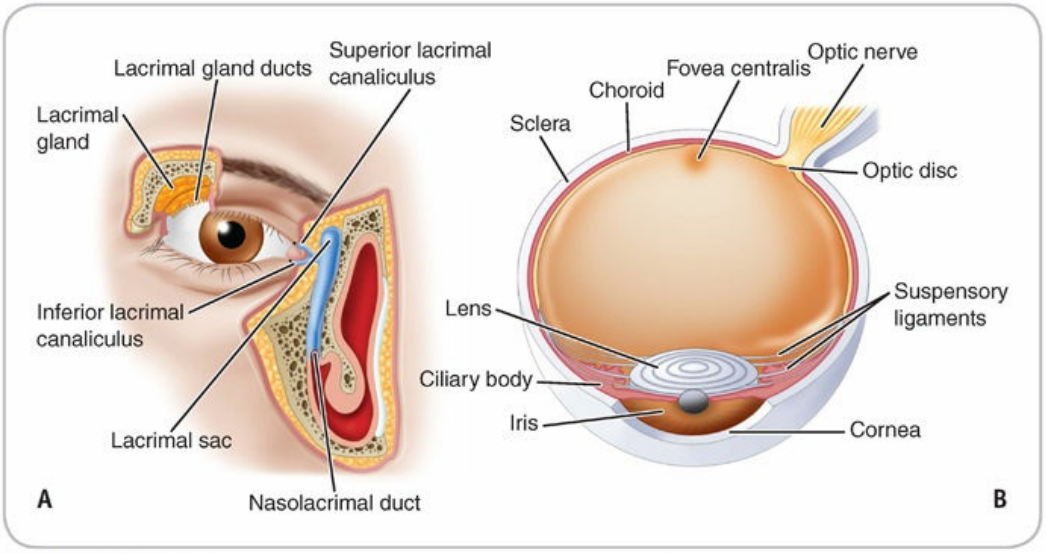



**Figure 20.3. The eye. A,** The lacrimal structures of the eye. **B,** Internal structures of the eye globe.

The eye is surrounded by three protective tissue layers called tunics. The outer tunic is a thick, white connective tissue called the sclera and forms the "white of the eye." The cornea, which is found in the central anterior part of the sclera, is clear to permit the passage of light into the eye. The choroid, or the middle covering, is a highly vascularized tissue that usually appears blue or brown on the anterior eye and contains the pupil. The inner protective layer is the retina, which contains light-sensitive photoreceptor cells that stimulate nerve endings to provide sight.

## The Nose

The nose is composed of bone and hyaline cartilage. The roof is formed by the cribriform plate of the ethmoid bone. The nasal bones form the bridge of the nose. Inferiorly, the lateral walls are shaped by the superior and middle conchae of the ethmoid bone, the vertical plates of the palatine bones, and the

inferior nasal conchae (Fig. 20.4). The nasal cavity is separated into right and left halves by the nasal septum, which is made of cartilage and can be deviated or fractured if struck by a blunt object. A deviated septum can complicate the assessment and treatment of soft-tissue injuries.

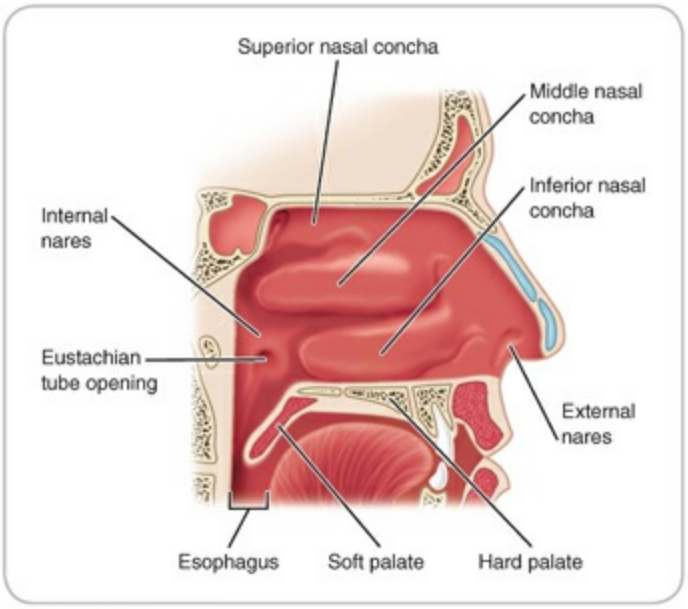



**Figure 20.4. The nose.** The nose is composed of bone and cartilage.

## The Ear

The ear is divided into three major areas: the outer ear (auricle and external auditory canal), the middle ear (tympanic membrane), and the inner ear (labyrinth) (Fig. 20.5). Assisting the middle and inner ear in the process of hearing and equalizing pressure between the two areas is the eustachian tube, a canal that links the nose and middle ear.

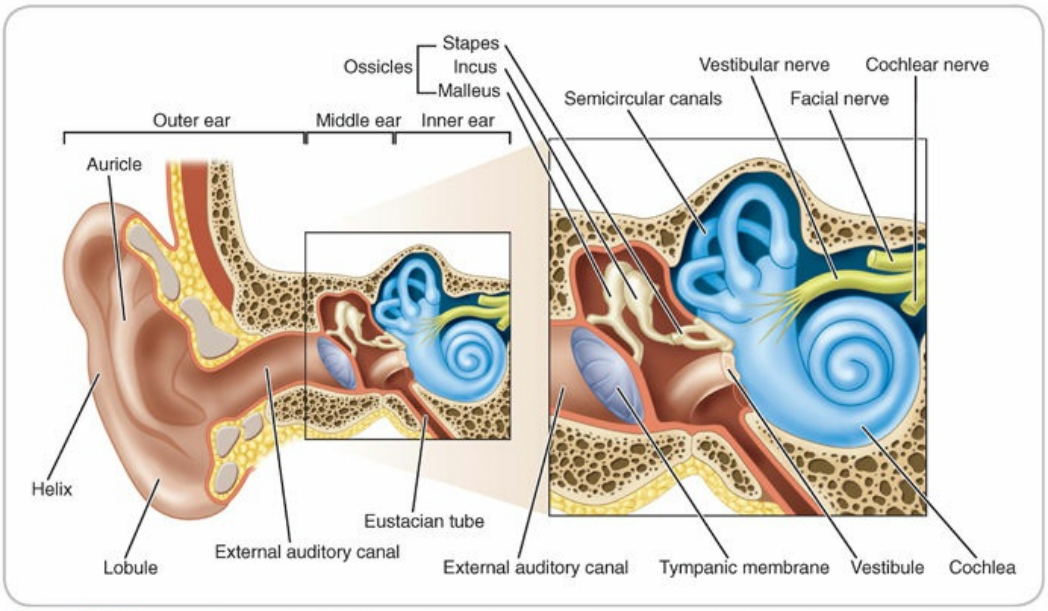



**Figure 20.5. The ear.** The ear is divided into three major areas: the outer ear (auricle and external auditory canal), the middle ear (tympanic membrane), and the inner ear (labyrinth).

## Nerves of the Head and Face

Twelve pairs of cranial nerves emerge from the brain. These nerves have motor functions, sensory functions, or both. The cranial nerves are numbered and named according to their functions and are listed in **Table 20.1**.

**TABLE 20.1 The Cranial Nerves**

| NUMBER | NAME | SENSORY | MOTOR FUNCTION | ASSESSMENT |
|---|---|---|---|---|
| I | Olfactory | X (smell) | Sense of smell | Identify familiar odors (chocolate, coffee). |
| II | Optic | X (vision) | Vision | Test visual fields: Snellen chart (blurring or double vision). |
| III | Oculomotor | X | Control of some of the extrinsic eye muscles | Test pupillary reaction to light. |
| IV | Trochlear | X | Control of the remaining extrinsic eye muscles | Perform upward and downward gaze. |
| V | Trigeminal | X (general sensation) | Sensation of the facial region and movement of the jaw muscles | Touch face to note difference in sensation. Clench teeth; push down on chin to separate jaws. |
| VI | Abducens | X | Control of lateral eye movement | Perform lateral and medial gaze. |
| VII | Facial | X (taste) | Control of facial movement, taste, and secretion of tears and saliva | Smile and show the teeth. Close eyes tight. |
| VIII | Vestibulocochlear | X (hearing and balance) | Hearing and equilibrium (acoustic) | Identify the sound of fingers snapping near the ear. Balance and coordination (stand on one foot). |
| IX | Glossopharyngeal | X (taste) | Taste, control of the tongue and pharynx, and secretion of saliva | Gag reflex; ask the athlete to swallow. |
| X | Vagus | X (taste) | Taste and sensation to the pharynx, larynx, trachea, and bronchioles | Gag reflex; ask athlete to swallow or say "Ah." |
| XI | Accessory | X | Control of movements of the pharynx, larynx, secretion of saliva | Resisted shoulder shrug |
| XII | Hypoglossal | X | Control of tongue movements | Stick out the tongue. |

## Blood Vessels of the Head and Face

The major vessels supplying the head and face are the common carotid and vertebral arteries (Fig. 20.6). The common carotid artery ascends through the neck on either side to divide into the external and internal carotid arteries just below the level of the jaw. The external carotid arteries and their branches supply most regions of the head external to the brain. The middle meningeal artery supplies the skull and dura mater; if this artery is damaged, serious epidural bleeding can result. The internal carotid arteries send branches to the eyes and supply portions of the cerebral hemispheres and the parietal and temporal lobes of the cerebrum. The left and right vertebral arteries and their branches supply blood to the posterior region of the brain.

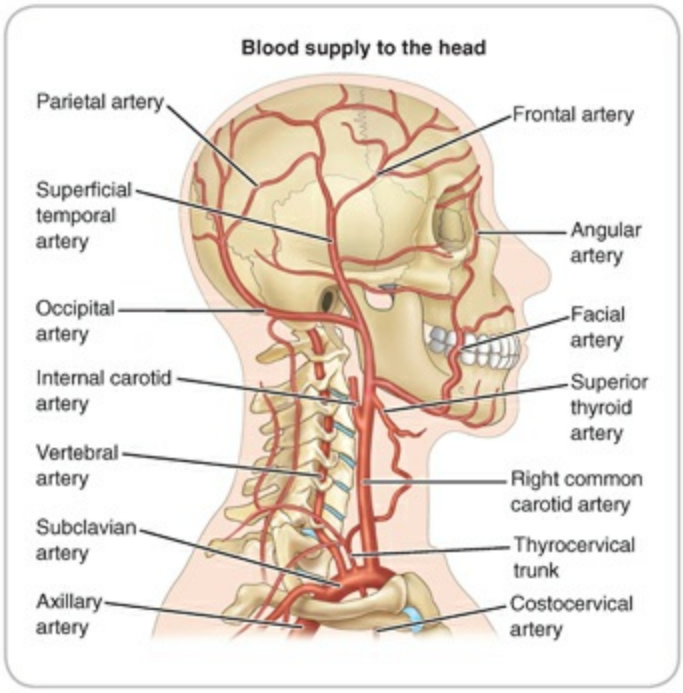



**Figure 20.6. Blood supply to the head.** The common carotid and vertebral arteries are the major vessels supplying blood to the brain.

Because the scalp and face have an extensive blood supply, superficial lacerations of the head tend to bleed profusely. Given the mechanism of injury, however, it is important to rule out cerebral trauma or skull fracture. If no signs of a cerebral trauma or skull fracture (discussed later in this chapter) are present, the scalp injury is not serious as long as bleeding is controlled.

## PREVENTION OF HEAD AND FACIAL INJURIES

A high school athletic director is faced with making budget cuts. He requests justification for purchasing mouth guards for teams other than football (i.e., soccer, basketball, lacrosse, and field hockey). Provide a rationale for ensuring that athletes in any sport involving contact should be provided with mouth guards.

The most important preventive measure for the head and facial area is the use of protective equipment. Many sports, such as baseball/softball, competitive bicycling, fencing, field hockey, football, ice hockey, lacrosse, and wrestling, require some type of head or facial protective equipment for participation. When used properly, protective equipment can protect the head and facial area from accidental or routine injuries, but no clinical evidence has definitively determined that use of protective equipment can prevent concussions.[1] Protective equipment cannot prevent all injuries. To minimize injuries, equipment must be properly fitted, clean, in good condition, and used in the manner for which it was designed.

Protective equipment may include a helmet, face guard, mouth guard, eyewear, ear wear, and a throat protector. Helmets protect the cranial portion of the skull by absorbing and dispersing impact forces, thereby reducing cerebral trauma. Face guards protect and shield the facial region. Mouth guards have been shown to reduce dental and oral soft-tissue injuries, jaw fractures, and temporomandibular joint (TMJ) injuries. Eyewear, ear wear, and throat protectors reduce injuries to their respective regions. Chapter 3 provides information regarding protective equipment for the head and face.

A properly fitted mouth guard can help to prevent dental and oral soft-tissue injuries, and it also can help to reduce the incidence of jaw fractures and TMJ injuries.

## CRANIAL INJURY MECHANISMS

Explain the mechanism for a contrecoup cerebral injury.

The occurrence of a skull fracture or intracranial injury is dependent on the material properties of the skull, the thickness of the skull in the specific area, the magnitude and direction of impact, and the size of the impact area. Direct impact causes two phenomena to occur—namely, deformation and acceleration. When a blow impacts the skull, the bone deforms and bends

inward, placing the inner border of the skull under tensile strain while the outer border is compressed (Fig. 20.7A). If the impact is of sufficient magnitude and the skull in the region of impact is thin, a skull fracture occurs at the site where tensile loading occurs. In contrast, if the skull is thick and dense enough at the area of impact, it may sustain inward bending without fracture. A fracture then may occur some distance from the impact zone in a region where the skull is thinner (Fig. 20.7B).

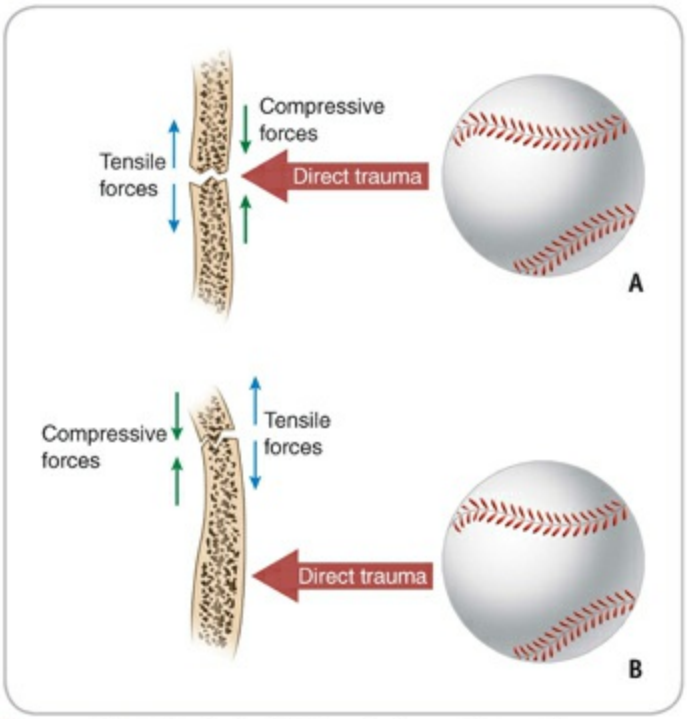



**Figure 20.7. Mechanical failure in bone.** When a blow impacts the skull, the bone deforms and bends inward, placing tensile stress on the inner border of the skull. **A,** If an impact is of sufficient magnitude and the skull is thin in the region of the impact, a skull fracture occurs at the impact site. **B,** If the skull is thick and dense enough at the area of impact, it may sustain bending without fracture; however, the fracture may occur some distance from the impact zone, in a region where the skull is thinner.

On impact, shock waves pass through the skull to the brain, causing it to accelerate. This acceleration can lead to shear, tensile, and compression strains within the brain substance, with shear being the most serious. Axial rotation coupled with acceleration can lead to **contrecoup injuries** (Fig. 20.8), which are injuries located away from the actual impact site.

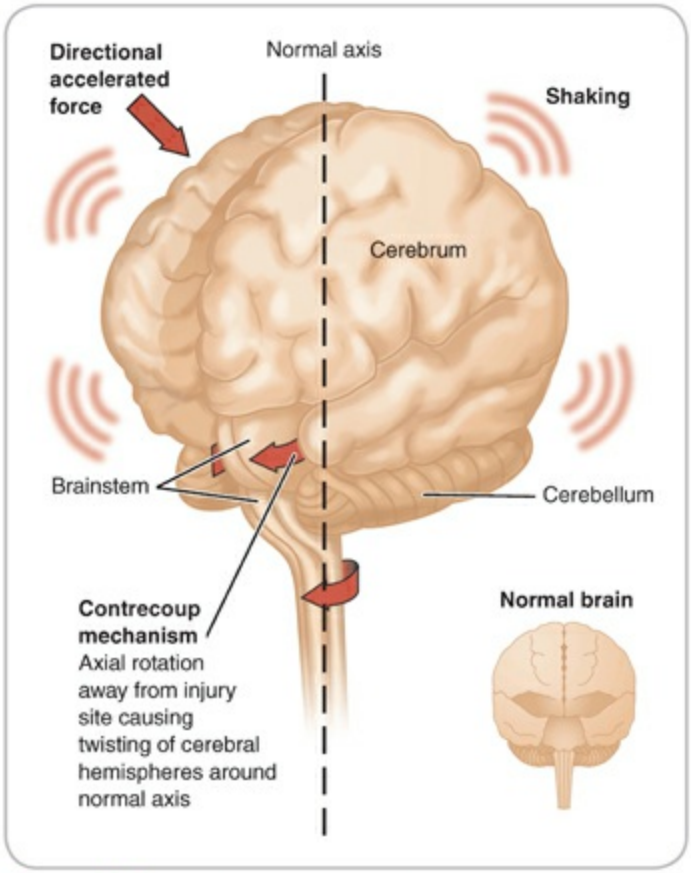



**Figure 20.8. A contrecoup injury.** Axial rotation coupled with acceleration can result in a contrecoup injury.

Cerebral trauma can lead to **focal injuries**, involving only localized damage (i.e., epidural, subdural, or intracerebral hematomas), or **diffuse injuries**, involving widespread disruption and damage to the function and/or structure of the brain. Although diffuse injuries account for only one-quarter of the fatalities caused by head trauma, they tend to be a more prevalent cause of long-term neurological deficits. If cerebral injuries are recognized and treated immediately, the severity can potentially be limited to the initial structural damage; however, if other factors, such as ischemia, hypoxia, cerebral swelling, and hemorrhaging around the brain occur, additional damage and possible neurological dysfunction result. Therefore, an accurate assessment of head injuries is essential to ensure prompt medical attention to rule out serious underlying problems that may complicate the original injury. A conscious, ambulatory patient should not be considered to have only a minor injury but, rather, should be assessed continually to determine if posttraumatic signs or

symptoms indicate a more serious underlying condition.

The mechanism for a contrecoup cerebral injury can be illustrated by this example: A football running back is sprinting downfield when he collides with an opposing player and is knocked backward, his head striking the ground. The running back's body and brain are moving in the same direction when an opposing force causes his brain to accelerate within the skull in the opposite direction. The injury occurs not at the site of contact with the ground but on the opposite side of the brain.

## ASSESSMENT OF CRANIAL CONDITIONS

A rugby player comes off the field complaining of what appears to be a "concussion." What questions should be asked as part of the history component during the assessment of this patient?

Any patient who receives a blow or any significant acceleration–deceleration type of force to the head should be evaluated thoroughly. Because significant head trauma may also cause neck injury, it should always be assumed that a cervical injury is present until cleared. Methods of assessing the cervical spine and cervical spine pathology are covered in the next chapter, Chapter 21. Although information presented in this chapter focuses on assessing the head in real-life situations, information presented in this chapter and in Chapter 21 are used simultaneously to assist the clinician in conducting the assessment. For matters of clarity, these components are presented separately. In addition, because of the complexity of assessing a cranial injury, additional thought questions and answers are provided throughout this section.

In approaching a patient who has sustained trauma to the head or face, the clinician should first conduct a primary survey to establish the status of the patient's airway, breathing, and circulation (ABCs). Next, assess the patient's level of consciousness using methods described in **Table 7.1** and begin

immediately observing for indications of trauma to the head such as posturing, abnormal pupils, raccoon eyes or Battle sign (see **Figs. 7.1** to 7.3), or the presence of CSF in blood coming from the nose or ears. If the patient is face down, the head and neck should be stabilized and the patient should be log rolled into a supine position while continuing to stabilize the cervical spine. Any mouth guard, dentures, or partial plates should be removed to prevent occlusion of the airway. Rescue breathing and cardiopulmonary resuscitation should be initiated as needed, and the emergency action plan (EAP) should be implemented.

## Vital Signs

It is imperative to begin conducting a vital sign assessment as quickly as possible to establish a baseline of information that can be rechecked periodically to determine if the patient's status is improving or deteriorating. Vital signs include pulse, respiration, blood pressure, and body temperature. With head trauma, however, body temperature is not as critical as the other signs. Any abnormal variations, presented in **Table 7.2**, such as a falling pulse rate, rising blood pressure, or irregular breathing, indicate increasing intracranial pressure.

1. **Pulse**
   - *Small, weak pulse*—Pulse pressure is diminished, and the pulse feels weak and small; causes include decreased stroke volume and increased peripheral resistance.
   - *Short, rapid, weak pulse*—indicates heart failure or shock
   - *Slow, bounding pulse*—indicates increasing intracranial pressure
   - *Accelerated pulse*—A rapid pulse (i.e., 150 beats per minute) may indicate pressure on the base of the brain.
2. **Respiration**
   - *Slow breathing (bradypnea)*—Breathing at less than 12 breaths per minute indicates increased intracranial pressure.

- *Cheyne-Stokes breathing*—Periods of deep breathing alternating with periods of apnea (no breathing) indicates brain damage.
- *Ataxic (Biot's) breathing*—Characterized by unpredictable irregularity; breaths may be shallow or deep and stop for short periods, indicating respiratory depression and brain damage typically at the medullary level.
- *Apneustic breathing*—Characterized by prolonged inspirations unrelieved by attempts to exhale, which indicates trauma to the pons.

3. **Blood pressure:** An increase in systolic blood pressure or a decrease in diastolic blood pressure indicates rising intracranial pressure. Low blood pressure rarely occurs in a head injury; however, it may indicate a possible cervical injury or serious blood loss from an injury elsewhere in the body.
4. **Pulse pressure:** The normal difference between diastolic and systolic pressure is approximately 40 mm Hg. A pulse pressure greater than 50 mm Hg indicates increased intracranial bleeding.

## History and Mental Status Testing

Information obtained during the history will assist the clinician in sequencing the different components of the assessment process. When dealing with a potential head injury, assessing mental status beyond the level of consciousness (AVPU, A/OX4, GCS) is often a part of the history-taking process (see **Table 7.1**). The patient may initially appear confused with memory loss and may have a heightened distractibility, an inability to maintain a coherent stream of thought, and an inability to carry out a sequence of goal-directed movements. The confusion and memory dysfunction may be immediate after injury, or it may be a delayed process, taking several minutes to fully evolve. The clinician should note the presence of slurred speech, difficulty in constructing sentences, or an inability to understand commands. The following examples may be used to gather the history of the injury and test the mental status of the injured participant:

1. **Orientation and mechanism of injury:** Ask the patient about the time, place, and situation. Attempt to determine the mechanism of injury (i.e., was the patient struck by a moving object such as ball, bat, knee or did the patient collide with another player, or fall with the head striking the ground).
2. **Loss of consciousness (LOC):** Although less than 10% of all concussions result in an LOC,[1] patients who have sustained an epidural hematoma often will have an initial LOC followed by a lucid period before declining. It is important to determine if the patient is totally unresponsive, confused, or disoriented. If LOC occurred, it is important to note whether it occurred immediately on direct impact or whether the person progressed to unconsciousness. In addition, the length of time of unconsciousness should be recorded. The patient's response to painful stimuli (e.g., squeezing the trapezius, pinching soft tissue between the thumb and index finger in the axilla, knuckle to the sternum, or squeezing the Achilles tendon) or positive results from pathological reflex testing (see **Table 7.2**) should be noted. The occurrence of a seizure also should be noted.
3. **Symptoms:** A headache is one of the most reported symptoms (86%) with a concussion[2,3]; however, progressive headaches indicate increasing intracranial pressure and signal danger. It is important to note if the patient is experiencing nausea, because intracranial pressure can stimulate the reflex onset of nausea and vomiting. If this symptom is present, it indicates a fairly serious intracranial injury. Other common symptoms that may be reported include dizziness, confusion, disorientation, blurred vision, amnesia, neck pain, and fatigue.[4] The patient may also report visual disturbances such as an increased sensitivity to light (photophobia) or "seeing stars or lights" as time of injury and an increased sensitivity to sound.
4. **Memory:** Assessment of memory should include question to assess for the presence of both **anterograde** (events after the point of injury) and

**retrograde** (events prior to the point of injury) amnesia. Assessing anterograde amnesia may be conducted by asking the patient to describe events from the time of injury to the current point in time. Retrograde amnesia can be assessed by asking the patient to describe the events leading up to the event that caused the injury. Other options include naming three words or identify three objects for the patient and then ask the person to recall these words or objects. Every 5 minutes, ask the patient to do so again. Additionally, ask the patient to recall recent newsworthy events or provide details of the current activity (e.g., plays, moves, strategies).

5. **Concentration:** Recite three digits and ask the patient to recite them backward. Move to four digits and then to five digits (e.g., 3-1-7, 4-6-8-2, and 5-3-0-7-4). Ask the patient to list the months of the year in reverse order.
6. **Behavior:** The patient's behavior, attitude, and demeanor may change after head trauma. This may present as irrational and inappropriate behavior, belligerence, or verbal or physical abuse directed at others.

The rugby player should be questioned regarding how the injury occurred, location, type, and intensity of pain and to determine if any LOC occurred. Next, it is important to see if the patient is confused, disoriented, dizzy, or nauseous or has a headache, blurred vision, ringing in the ears, sensitivity to light or sound, or feels out of it. Does the patient remember what happened before and after the injury occurred? The ability to concentrate is included during the history-taking process and involves providing the patient with a set of serial items and asking them to recite the items back to you in reverse order.

## Observation and Inspection

In the continued assessment of this patient, what should be included in the physical exam portion of the evaluation?

An observation of facial expression and function should be performed throughout the evaluation (Table 20.1). The following areas and conditions should be assessed in the observation component of the evaluation:

1. **Leakage of CSF:** CSF is a clear, colorless fluid that protects and cushions the brain and spinal cord. A basilar skull fracture may result in blood and CSF leaking from the ear. A fracture to the cribriform plate in the anterior cranial area may result in blood and CSF leaking from the nose.
2. **Signs of trauma:** Discoloration around the eyes (raccoon eyes) and behind the ears (Battle sign) may indicate a skull fracture. A depression, elevation, or bleeding may indicate a skull fracture, laceration, or hematoma. Snoring, which may result from a fracture to the anterior cranial floor, should be noted.
3. **Skin color:** Skin color and the presence of moisture or sweat should be assessed. If shock is developing, the skin may appear ashen or pale and may be moist and cool.
4. **Loss of emotional control:** Irritability, aggressive behavior, or uncontrolled crying for no apparent reason indicates cerebral dysfunction.

## Palpation

Palpation can help to determine possible skull or facial fractures. The clinician should palpate for point tenderness, crepitus, depressions, elevations, swelling, blood, or changes in skin temperature. The following sites should be palpated:

1. Scalp and hair
2. Base of the skull (occiput), external ear, and periauricular area
3. TMJ
4. Cervical spinous processes

5. Hyoid bone and cartilages
6. Mandible
7. Maxilla
8. Teeth
9. Zygomatic arch (cheek)
10. Frontal bone and entire eye orbit
11. Nasal bones and nasal cartilage

## Neurological Tests

Tests should be used that assess the upper motor neuron function of the brain through coordination, sensation, and agility and should include a combination of cognition, postural stability, and self-reported symptoms. An evaluation of myotomes and dermatomes is not an effective tool in assessing cranial injuries because they address lower motor neuron function associated with the spinal column and spinal nerves.

1. **Cranial nerve assessment:** The integrity of the cranial nerves can be assessed quickly by sense of smell, vision, eye tracking, smiling, clenching the jaw, hearing, balance, sense of taste, speaking, and strength of shoulder shrugs (Table 20.1).
2. **Pupil abnormalities:** Pupils are equal and reactive to light (PEARL). A dilated pupil on one side may indicate a subdural or epidural hematoma. Dilated pupils on both sides indicate a severe cranial injury with death imminent. The clinician should ask the patient to look up, down, and diagonally (i.e., move from an upper left gaze to a lower right gaze; upper right gaze to a lower left gaze). The coordinated and fluid motion of both eyes should be noted. The patient should be asked about blurred or double vision or the presence of "stars" or flashes of light on impact. Blurred or double vision, abnormal oscillating movements of the eye (**nystagmus**), or uncoordinated gross movement through the cardinal planes indicate a

disturbance of the cranial nerves that innervate the eyes and eye muscles.

3. **Babinski reflex:** The patient should be lying down with the eyes closed and the leg held in a slightly elevated and flexed position. A pointed object is stroked along the plantar aspect of the foot. A normal sign is for the toes to curl downward in flexion and adduction (**Fig. 20.9A**). An abnormal Babinski sign suggests an upper motor neuron lesion and is demonstrated by the extension of the big toe and abduction (splaying) of the other toes (**Fig. 20.9B**).

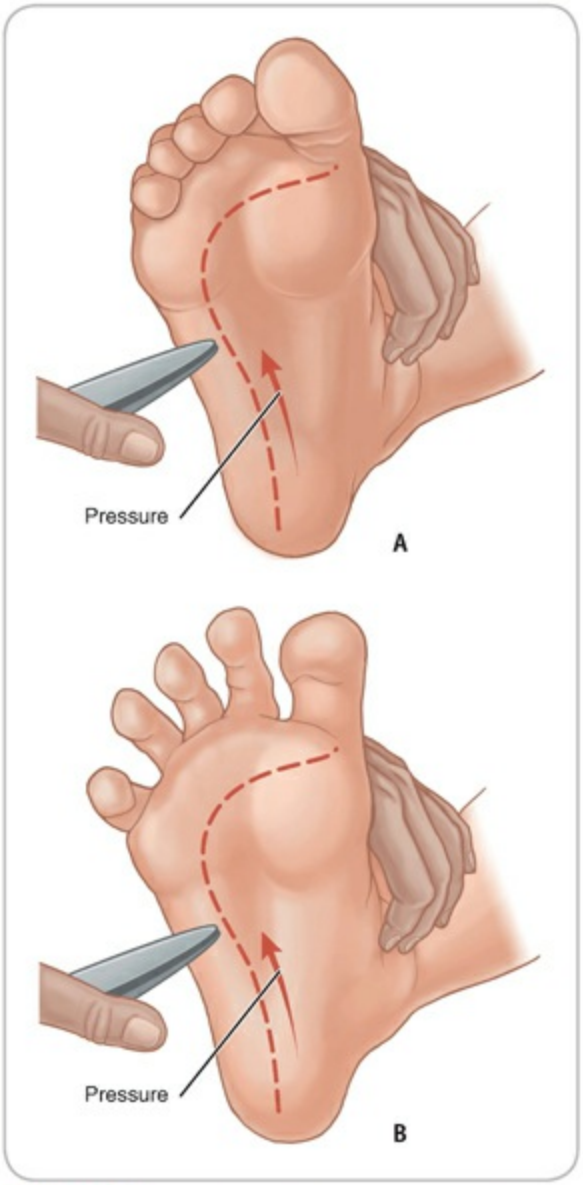



**Figure 20.9. The Babinski reflex.** The clinician strokes the bottom of the foot along the lateral border, moving distally into the middle of the foot and over the ball of the foot. **A,** A normal sign is the toes curling under (flexing). **B,** An abnormal sign shows the toes splaying.

4. **Strength:** A bilateral comparison of grip strength should be performed by having the clinician place the hands inside the patient's hands and then asking the patient to squeeze.
5. **Neuropsychological assessments**
    - **Standardized Assessment of Concussion:** SCAT3[1,5,6] is an

abbreviated neurocognitive test designed for medical personnel in evaluating athletes aged 13 years and older for potential concussion. A modified Child-SCAT3 should be used for children aged 5 to 13 years of age.[6] SCAT3 (**Fig. 20.10**) evaluates four key mental functions (orientation, immediate memory, concentration, and delayed recall) as well as balance (Modified Balance Error Scoring System testing) and symptoms (graded symptoms score). The graded symptom checklist has been recommended by the National Athletic Trainers' Association,[1] the Zurich International Conference on Concussion in Sport,[6] and the American Academy of Pediatrics[7] for use during the initial evaluation of a head injury. The SCAT3 is designed for use in assessing the presence of concussion and is useful only for sideline evaluations and follow-up assessment within the first 24 hours.[1]

## ATHLETE INFORMATION

**Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.**

### Signs to watch for

Problems could arise over the first 24 – 48 hours. The athlete should not be left alone and must go to a hospital at once if they:

- Have a headache that gets worse
- Are very drowsy or can't be awakened
- Can't recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused; are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on their feet; have slurred speech

**Remember, it is better to be safe.**
**Consult your doctor after a suspected concussion.**

### Return to play

Athletes should not be returned to play the same day of injury.
When returning athletes to play, they should be **medically cleared and then follow a stepwise supervised program,** with stages of progression.

**For example:**

| Rehabilitation stage | Functional exercise at each stage of rehabilitation | Objective of each stage |
|---|---|---|
| No activity | Physical and cognitive rest | Recovery |
| Light aerobic exercise | Walking, swimming or stationary cycling keeping intensity, 70 % maximum predicted heart rate. No resistance training | Increase heart rate |
| Sport-specific exercise | Skating drills in ice hockey, running drills in soccer. No head impact activities | Add movement |
| Non-contact training drills | Progression to more complex training drills, eg passing drills in football and ice hockey. May start progressive resistance training | Exercise, coordination, and cognitive load |
| Full contact practice | Following medical clearance participate in normal training activities | Restore confidence and assess functional skills by coaching staff |
| Return to play | Normal game play | |

There should be at least 24 hours (or longer) for each stage and if symptoms recur the athlete should rest until they resolve once again and then resume the program at the previous asymptomatic stage. Resistance training should only be added in the later stages.

If the athlete is symptomatic for more than 10 days, then consultation by a medical practitioner who is expert in the management of concussion, is recommended.

**Medical clearance should be given before return to play.**

### Scoring Summary:

| Test Domain | Score | | |
|---|---|---|---|
| | Date: | Date: | Date: |
| Number of Symptoms of 22 | | | |
| Symptom Severity Score of 132 | | | |
| Orientation of 5 | | | |
| Immediate Memory of 15 | | | |
| Concentration of 5 | | | |
| Delayed Recall of 5 | | | |
| **SAC Total** | | | |
| BESS (total errors) | | | |
| Tandem Gait (seconds) | | | |
| Coordination of 1 | | | |

### Notes:

## CONCUSSION INJURY ADVICE

(To be given to the **person monitoring** the concussed athlete)

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. Recovery time is variable across individuals and the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

**If you notice any change in behaviour, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please contact your doctor or the nearest hospital emergency department immediately.**

**Other important points:**

- Rest (physically and mentally), including training or playing sports until symptoms resolve and you are medically cleared
- No alcohol
- No prescription or non-prescription drugs without medical supervision. Specifically:
  - No sleeping tablets
  - Do not use aspirin, anti-inflammatory medication or sedating pain killers
- Do not drive until medically cleared
- Do not train or play sport until medically cleared

**Clinic phone number**

Patient's name _____

Date / time of injury _____

Date / time of medical review _____

Treating physician _____

Contact details or stamp

**Figure 20.10. The Sport Concussion Assessment Tool 3 (SCAT3).**

# SCAT3™

## Sport Concussion Assessment Tool – 3rd Edition

For use by medical professionals only

Name | Date / Time of Injury: Date of Assessment: | Examiner:

### What is the SCAT3?[1]

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged from 13 years and older. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively[2]. For younger persons, ages 12 and under, please use the Child SCAT3. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool[3]. Preseason baseline testing with the SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.

**NOTE:** The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgement. An athlete may have a concussion even if their SCAT3 is "normal".

### What is a concussion?

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific signs and/or symptoms (some examples listed below) and most often does not involve loss of consciousness. Concussion should be suspected in the presence of **any one or more** of the following:

- Symptoms (e.g., headache), or
- Physical signs (e.g., unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour (e.g., change in personality).

## SIDELINE ASSESSMENT

### Indications for Emergency Management

**NOTE:** A hit to the head can sometimes be associated with a more serious brain injury. Any of the following warrants consideration of activating emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
  Deteriorating mental status
  Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs

### Potential signs of concussion?

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and **should not be permitted to return to sport the same day** if a concussion is suspected.

| | |
|---|---|
| Any loss of consciousness? | ☐ Y ☐ N |
| "If so, how long?" | _____ |
| Balance or motor incoordination (stumbles, slow/laboured movements, etc.)? | ☐ Y ☐ N |
| Disorientation or confusion (inability to respond appropriately to questions)? | ☐ Y ☐ N |
| Loss of memory: | ☐ Y ☐ N |
| "If so, how long?" | _____ |
| "Before or after the injury?" | _____ |
| Blank or vacant look: | ☐ Y ☐ N |
| Visible facial injury in combination with any of the above: | ☐ Y ☐ N |

### 1 Glasgow coma scale (GCS)

| | |
|---|---|
| **Best eye response (E)** | |
| No eye opening | 1 |
| Eye opening in response to pain | 2 |
| Eye opening to speech | 3 |
| Eyes opening spontaneously | 4 |
| **Best verbal response (V)** | |
| No verbal response | 1 |
| Incomprehensible sounds | 2 |
| Inappropriate words | 3 |
| Confused | 4 |
| Oriented | 5 |
| **Best motor response (M)** | |
| No motor response | 1 |
| Extension to pain | 2 |
| Abnormal flexion to pain | 3 |
| Flexion / Withdrawal to pain | 4 |
| Localizes to pain | 5 |
| Obeys commands | 6 |
| **Glasgow Coma score (E + V + M)** | of 15 |

GCS should be recorded for all athletes in case of subsequent deterioration.

### 2 Maddocks Score[3]

*"I am going to ask you a few questions, please listen carefully and give your best effort."*

Modified Maddocks questions (1 point for each correct answer)

| | | |
|---|---|---|
| What venue are we at today? | 0 | 1 |
| Which half is it now? | 0 | 1 |
| Who scored last in this match? | 0 | 1 |
| What team did you play last week / game? | 0 | 1 |
| Did your team win the last game? | 0 | 1 |
| **Maddocks score** | | of 5 |

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.

**Notes:** Mechanism of Injury ("tell me what happened"?):

_____

_____

_____

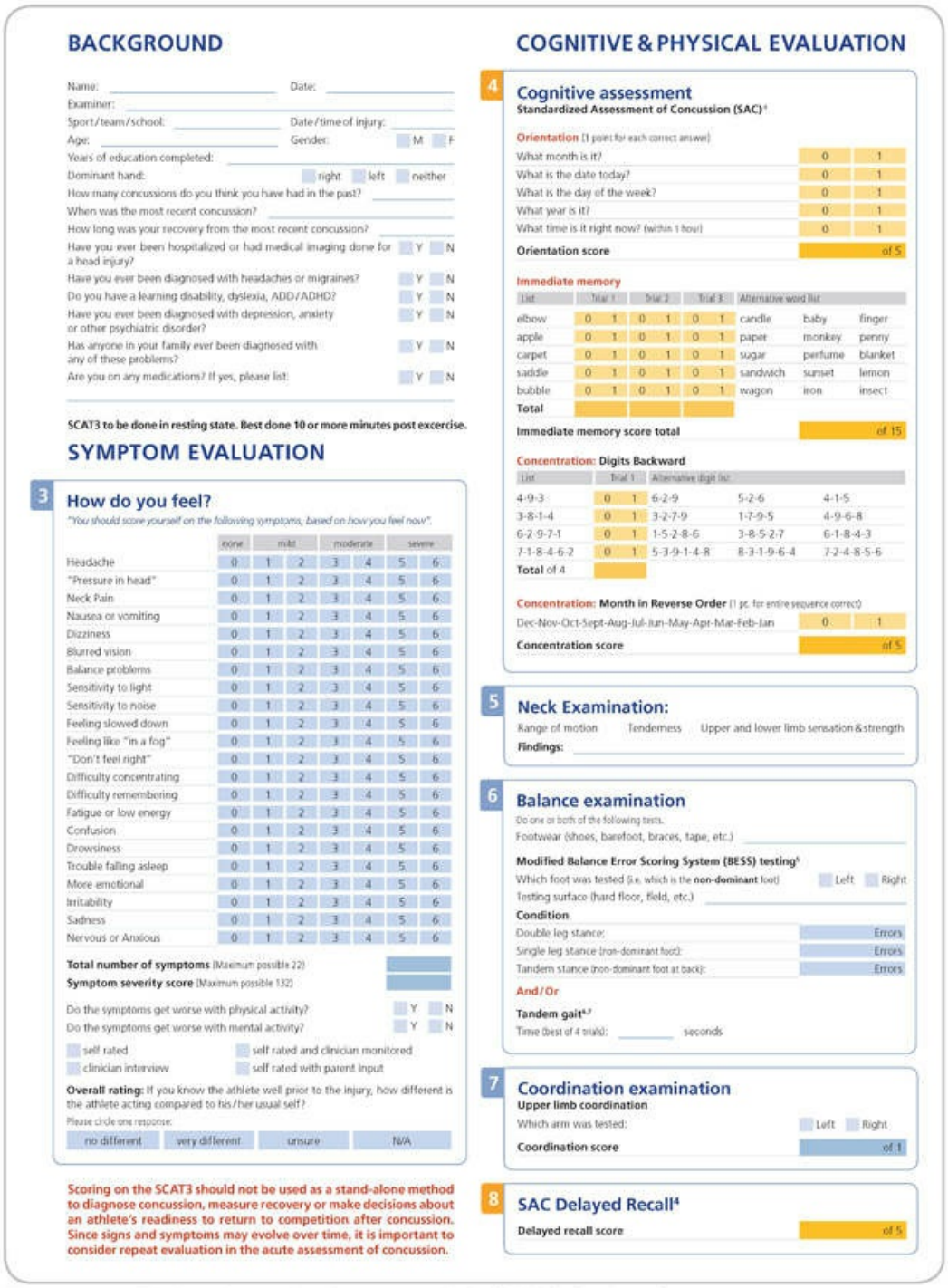
_____

_____

**Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of injury.**



**Figure 20.10. The Sport Concussion Assessment Tool 3 (SCAT3).**



## BACKGROUND

Name: _____ Date: _____

Examiner: _____

Sport/team/school: _____ Date/time of injury: _____

Age: _____ Gender: ☐ M ☐ F

Years of education completed: _____

Dominant hand: ☐ right ☐ left ☐ neither

How many concussions do you think you have had in the past? _____

When was the most recent concussion? _____

How long was your recovery from the most recent concussion? _____

Have you ever been hospitalized or had medical imaging done for a head injury? ☐ Y ☐ N

Have you ever been diagnosed with headaches or migraines? ☐ Y ☐ N

Do you have a learning disability, dyslexia, ADD/ADHD? ☐ Y ☐ N

Have you ever been diagnosed with depression, anxiety or other psychiatric disorder? ☐ Y ☐ N

Has anyone in your family ever been diagnosed with any of these problems? ☐ Y ☐ N

Are you on any medications? If yes, please list: ☐ Y ☐ N

**SCAT3 to be done in resting state. Best done 10 or more minutes post excercise.**

## SYMPTOM EVALUATION

### 3 How do you feel?

*"You should score yourself on the following symptoms, based on how you feel now".*

| | none | mild | | moderate | | severe | |
|---|---|---|---|---|---|---|---|
| Headache | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| "Pressure in head" | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Neck Pain | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Nausea or vomiting | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Dizziness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Blurred vision | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Balance problems | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sensitivity to light | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sensitivity to noise | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Feeling slowed down | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Feeling like "in a fog" | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| "Don't feel right" | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Difficulty concentrating | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Difficulty remembering | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Fatigue or low energy | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Confusion | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Drowsiness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Trouble falling asleep | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| More emotional | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Irritability | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Sadness | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Nervous or Anxious | 0 | 1 | 2 | 3 | 4 | 5 | 6 |

**Total number of symptoms** (Maximum possible 22) _____

**Symptom severity score** (Maximum possible 132) _____

Do the symptoms get worse with physical activity? ☐ Y ☐ N

Do the symptoms get worse with mental activity? ☐ Y ☐ N

☐ self rated ☐ self rated and clinician monitored

☐ clinician interview ☐ self rated with parent input

**Overall rating:** If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

no different | very different | unsure | N/A

**Scoring on the SCAT3 should not be used as a stand-alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.**

## COGNITIVE & PHYSICAL EVALUATION

### 4 Cognitive assessment

**Standardized Assessment of Concussion (SAC)[4]**

**Orientation** (1 point for each correct answer)

| | | |
|---|---|---|
| What month is it? | 0 | 1 |
| What is the date today? | 0 | 1 |
| What is the day of the week? | 0 | 1 |
| What year is it? | 0 | 1 |
| What time is it right now? (within 1 hour) | 0 | 1 |
| **Orientation score** | | of 5 |

**Immediate memory**

| List | Trial 1 | | Trial 2 | | Trial 3 | | Alternative word list | | |
|---|---|---|---|---|---|---|---|---|---|
| elbow | 0 | 1 | 0 | 1 | 0 | 1 | candle | baby | finger |
| apple | 0 | 1 | 0 | 1 | 0 | 1 | paper | monkey | penny |
| carpet | 0 | 1 | 0 | 1 | 0 | 1 | sugar | perfume | blanket |
| saddle | 0 | 1 | 0 | 1 | 0 | 1 | sandwich | sunset | lemon |
| bubble | 0 | 1 | 0 | 1 | 0 | 1 | wagon | iron | insect |
| **Total** | | | | | | | | | |

**Immediate memory score total** of 15

**Concentration: Digits Backward**

| List | Trial 1 | Alternative digit list | | |
|---|---|---|---|---|
| 4-9-3 | 0 1 | 6-2-9 | 5-2-6 | 4-1-5 |
| 3-8-1-4 | 0 1 | 3-2-7-9 | 1-7-9-5 | 4-9-6-8 |
| 6-2-9-7-1 | 0 1 | 1-5-2-8-6 | 3-8-5-2-7 | 6-1-8-4-3 |
| 7-1-8-4-6-2 | 0 1 | 5-3-9-1-4-8 | 8-3-1-9-6-4 | 7-2-4-8-5-6 |
| **Total** of 4 | | | | |

**Concentration: Month in Reverse Order** (1 pt. for entire sequence correct)

| | | |
|---|---|---|
| Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan | 0 | 1 |
| **Concentration score** | | of 5 |

### 5 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength

**Findings:** _____

### 6 Balance examination

Do one or both of the following tests.

Footwear (shoes, barefoot, braces, tape, etc.) _____

**Modified Balance Error Scoring System (BESS) testing[5]**

Which foot was tested (i.e. which is the **non-dominant** foot) ☐ Left ☐ Right

Testing surface (hard floor, field, etc.) _____

**Condition**

| | |
|---|---|
| Double leg stance: | Errors |
| Single leg stance (non-dominant foot): | Errors |
| Tandem stance (non-dominant foot at back): | Errors |

**And/Or**

**Tandem gait[6,7]**

Time (best of 4 trials): _____ seconds

### 7 Coordination examination

**Upper limb coordination**

Which arm was tested: ☐ Left ☐ Right

**Coordination score** of 1

### 8 SAC Delayed Recall[4]

**Delayed recall score** of 5

**Figure 20.10. The Sport Concussion Assessment Tool 3 (SCAT3).** *(continued)*

## INSTRUCTIONS

Words in *Italics* throughout the SCAT3 are the instructions given to the athlete by the tester.

### Symptom Scale

*"You should score yourself on the following symptoms, based on how you feel now".*

To be completed by the athlete. In situations where the symptom scale is being completed after exercise, it should still be done in a resting state, at least 10 minutes post exercise.
For total number of symptoms, maximum possible is 22.
For Symptom severity score, add all scores in table, maximum possible is 22 x 6 = 132.

### SAC[4]

**Immediate Memory**

*"I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order."*

**Trials 2 & 3:**

*"I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before."*

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. **Score 1 pt. for each correct response.** Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

**Concentration**

**Digits backward**

*"I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."*

If correct, go to next string length. If incorrect, read trial 2. **One point possible for each string length**. Stop after incorrect on both trials. The digits should be read at the rate of one per second.

**Months in reverse order**

*"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November … Go ahead"*

**1 pt. for entire sequence correct**

**Delayed Recall**

The delayed recall should be performed after completion of the Balance and Coordination Examination.

*"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."*

**Score 1 pt. for each correct response**

### Balance Examination

**Modified Balance Error Scoring System (BESS) testing[5]**

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[5]. A stopwatch or watch with a second hand is required for this testing.

*"I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."*

**(a) Double leg stance:**

*"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."*

**(b) Single leg stance:**

*"If you were to kick a ball, which foot would you use? [This will be the dominant foot] Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

**(c) Tandem stance:**

*"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

**Balance testing – types of errors**

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. **The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10.** If a athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of **five seconds** at the start are assigned the highest possible score, ten, for that testing condition.

**OPTION:** For further assessment, the same 3 stances can be performed on a surface of medium density foam (e.g., approximately 50 cm x 40 cm x 6 cm).

**Tandem Gait[6,7]**

*Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. A total of 4 trials are done and the best time is retained. Athletes should complete the test in 14 seconds. Athletes fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object. In this case, the time is not recorded and the trial repeated, if appropriate.*

### Coordination Examination

**Upper limb coordination**

Finger-to-nose (FTN) task:

*"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended), pointing in front of you. When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose, and then return to the starting position, as quickly and as accurately as possible."*

**Scoring: 5 correct repetitions in < 4 seconds = 1**
**Note for testers:** Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. **Failure should be scored as 0.**

### References & Footnotes


1. This tool has been developed by a group of international experts at the 4th International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2012. The full details of the conference outcomes and the authors of the tool are published in The BJSM Injury Prevention and Health Protection, 2013, Volume 47, Issue 5. The outcome paper will also be simultaneously co-published in other leading biomedical journals with the copyright held by the Concussion in Sport Group, to allow unrestricted distribution, providing no alterations are made.

2. McCrory P et al., Consensus Statement on Concussion in Sport – the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. British Journal of Sports Medicine 2009; 43: i76-89.

3. Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine. 1995; 5(1): 32 – 3.

4. McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sport Medicine. 2001; 11: 176 – 181.

5. Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24 – 30.

6. Schneiders, A.G., Sullivan, S.J., Gray, A., Hammond-Tooke, G. & McCrory, P. Normative values for 16-37 year old subjects for three clinical measures of motor performance used in the assessment of sports concussions. Journal of Science and Medicine in Sport. 2010; 13(2): 196 – 201.

7. Schneiders, A.G., Sullivan, S.J., Kvarnstrom, J.K., Olsson, M., Yden, T. & Marshall, S.W. The effect of footwear and sports-surface on dynamic neurological screening in sport-related concussion. Journal of Science and Medicine in Sport. 2010; 13(4): 382 – 386


**Figure 20.10. The Sport Concussion Assessment Tool 3 (SCAT3).** *(continued)*

- **Paper-and-pencil tests:** A number of assessment tools focus on verbal learning, verbal scanning, attention, concentration, short-term memory, visual perception and tracking, and general brain function. These include the Hopkins Verbal Learning Test (John Hopkins University, Baltimore, MD), Trail Making Test A & B (Reitan Neuropsychology Laboratory, Tucson, AZ), Wechsler Digit Span Test (Psychological

Corporation, San Antonio, TX), Stroop Color-Word Interference Test (Stoelting Co, Wood Dale, IL), Symbol Digit Modalities Test (Western Psychological Services, Los Angeles, CA), and Controlled Oral Word Association Test (COWAT; Psychological Assessment Resources, Inc, Odessa, FL).[8] However, the SCAT2/3 are the mostly used.

- **Computerized neuropsychological tests:** Recently, a number of computerized neuropsychological tests have been developed to test patients who have sustained a concussion. Advantages in administering these tests include the ability to conduct, store, retrieve, and compare baseline values with postinjury values.[9] Examples of the more common tests include the Concussion Assessment and Cognitive Testing, Automated Neuropsychological Assessment Metrics (ANAM) (National Rehabilitation Hospital, Assistive Technology and Neuroscience Center, Washington, DC), CogSport Axon (CogState Ltd, Victoria, Australia), Concussion Resolution Index (CRI) (HeadMinder, Inc, New York, NY), Concussion Vital Signs, and the Immediate Postconcussion Assessment and Cognitive Testing (ImPACT; University of Pittsburg Medical Center, Pittsburgh, PA).[1] Each of the computerized tests has published data on test–retest reliability, and all have demonstrated deficits in concussed athletes compared with their baseline assessments.[10–13]

6. **Coordination and balance**

- **Finger-to-nose test:** The purpose of the finger-to-nose (FTN) test is to assess voluntary muscle control and upper limb coordination.[14] In order for coordinated movement to occur, there must be integration of proprioceptive information coming from the limb and going to the brain, primarily the cerebellum. The information is processed and return information is sent back to the limb, directing movement quality, speed, and accuracy. If the cerebellum has been damaged, smooth motion does not occur. The FTN test has been used to measure temporal coordination in poststroke patients.[14] The method described

for performing the FTN test on poststroke patients is similar to the method described in the SCAT3. When used with poststroke patients, patients completed the test twice, once with eyes open and once with eyes closed, and the starting position is with hands on knees.[14] According to the SCAT3 protocol, to perform the FTN test, the patient is in a seated position with arm flexed at 90° and fully extended. The patient is instructed to touch his or her nose five consecutive times but must return to the starting position after each nose touch. The action is timed. The clinician should note if the patient accurately touches his or her nose and whether or not the patient returns arms fully to the starting position between each attempts (**Fig. 20.11**). The patient receives a score of 1 if the patient is able to perform five correct repetitions in less than 4 seconds. The patient fails the test and receives a score of 0 if the patient does not touch his or her nose, does not fully extend the elbow, or cannot perform five repetitions successfully.[5]

**Figure 20.11. A finger-to-nose test.** The patient should be seated with the eyes open and shoulders flexed to 90° with arms fully extended, stretched out in front of the patient's body. The clinician instructs the patient to touch the index finger to the nose five consecutive times, returning to the starting position between each nose touch. An inability to perform this test indicates physical disorientation and a lack of coordination and should preclude reentry to activity.

- **Modified Balance Error Scoring System (BESS):** Designed to assess impairment of balance and coordination in the physically active

population, this test assesses balance using three different stances on two different types of surfaces. The BESS has been found to have moderate to good reliability in detecting large balance deficits in patients with concussion or fatigue.[15] The *modified BESS* has been found to have greater reliability than the original BESS and is more easily and quickly administered.[15,16] The assessment involves three different stances (**Table 20.2**) with each stance being completed twice, once while standing on a firm surface and again while standing on a foam surface for a total of six trials (**Fig. 20.12**). The battery of tests is performed before the start of participation in an activity or sport (e.g., as part of the preparticipation examination) to establish a baseline of information. Following head injury, the modified BESS can be administered on site or in an office/clinic setting to compare the current results with the initial findings.

**TABLE 20.2 Modified Balance Error Scoring System[a]**

| STANCE/CRITERIA | NUMBER OF ERRORS | MAXIMUM ERRORS ALLOWED |
|---|---|---|
| **Double-leg stance (narrow stance; feet together):** Patient should have his or her hands on the hips and eyes closed. | | 10 |
| **Single-leg stance (standing on nondominant foot with the dominant leg held in approximately 30° of hip flexion and 45° of knee flexion):** Patient should have his or her hands on the hips and eyes closed. | | 10 |
| **Tandem stance (standing heel to toe with nondominant foot in back, and weight on nondominant foot):** Patient should have his or her hands on the hips and eyes closed. | | 10 |
| Total Scores | | 30 |

**Balance Testing—Types of Errors[5]**

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into >30° abduction
5. Lifting forefoot or heel
6. Remaining out of test position >5 seconds

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The clinician will begin counting errors only after the patient has assumed the proper start position. *The modified Balance Error Scoring System is calculated by adding 1 error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10.* If an athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of *5 seconds* at the start are assigned the highest possible score, 10, for that testing condition.[5]

[a]This test is based on a modified version of the original Balance Error Scoring System test and is a component of the SCAT3.[5,15,16] To administer the test, the clinician will need a device that measures time in seconds.

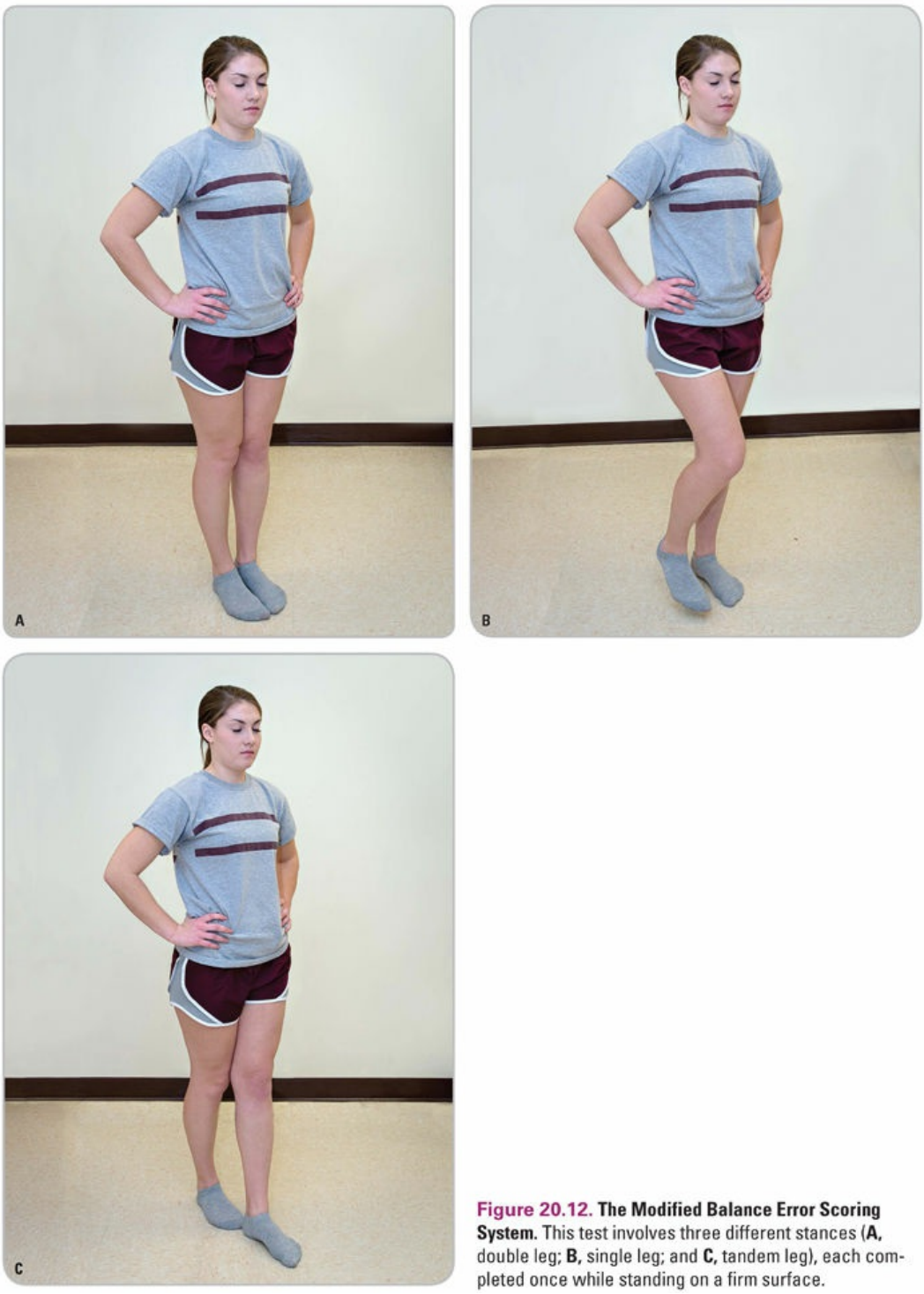



**Figure 20.12. The Modified Balance Error Scoring System.** This test involves three different stances (**A,** double leg; **B,** single leg; and **C,** tandem leg), each completed once while standing on a firm surface.

## Determination of Findings

Protocols for caring for patients with suspected cranial injury should be included within the organization's policy and procedures as well as a

component of the EAP. If the patient is not in a crisis situation, an evaluation of vital signs, mental status, symptoms check, and neurological tests should be completed every 5 to 7 minutes to determine the progress of the condition. If the patient has been evaluated by a physician on site and the signs and symptoms linger but appear to be minor, it is essential to ensure ongoing monitoring of the patient. An individual close to the injured party, such as a parent, spouse, or roommate, should be informed of the injury and be told to look for problematic signs, including changes in behavior, unsteady gait, slurring of speech, a progressive headache or nausea, restlessness, mental confusion, or drowsiness. These danger signs should be fully explained to the observer and provided on an information sheet.

Application Strategy 20.1 summarizes an assessment of a cranial injury.

**APPLICATION STRATEGY 20.1**

## Cranial Injury Evaluation

**Determine the initial level of consciousness.**

1. If unconscious or altered level of conscious and/or complaining of neck pain or findings consistent with cervical spine injury:
   - **a.** Stabilize head and neck.
   - **b.** Check ABCs.
   - **c.** Remove equipment.
   - **d.** Activate the emergency plan, including summoning EMS if necessary.
   - **e.** Take and monitor vital signs (i.e., pulse, respiration, and blood pressure).
   - **f.** Babinski reflex
2. If conscious with no complaints of neck pain or findings consistent with cervical spine injury:
   - **a.** Take history and assess mental status:
     - Orientation (e.g., time, place, person, and situation-mechanism of injury)

- Concentration (e.g., count digits backward or recite the months of the year in reverse order)
- Memory (e.g., names of teams in previous contests, recall of three words and three objects, recent newsworthy events, or details of the contest)
- Symptoms (e.g., headache, nausea, or tinnitus, pain)

**b.** Observation and inspection
- Leakage of CSF
- Signs of trauma (e.g., deformity, body posturing, or discoloration around the eyes and behind the ears)
- Loss of emotional control (e.g., irritability, aggressiveness, or uncontrolled crying)

**c.** Palpate bony and soft-tissue structures for point tenderness, crepitus, depressions, elevations, swelling, blood, or changes in skin temperature.

**d.** Neurological examination
- Cranial nerve assessment
- Pupil abnormalities (e.g., pupil size, response to light, eye movement, nystagmus, or blurred or double vision)
- Strength
- Neuropsychological assessments (SCAT3)
- Coordination and balance (e.g., finger-to-nose test, gait, error scoring system) (SCAT3)

**3.** If patient presents with normal findings after repeated assessment over period of time, administer external provocation tests and monitor for onset or return or increase of symptoms.

**a.** External provocative test
- 40-yard sprint
- Five sit-ups
- Five push-ups
- Five knee bends

**b.** Take vital signs, and recheck every 5–7 minutes.

Once history reveals the potential that the patient may have sustained a brain injury, vital signs should be assessed at once and the patient inspected for signs of skull and brain trauma. A cranial nerve assessment and assessment of mental status should be conducted followed by administering the SCAT3.

## SCALP INJURIES

In attempting to keep a ball from going out of bounds, a basketball player collides with the bleachers. As the athletic trainer approaches the player, she notices bleeding from the scalp. Explain the immediate management of this injury.

The scalp is the outermost anatomical structure of the cranium and the first area of contact in head trauma. The scalp is highly vascular and bleeds freely when compromised, making it a frequent site for soft-tissue injuries.

### Etiology

Blunt trauma or penetrating trauma often leads to scalp abrasions, lacerations, contusions, or hematomas between the layers of tissue.

### Signs and Symptoms

The patient will report being hit on the head. Bleeding can be profuse and may mask serious underlying conditions; therefore, damage to the brain and spine should be cleared through history taking and if needed, physical examination.

### Management

The primary concern with any scalp injury is to control bleeding, prevent contamination, and assess for a possible skull fracture. In keeping with universal precautions, latex gloves should be worn during the management of any open wound. Mild direct pressure should be applied to the area with

sterile gauze until the bleeding has stopped. The wound should be inspected for any foreign bodies or signs of a skull fracture. If a skull fracture is ruled out, the wound should be cleansed with surgical soap or saline solution and covered with a sterile dressing, and the patient should be referred to a physician for possible suturing.

Abrasions and contusions should be treated with gentle cleansing, topical antiseptics, and ice to control hemorrhage. Hematomas, or "goose eggs," involve a collection of blood between the layers of the scalp and the skull. Crushed ice and a pressure bandage should be used to control hemorrhage and edema. If the condition does not improve in 24 hours, the patient should be referred to a physician.

In managing the bleeding scalp, it would be appropriate for the athletic trainer to hand sterile gauze to the patient and direct the patient to apply gentle pressure to the area while the athletic trainer puts on latex gloves. Once gloved, the athletic trainer should inspect the area and continue to apply pressure until the bleeding has stopped. If a skull fracture is ruled out, the area should be cleansed with surgical soap or saline solution and covered with a sterile dressing. Depending on the nature of the wound, referral to a physician may be required for possible suturing.

## SKULL FRACTURES

While driving toward the basket, a basketball player is undercut. She falls sideways and strikes her head sharply on the floor. The patient complains of an intense headache, disorientation, and blurred vision. Might these signs and symptoms indicate that a possible skull fracture may be present?

### Etiology

When a severe blow to the head occurs, a skull fracture should always be suspected. Skull fractures may be linear (i.e., in a line), comminuted (i.e., in multiple pieces), depressed (i.e., fragments driven internally toward the brain), or basilar (i.e., involving the base of the skull) (Fig. 20.13). Often, however, it is difficult to detect the presence of a deep scalp hematoma. With a break in the skin adjacent to the fracture site and a tear in the underlying dura mater, a patient has a high risk of bacterial infection into the intracranial cavity, which can result in **septic meningitis**.

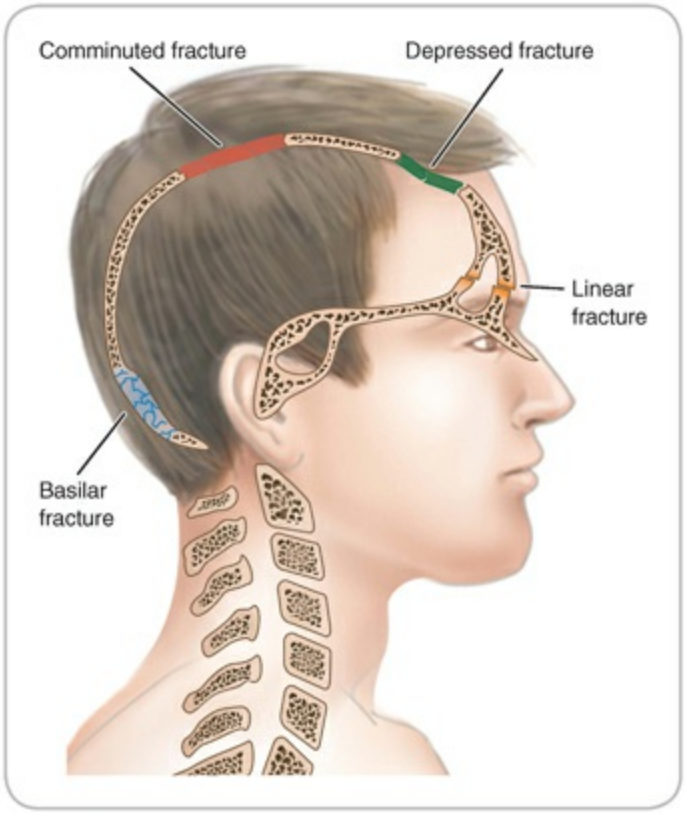



**Figure 20.13. Skull fractures.** Fractures of the skull are categorized as linear, comminuted, depressed, or basilar.

## Signs and Symptoms

Depending on the fracture site, different signs may appear (Box 20.1). For example, a fracture at the eyebrow level may travel into the anterior cranial fossa and sinuses, leading to discoloration around the eyes (**raccoon eyes**). Bony fragments may damage the optic or olfactory cranial nerves, leading to blindness or a loss of smell. A basilar fracture above and behind the ear may

lead to a **Battle sign**, which is a discoloration that can appear within minutes behind the ear (Fig. 20.14). In some cases, blood or CSF may leak from the nose or ear canal. Identification of the type of leaking fluid can be assessed by gently absorbing some of it with a gauze pad and then observing the pad for possible separation of clear fluid from blood. This action is called "targeting," or the "halo test," and it is important to note that this test is not always reliable. A hearing loss or facial paralysis also may be present. A fracture to the temple region may damage the meningeal arteries, causing epidural bleeding between the dura mater and the skull (epidural hematoma). This can be life-threatening and is discussed in more detail in the Focal Cerebral Conditions.

### BOX 20.1 Possible Signs and Symptoms of a Skull Fracture

- Visible deformity (do not be misled by a "goose egg" [a fracture may be under the site])
- Bleeding or clear fluid (CSF) from the nose and/or ear
- Deep laceration or severe bruise to the scalp
- Loss of smell
- Palpable depression or crepitus
- Loss of sight or major vision disturbances
- Unequal pupils
- Unconsciousness for more than 2 minutes after direct trauma to the head
- Discoloration under both eyes (raccoon eyes) or behind the ear (Battle sign)

**Figure 20.14. Battle sign.** Superficial ecchymosis over the mastoid process.

## Management

A skull fracture can be life-threatening. If any of the signs and symptoms mentioned in Box 20.1 becomes apparent, activate the emergency plan. Application Strategy 20.2 summarizes management of a suspected skull fracture.

**APPLICATION STRATEGY 20.2**

### Evaluation and Management of a Suspected Skull Fracture

**Evaluation**

1. Stabilize the head and neck.
2. Check the ABCs.
3. Take vital signs (i.e., pulse, respiration, and blood pressure).
4. Observe for the following:
   - Swelling or discoloration around the eyes or behind the ears
   - Blood or CSF leaking from the nose or ears
   - Pupil size, pupillary response to light, and eye movement
5. Palpate for depressions, blood, and crepitus. Palpate cervical vertebrae for associated neck injury.

**Management**

1. Activate the emergency plan, including summoning EMS.
2. Cover any open wounds with a sterile dressing but do not apply pressure to the area.
3. Elevate the upper body and head if there is no evidence of shock or of neck or spinal injury. If such evidence is present, keep the patient lying flat.
4. Treat for shock.
5. Recheck vital signs and symptoms every 5 minutes until EMS arrives.

Signs that indicate a possible skull fracture include deformity, unequal pupils, discoloration around both eyes or behind the ears, bleeding or CSF leaking from the nose and/or ear, and any loss of sight or smell. The basketball player did not exhibit any of these red flags. Even so, the patient should be thoroughly evaluated for head trauma. If any of the signs appear during the assessment, the emergency plan should be activated.

## FOCAL CEREBRAL CONDITIONS



After colliding with a fellow lacrosse player, a player complains of a headache and dizziness. Following 15 minutes of ice application to the region, the patient complains of increasing headache, dizziness, and nausea. There also is increased mental confusion. What do these symptoms indicate, and how should this injury be managed?

Focal cerebral injuries usually result in a localized collection of blood or hematoma. The skull has no room for additional accumulation of blood or fluid; as such, any additional foreign matter within the cranial cavity increases pressure on the brain, leading to significant alteration in neurological function. Depending on the location of the accumulated blood relative to the dura mater,

these hematomas are classified as epidural (outside the dura mater) or subdural (deep to the dura mater). A cerebral contusion also is classified as a focal injury; however, no mass-occupying lesion is associated with this condition.

## Epidural Hematoma

### *Etiology*

An epidural hematoma is very rare during sport participation. Typically, the condition is caused by a direct blow to the side of the head and almost always is associated with a skull fracture (Fig. 20.15A). If the middle meningeal artery or its branches are severed, the subsequent arterial bleeding leads to a "high-pressure" epidural hematoma. The middle meningeal vein also may be damaged, leading to a more insidious onset of symptoms.

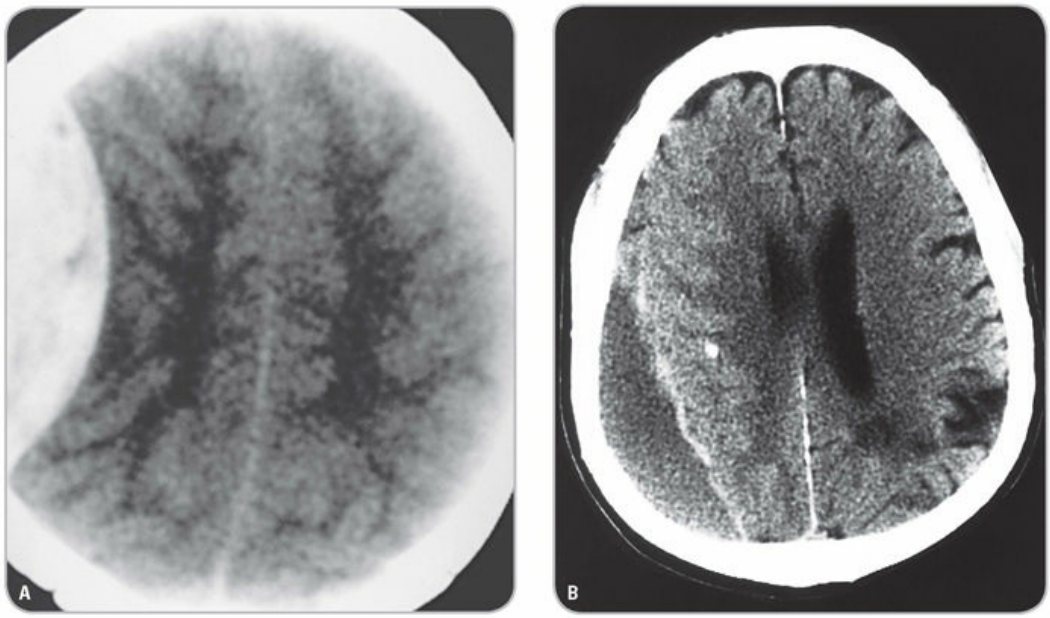



**Figure 20.15. Cerebral hematomas. A,** This epidural hematoma resulted from a fracture that extended into the orbital roof and sinus area, leading to rapid hemorrhage in the right frontal lobe of the brain. **B,** The subdural hematoma on the right side of the brain is fairly evident. A chronic subdural hematoma can be seen on the left side of the brain.

### *Signs and Symptoms*

The patient may experience an initial LOC at the time of injury, followed by a lucid interval during which the patient feels relatively normal and

asymptomatic. Within 10 to 20 minutes, however, a gradual decline in mental status occurs as the hematoma outside the brain reaches a critical size and compresses the underlying brain. Other signs and symptoms may include increased headache, drowsiness, nausea, and vomiting, as well as a decreased level of consciousness; an ipsilateral dilated pupil on the side of the hematoma; and subsequently, contralateral weakness and decerebrate posturing (see **Fig. 7.1**). This triad of symptoms, however, is only present in one-third of patients with epidural hematomas.[17]

### *Management*

Activation of the emergency plan, including summoning emergency medical services (EMS), is warranted. The clinician should continue to maintain the ABCs, assess vital signs, and treat for shock. This condition may require immediate surgery to decompress the hematoma to control arterial bleeding.

## Subdural Hematoma

### *Etiology*

A subdural hematoma is approximately threefold more frequent than an epidural hematoma and is the leading cause of catastrophic death in football players.[17] Hemorrhage occurs when the bridging veins between the brain and the dura mater are torn. It is caused by acceleration forces of the head rather than by the impact of the force. A subdural hematoma may be classified as either acute, which presents 48 to 72 hours after injury, or chronic (**Fig. 20.15B**), which occurs in a later time frame with more variable clinical manifestations, and either simple or complicated. In a simple subdural hematoma, blood collects in the subdural space, but no underlying cerebral injury occurs. Complex subdural hematomas are characterized by contusions of the brain's surface and associated cerebral swelling that increase intracerebral pressure. The mortality rate for simple subdural hematomas is approximately 20%, whereas complicated subdural hematomas have a mortality rate of 50%.[18]

## *Signs and Symptoms*

In a simple subdural hematoma, the patient is less likely to be rendered unconscious. These patients seldom demonstrate deterioration in the level of consciousness, and fewer than 15% have a lucid interval. **In a complicated subdural hematoma, the patient typically is knocked out and remains unconscious.** Signs and symptoms of increasing intracranial pressure include the following:

- Pupillary dilation and retinal changes on the affected side
- Irregular eye tracking or eye movement
- Severe headache
- Nausea and/or vomiting
- Confusion and/or drastic changes in emotional control
- Progressive or sudden impairment of consciousness
- Rising blood pressure
- Falling pulse rate
- Irregular respirations
- Increased body temperature

Signs and symptoms may not become apparent for hours, days, or even weeks after injury, subsequent to the clot absorbing fluid and expanding.

## *Management*

The early diagnosis of a subdural hematoma is essential for a successful recovery. LOC implies a poor prognosis, with an overall mortality rate of 35% to 50%.[19]

Activation of the emergency plan, including summoning EMS, is warranted. The clinician should continue to maintain the ABCs, assess vital signs, and treat for shock.

# Cerebral Contusion

A cerebral contusion is a focal injury, but a mass-occupying lesion is not present. Instead, a microhemorrhage, cerebral infarction, necrosis, and edema of the brain occur. This condition is visible on a computed tomographic (CT) scan as an area of high-density blood interspersed with brain tissue.

## *Etiology*

Cerebral contusions most often occur as a result of an acceleration–deceleration mechanism from the inward deformation of the skull at the impact site. For example, an acceleration force is generated when another patient or an object (e.g., a ball or hockey puck) hits a patient's head. In this situation, the site of maximal injury usually is at the point of impact (i.e., coup injury). In comparison, deceleration forces are generated when a patient's head strikes the ground, and the subsequent site of maximal injury is opposite the point of impact (i.e., contrecoup injury). Injury results from the brain rebounding against the skull or from a vacuum phenomenon existing within the parenchyma at that location. The contrecoup lesions lead to hemorrhage in the cerebral tissue directly opposite the impact site, typically at the inferior surfaces of the frontal and temporal lobes. Although the contusion can occur in any portion of the cortex, brainstem, or cerebellum, these lobes, because of the close anatomical relationship between bony ridges and the frontal lobes, are particularly susceptible to this type of injury. The injury may be limited to small, localized areas or may involve large, extensive areas.

## *Signs and Symptoms*

Clinical signs and symptoms vary greatly, depending on the location, number, and extent of the hemorrhagic lesions. A cerebral contusion injury may evolve over hours or days after the injury. The patient may present with essentially normal function or may experience any type of neurological deterioration, including coma. Frequently, behavioral or mental status changes are present because of the involvement of the frontal or temporal lobes.[20] A danger flag (red flag) exists when a patient has a normal neurological examination but

persistent symptoms such as headaches, dizziness, or nausea occurs.

### *Management*

Activation of the emergency plan, including summoning EMS, is warranted. The clinician should continue to maintain the ABCs, assess vital signs, and treat for shock.

Increasing dizziness, headache, nausea, and mental confusion are red flags that indicate serious intracranial hemorrhage. The management of this condition involves activating the emergency plan (including summoning EMS), monitoring vital signs, and treating for shock.

## DIFFUSE CEREBRAL CONDITIONS

After colliding with an opponent, a high school football player was momentarily stunned, "saw stars," and had blurred vision for approximately 30 seconds. After 3 or 4 minutes, the patient reported feeling much better, except for a slight headache. Can this patient return to activity?

Diffuse cerebral injuries involve trauma to widespread areas of the brain rather than to one specific site. The range of these injuries can vary from mild to severe, involving the impairment of neural function, structural damage, or both.

## Cerebral Concussions

### *Etiology*

In November 2001, the First International Symposium on Concussion in Sport was held in Vienna[21] to provide recommendations to improve the safety and health of athletes who suffer concussive injuries. Several issues were discussed, including protective equipment, epidemiology, and basic and

clinical science, grading systems, cognitive assessment, and management. A second international symposium in 2004, held in Prague,[22] subsequently defined sport-related concussions as a complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces. In 2008, the Third International Conference on Concussion in Sport, held in Zurich,[23] sought to revise and update recommendations from the first two symposia. The Fourth International Symposium on Concussion in Sport was held in Zurich in 2012[6] and further revised the SCAT and graduated return to play protocols. The science and our understanding of concussions continue to evolve; therefore, the management of return-to-play (RTP) decisions remains the realm of clinical judgment for each individual patient.

## *Definition of Concussion*

Although some professionals use the terms concussion and mild traumatic brain injury (mTBI) interchangeably, this is not recommended. Concussions are considered a subset of traumatic brain injury and should never be referred to as "ding" or "bell ringer."[1,6] The Fourth International Symposium on Concussion in Sport defined concussion as "a brain injury and is a complex pathophysiological process affecting the brain, induced by biomechanical forces."[6] With concussions, certain common features incorporate clinical, pathological, and biomechanical injury constructs that may be used to further define the nature of a concussive head injury and include the following[1,6,21–23]:

- Concussions may be caused by a direct blow to the head, face, neck, or elsewhere on the body with an impulsive force that can be transmitted to the head. These injuries typically result in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. In some cases, the onset of impairment may take longer.[6]
- Neuropathologic changes may occur, but the acute clinical symptoms typically reflect a functional disturbance rather than a structural injury.
- Concussions may or may not involve an LOC but instead may lead to a gradient of clinical symptoms that are associated with grossly normal

structural neuroimaging studies.

- Resolution of the clinical and cognitive symptoms usually follows a sequential course. The injury may cause an immediate and transient impairment of neural function, such as alteration of consciousness and disturbance of vision and equilibrium. Under normal conditions, the brain balances a series of electrochemical events in billions of brain cells. When the brain is shaken or jarred, brain function can be disrupted temporarily without causing injury or damage to brain tissue. For example, mild trauma can result in an interruption of cerebral function. Signs and symptoms range from mild to moderate and are transient and reversible. This can be attributed to the minimal damage to soft-tissue structures. As the impact magnitude increases with an acceleration injury, both cerebral function and structural damage may occur, resulting in more serious signs and symptoms. These include varying degrees of LOC, headache, confusion, memory loss, nausea, **tinnitus**, pupillary changes, dizziness, and loss of coordination.

## *Classification of Concussions*

Although more than 16 different classification schemes attempt to define the various degrees of brain dysfunction in cerebral concussions, current best practices do not recommend using a concussion grading scale to base concussion management.[1,6] Instead, once a diagnosis of concussion has been made, management should be based on the patient's individual findings. The majority (80% to 90%) of concussions resolve in a short (7- to 10-day) period, although the recovery time frame may be longer in children and adolescents.[1,6] It is critical to understand that no two concussions are identical, nor will the signs and symptoms be the same. Each injury will vary depending on the magnitude of force to the head, the level of metabolic dysfunction, the tissue damage and duration of time needed to recover, the number of previous concussions, and the time between injuries.

## *Baseline Measurements*

Information obtained postinjury is more meaningful when there is baseline data

for comparison. Athletes at high risk for sustaining a concussion should have baseline testing done prior to the onset of the competitive season. For athletes who have a history of concussions as well as adolescent athletes, baseline testing should occur annually.[1] Baseline testing should include clinical history and symptoms, physical and neurological assessment, and motor control and neurocognitive function.[1,6] A sample concussion baseline assessment protocol is presented in Table 20.3.

**TABLE 20.3 Concussion Baseline Testing Protocol Sample**

| COMPONENT | SAMPLE TESTING/QUESTIONS |
|---|---|
| History | 1. How many concussions have you had?<br>2. What is the time span in which you experienced your concussions?<br>3. What was the longest amount of time it took for all symptoms to resolve?<br>4. Did you ever lose consciousness? If so, how long?<br>5. Did you ever experience seizures?<br>6. Do you ever or are you currently experiencing any of these symptoms?<br>a. Headache, nausea, vomiting, dizziness, ringing in the ears, blurred vision<br>b. Dizziness, memory loss, confusion, feeling in fog, disoriented, fatigued<br>c. Difficulty sleeping or altered sleeping patterns, change in personality |
| Physical and neurological assessment | 1. Vital sign assessment<br>2. Cranial nerve assessment<br>3. VOMS[25] |
| Motor control | 1. Modified BESS test<br>2. FTN test |
| Neurocognitive function | 1. SCAT3 (sections 4 and 8)<br>2. The ImPACT test |

The SCAT3 can be used in entirety to obtain baseline measurements.

## *Signs and Symptoms*

The 2012 Zurich panel agreed that the diagnosis of a concussion will involve the assessment of a range of clinical manifestations in five categories: symptoms, physical, emotional, cognitive, and sleep (Table 20.4).[6] A headache is one of the most reported symptoms (86%) with a concussion.[2,3] LOC occurs in less than 10% of concussions but does indicate that further imaging and intervention is necessary.[2] Amnesia is another important indicator of a more serious injury. In a recent study, it was found that males reported more cognitive symptoms, such as amnesia and confusion/disorientation, more frequently than did females. Females, on the other hand, reported more neurobehavioral and somatic symptoms, such as drowsiness and sensitivity to noise.[24] The patient should be assessed for **retrograde** (before the event) and **anterograde** (after the event) amnesia by asking questions about events before

and after the injury. Other signs and symptoms that may become apparent are similar to depression, anxiety, and attention-deficit disorders. It is recommended that the patient should be monitored at 5-minute intervals from the time of injury until the condition is rectified or the patient is referred for further care.[3]

**TABLE 20.4 Clinical Manifestations of Concussion**

| SYMPTOMS | PHYSICAL | EMOTIONAL | COGNITIVE | DISORDERED SLEEP |
|---|---|---|---|---|
| Headache<br>Nausea<br>Vomiting | LOC<br>Balance problems<br>Visual problems<br>Fatigued<br>Photophobia<br>Sensitivity to noise | Irritability<br>Sadness<br>More emotional<br>Nervousness | Feeling like in a "fog"<br>Dazed or stunned<br>Feeling slowed down<br>Difficulty concentrating<br>Difficulty remembering<br>Forgetful of recent information<br>Confused about recent events<br>Answers questions slowly<br>Repeats questions | Insomnia<br>Drowsiness<br>Sleeping more than usual<br>Sleeping less than usual<br>Difficulty falling asleep |

## *External Provocative Tests*

For patients who report no symptoms, it may be appropriate to use external provocative tests. If the assessment has already determined a possible intracranial injury, the patient should not be subjected to these tests. External provocative tests require the patient to perform exertional activities, such as running or push-ups. Any appearance of associated symptoms (e.g., headaches, dizziness, nausea, unsteadiness, photophobia, blurred or double vision, loss of emotional control, or mental status changes) is abnormal.

- 40-yard sprint
- Five jumping jacks
- Five sit-ups
- Five push-ups
- Five knee bends

## *Management*

Because many of the signs and symptoms of concussion are similar to those of cerebral hematomas and contusions, these more acute life-threatening conditions must be ruled out. If cerebral hematoma or contusion is suspected at

any time during the assessment and monitoring process, or cannot be clearly ruled out, the EAP should be activated and the patient monitored for ABCs until EMS arrives and care is transferred.

For the patient with a suspected concussion, the patient should be removed from play and examined immediately using standard emergency management principles, including the assessment of the cervical spine and cranial nerves to identify any cervical spine or vascular intracerebral injuries.[6] Once the immediate first aid is administered, a detailed clinical assessment of signs and symptoms should be made using the SCAT3 or a similar tool, such as Maddocks questions, or the Standardized Assessment of Concussion (SAC) (**Fig. 20.10**).[1,5,6]

A brief **Vestibular/Ocular Motor Screening (VOMS) Assessment** has also been found to be a clinically useful tool for detecting sport-related concussions.[25] VOMS is designed to assess for presence of vestibular and ocular motor deficits by comparing onset and intensity of patient symptoms pre- and posttesting. Five motions or domains are tested: (1) smooth pursuit, (2) horizontal and vertical **saccades**, (3) convergence, (4) horizontal vestibular ocular reflex (VOR), and (5) visual motion sensitivity (VMS). Patients are asked to rate their symptoms on a scale of 0 (none) to 10 (severe) after each assessment to see if the motion/actions provoke symptoms. Patients are questioned on the following symptoms: headache, dizziness, nausea, and fogginess. Onset or increase in symptoms suggests presence of vestibular/ocular motor deficits associated with a concussion. VOMS can be used as part of the battery of baseline tests for acute evaluation and follow evaluation. Positive findings suggest that the patient may benefit from having vestibular ocular therapy as part of the overall treatment plan.[25] The suspected diagnosis of a concussion should include one or more of the following domains[6]:

- Symptoms: somatic (e.g., headache), cognitive (e.g., feeling “like in a fog”), and/or emotional symptoms (e.g., extremes of emotion or unstable)
- Physical signs (e.g., LOC, amnesia, visual problems)

- Behavior changes (e.g., irritability, sadness)
- Cognitive impairment (e.g., slowed reaction times, difficulty concentrating)
- Sleep disturbance (e.g., drowsiness)

If any of these signs and symptoms is present, a concussion should be suspected. The patient is removed from participation and evaluated by a physician or athletic trainer. The diagnosis of concussion is made through the clinical evaluation and supported by assessment tools, such as the SCAT3.[1,6] The patient should be monitored for the initial few hours postinjury. During this time, vital signs and assessment of mental status, neurological function, and symptoms should be checked at regular intervals for deterioration in status.[6] The patient is not allowed to return to participation on the day of injury.[1]

Patients who have been diagnosed with a concussion should be instructed to avoid ingesting or taking any medications or substances that may impair cognitive function and neurological recovery.[1] During the acute stages of recovery (the first 24 to 48 hours), the patient is instructed to avoid physical exertion and cognitive load and instead should be encouraged to rest. It is important to eat well and stay hydrated. The patient will also need academic accommodation during the healing process because cognitive load can delay the healing process and exacerbate symptoms.[1]

## *Return-to-Play Protocol*

The foundation of concussion management is physical and cognitive rest until symptoms resolve and then a graduated program of exertion is conducted prior to medical clearance and RTP. Most patients will recover spontaneously over several days, but each must be reminded that both a physical and cognitive rest is required. Activities that require focus and concentration (e.g., academic work, video games, text messaging) may exacerbate symptoms and delay recovery. RTP following a concussion should follow a stepwise process, as outlined in **Table 20.5**. With this progression, the patient can proceed to the next level if asymptomatic at the current level. Generally speaking, each level

should take approximately 24 hours so that the patient can move through the protocol in about 1 week once asymptomatic at rest and with provocative exercise.

**TABLE 20.5 Graduated Return-to-Play Protocol**

| REHABILITATION STAGE | FUNCTIONAL EXERCISE AT EACH STAGE OF REHABILITATION | OBJECTIVE OF EACH STAGE |
|---|---|---|
| 1. Active recovery | Symptom limited physical and cognitive rest; biking in darkened room, low intensity, no resistance, looking forward with no head motion | Recovery |
| 2. Light aerobic exercise | Walking, swimming, or stationary cycling, keeping intensity <70% of maximum predicted heart rate; no resistance training | Increase heart rate |
| 3. Sport-specific exercise | Skating drills in ice hockey, running drills in soccer, no head impact activities | Add movement |
| 4. Noncontact training drills | Progression to more complex training drills (e.g., passing drills in football and ice hockey); may start progressive resistance training | Exercise, coordination, and cognitive load |
| 5. Full-contact practice | Following medical clearance, participate informal training activities | Restore athlete's confidence; coaching staff assesses functional skills |
| 6. Return to play | Normal game play | |

From McCrory P, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med.* 2013;47:250–258.

In some sport settings with physicians experienced in concussion management and with sufficient resources (e.g., access to neuropsychologists, consultants, neuroimaging), as well as access to immediate sideline neurocognitive assessment, RTP may be more rapid. The same basic principles still require full clinical and cognitive recovery before consideration of RTP. This is supported by the American Academy of Neurology, U.S. Team Physician Consensus Statement, and National Athletic Trainers' Association position statement.[8,16] For individuals younger than the age of 18 years, it is recommended that a more conservative approach be taken.[6,12]

# Posttraumatic Headaches

## *Etiology*

Posttraumatic vascular headaches can be confused with a simple concussion or a postconcussive headache. A vascular headache is a result of vasospasm and does not usually occur with impact but rather develops shortly afterward.

## *Signs and Symptoms*

Symptoms, such as a localized area of blindness, may follow the appearance of brilliantly colored, shimmering lights (scintillating scotoma). Posttraumatic

migraine headaches, also referred to as a footballer's migraine, have been reported in soccer players after repetitive heading of the ball. In addition, migraines are characterized by recurrent attacks of severe headache with sudden onset, with or without visual or gastrointestinal problems.

### *Management*

This patient should be immediately referred to a physician for further evaluation and care.

## Postconcussion Syndrome

### *Etiology*

**Postconcussion syndrome** (PCS) may develop after any concussion and tends to occur more frequently in women than in men.[26,27] There is a normal course of symptom persistence after any concussion, which is generally followed by a gradual resolution. The difference between postconcussive *symptoms* and postconcussive *syndrome* is the length of symptom persistence. A myriad of cognitive, physical, or emotional impairments may last for several weeks to months after injury. The extended duration of symptoms is thought to be related to altered neurotransmitter function.

### *Signs and Symptoms*

Physical symptoms of PCS include headache, vertigo, fatigue and low energy, sleep disturbance, nausea, vision changes, tinnitus, dizziness, light, and photophobia. Cognitive symptoms include slowed thinking and response time, mental fogginess, poor concentration, distractibility, trouble with learning and memory, disorganization, and problem-solving difficulties. Behavioral symptoms may include depression, anxiety, panic attacks, irritability, personality changes, increased emotionality, clinginess, apathy, increased sensitivity to alcohol, and lowered frustration tolerance.[28] Some of these symptoms may predispose the patient to second-impact syndrome.

### *Management*

The patient can undergo magnetic resonance imaging (MRI) or CT, but the scan generally is normal in the initial and the follow-up evaluation. No definitive treatment exists other than independent symptomatic measures to control the symptoms. When available, patients with PCS should be referred to an experienced neuropsychologist for evaluation. Computerized neuropsychiatric testing may be helpful as a tool for RTP decisions, and with persisting symptoms, traditional neuropsychiatric testing can be considered. Medications may be beneficial in some cases. A physician and neuropsychologist should supervise the level of activity and should prohibit the patient from returning to activity until symptoms resolve both at rest and on exertion. A trial off of any medications for PCS is essential to be certain the patient has truly become asymptomatic and has a symptom-free interval before RTP.[1,29]

## Second-Impact Syndrome

### *Etiology*

Second-impact syndrome (SIS), a type of diffuse brain injury, is precipitated by an earlier event where a patient sustains a concussion which is unresolved. If, while in this postconcussive state, the patient receives a second blow to the head, SIS may result. Diffuse cerebral swelling and brainstem herniation occur.[30] This cascade of events can occur in 3 to 5 minutes from the time the patient receives the subsequent blow.[31]

### *Signs and Symptoms*

With the initial injury, visual, motor, or sensory changes occur, and the patient may have difficulty with thought and memory. Before these symptoms resolve, which may take days or even weeks, the patient returns to activity and sustains a second head trauma. This second trauma may be relatively minor and does not have to be the result of direct contact. Following the trauma, the patient may appear to be stunned but often completes the current action or play and, in some cases, can walk unassisted. As the vascular engorgement within the cranium increases intracranial pressure, the brainstem becomes compromised. Subsequently, the patient collapses with rapidly dilating pupils, progressing to

a loss of eye movement, coma, and respiratory failure. The usual interval from second impact to brainstem failure is short (typically 2 to 5 minutes).

### *Management*

Management involves an immediate activation of the emergency care plan, including summoning EMS, and maintenance of basic life support. The first step in providing appropriate care is recognizing that the patient has sustained a traumatic brain injury and immediate activation of the EAP and summoning EMS is imperative. For patients with a Glasgow Coma Scale of less than 9 and an $SpO_2$ level of less than 90%, supplemental oxygen should be administered while waiting for EMS to arrive.[32] Otherwise, maintain open airway, monitor LOC and ABCs, assess vital signs, and treat for shock.

During efforts to prevent SIS, it is imperative that any patient who complains of a headache, light-headedness, visual disturbances, or other neurological symptoms not be allowed to participate in any physical activity with the potential for head trauma until totally asymptomatic.

The patient was momentarily stunned, "saw stars," and had blurred vision. This is not uncommon in a simple concussion. A lingering headache should signal caution, however, and return to activity should not be permitted. This patient should be carefully watched for increased headache intensity, unsteady gait, nausea, photophobia, or mood swings, which dictate immediate evaluation by a physician.

## FACIAL CONDITIONS

A hockey player was taking a shot on goal when his stick hit the jaw of the player guarding him. That player skated off the ice and was bleeding from the mouth and unable to close the jaw. He is having difficulty articulating his words. Explain the palpation of this condition. What type of injury should be suspected, and why?

Injuries to the cheek, nose, lips, and jaw are very common in sports that involve moving projectiles (e.g., sticks, balls, bats, racquets), in contact sports (e.g., football, rugby, ice hockey), and in sports that involve collisions with objects (e.g., diving, skiing, ice hockey, swimming). Many of these injuries can be prevented by wearing properly fitted face masks and mouth guards. Because the facial area has a vast arterial system, lacerations bleed freely and rapid swelling often hides the true extent of injury. Box 20.2 identifies the signs and symptoms of serious facial injuries that warrant further examination by a physician.

**BOX 20.2 Facial Red Flags Requiring Further Examination by a Physician**

- Obvious deformity or crepitus
- Irregular eye movement or failure to accommodate to light
- Appearance of a long face
- Malocclusion of the teeth
- Increased pain on palpation

## Facial Soft-Tissue Conditions

### *Etiology*

Facial injuries are very common in contact and collision sports. Contusions, which are the most commonly encountered facial injury, usually result from blunt trauma.[33] Blunt trauma can be caused by a direct compressive force with a sharp object, such as hockey puck or another player's elbow or head.

### *Signs and Symptoms*

As in scalp injuries, facial injuries are painful and bleed freely.

### *Management*

Facial contusions, abrasions, and lacerations are managed in the same manner

as those located elsewhere on the body. Ice is applied to control swelling and hemorrhage. If an abrasion or laceration is present, the wound should be cleansed with sterile saline, an antibiotic ointment should be used, and an occlusive dressing of gauze or tape should be applied. Tissue adhesive (e.g., DERMABOND) is recommended for the closure of simple lacerations, rather than butterfly bandages or Steri-Strips, particularly where there is not a point of high skin tension. The area can then be protected with sterile gauze and tape. The patient can return to participation, but at the conclusion of the event, the patient should see a physician to determine if sutures are needed. Lacerations older than 12 hours should not be sutured but, rather, should be allowed to heal by secondary intention because of the increased risk of wound infection.[34] Larger and more complicated injuries, such as those with jagged edges or damage to nerves, veins, or bony structures, should be referred immediately to a physician.

## Temporomandibular Joint Conditions

### *Etiology*

The TMJ is a sliding hinge joint that is stabilized by ligaments and is separated into upper and lower compartments by a fibrocartilage meniscus. Injury occurs when a blow to the mandible transmits the force to the condyles. Injuries may involve intracapsular bleeding (hemarthrosis), inflammation of the capsular ligaments (capsulitis), meniscal displacement, subluxation/dislocation of the condyles, or fracture.

### *Signs and Symptoms*

Common signs and symptoms include an inability to open the mouth (normal opening = 40 mm or 1.6 in), deviation of the jaw to the side of the injury on opening, pain on opening and biting, malocclusion (change in bite), joint noise (i.e., clicking, popping, crepitus), or an inability to close the mouth.[33]

### *Management*

A crushed ice pack should be placed over the area to control swelling. The

clinician may elect to temporarily immobilize the jaw with an elastic bandage wrapped under the chin and over the top of the head. Subsequent management of TMJ injuries often involves refraining from opening the mouth for 7 to 10 days and eating a soft diet. Anti-inflammatory medication may assist in reducing pain and inflammation. During the acute period, lifting of heavy weights should be restricted.

## Facial Fractures

Direct impact can fracture the facial bones, including the mandible (jaw), the maxilla (upper jaw), the zygomatic bone (cheek), or nasal bones. The most common fractures occur to the nasal bones, followed by the zygomatic bone and the mandible, respectively.[35]

### *Zygomatic Fractures*

#### Etiology

Besides forming the cheekbone, the zygoma forms a portion of the eye orbit and orbital rim, serves as an attachment point for the masseter muscle, and forms the outer facial frame. As such, fractures can affect the vision, the function of the jaw, and cosmetically, the width of the face.[36] Fractures to the zygomatic bone are typically caused by a direct blow to the arch, such as when being hit by a hockey puck or hockey stick.

#### Signs and Symptoms

Direct impact to the zygomatic bone results in a flat or depressed appearance of the cheek. Swelling and periorbital ecchymosis about the eye may occlude vision and hide damage to the orbit. Occasionally, the eye on the side of the fracture may appear to be sunken, or the eye opposite the fracture may appear to be raised. Double vision is common, and paresthesia or anesthesia (numbness) may be present on the affected cheek.

#### Management

A crushed ice pack should be placed over the area to control swelling, but it is

important to avoid pressure or compression over the fracture site. The patient should be referred immediately to a physician. In most cases, the condition can easily be reduced surgically and may not require internal fixation. An exception occurs when the fracture involves the eye orbit and surgical repair becomes more extensive. Healing usually occurs within 6 to 8 weeks. Special facial protection should be worn for 3 to 4 months. A complication of this condition includes blurred vision over an extended period. As such, patients in activities requiring eye–hand coordination may not return to the previous level of participation for some time.

## *Mandibular Fractures*

### Etiology

Direct trauma to the lower jaw, often seen in contact sports, can lead to a mandibular fracture. Because of the sharp angles and little padding, this bone is particularly at risk for injury.

### Signs and Symptoms

Mandibular fractures present with swelling, malocclusion, numbness in the distribution of the inferior alveolar nerve (lower lip), and intraoral lacerations.[36] This injury seldom occurs as an isolated, single fracture; it more often is a double fracture or a fracture dislocation. The most common fracture sites are the mandibular angle and condyles, which lead to malocclusion (**Fig. 20.16**). Because the articulation of words is impossible, changes in speech are apparent. Oral bleeding may occur even though a mouth guard is properly fitted and worn. Pain, discoloration, swelling, and facial distortion may be present. The patient is unable to maintain a firm bite on a tongue depressor placed in the mouth (**Fig. 20.17**).

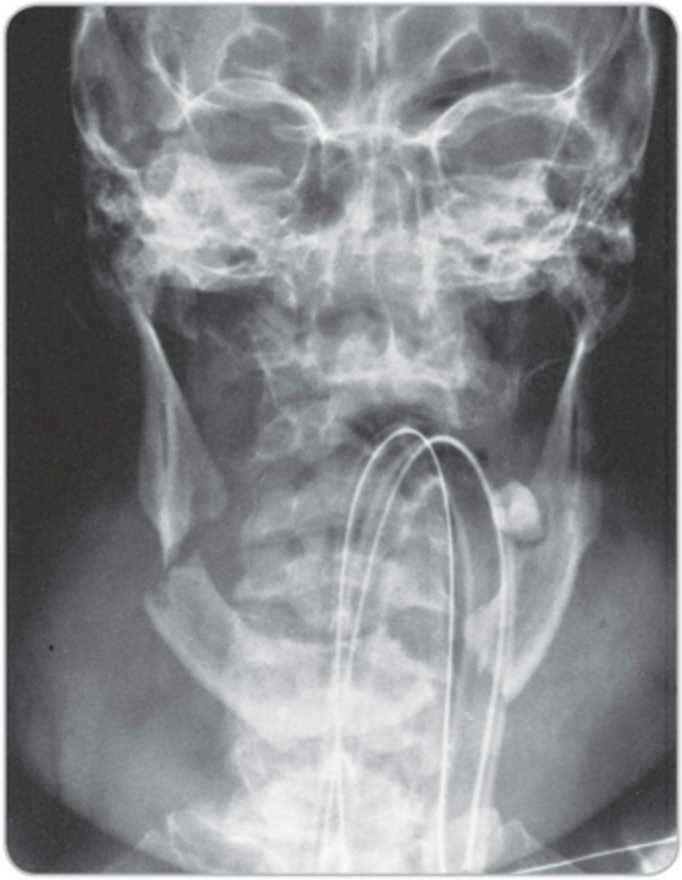


**Figure 20.16. A mandibular fracture.** The most common site for a mandibular fracture is near the angle of the jaw, which leads to malocclusion of the teeth.

**Figure 20.17. The tongue blade test.** In a suspected mandibular fracture, a tongue blade (tongue depressor) is placed in the patient's mouth. The patient is instructed to hold the blade in place as the clinician rotates or twists the blade. A positive sign is the inability to hold a firm bite on the blade or increased pain on movement of the blade.

### Management

It is important with this type of fracture for the clinician to maintain an open airway, because the tongue may occlude the airway. Management involves dressing any open wounds and immobilizing the jaw with an elastic bandage wrapped under the chin and over the top of the head. A crushed ice pack may be placed over the area to control swelling; however, pressure or compression over the fracture site should be avoided. The patient should be referred immediately to a physician. Repair involves internal fixation (i.e., wiring the jaw closed) or using bone plates, which may allow some patients to return to sport participation. During the healing period, a high-protein, high-carbohydrate liquid diet is required. A weight loss of 5% to 10% is not uncommon. Mild activities such as stationary bicycling, swimming, and the use of light weights to maintain muscle tone and conditioning are recommended.

## *Maxillary Fractures*

### Etiology

Fractures of the maxilla are classified according to fracture patterns described by René Le Fort and are based on the most superior level of the fracture site (**Fig. 20.18**). Most fractures result from very high-impact forces, such as a hockey stick or an opponent's elbow. The more serious fractures can lead to airway obstruction and generally require hospitalization. This injury ranks as the fourth most common facial fracture.

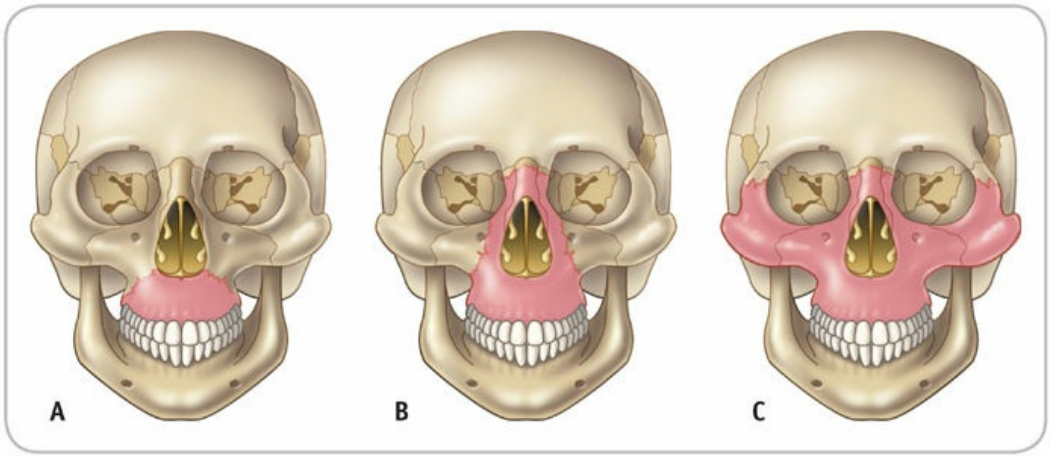



**Figure 20.18. Maxillary fractures.** Fractures to the maxilla may involve separation of the palate (Le Fort Fracture I) **(A)**, may extend into the nasal region (Le Fort Fracture II) **(B)**, or may involve complete craniofacial dissociation (Le Fort Fracture III) **(C)**.

## Signs and Symptoms

If the upper jaw or midface is fractured, the maxilla may be mobile, giving the appearance of a longer face. Nasal bleeding, ecchymosis in the cheek or buccal region, malocclusion, nasal deformity, or a flattening and splaying of the naso-orbital region may be present.

## Management

Treatment involves maintaining the airway. A forward-sitting position allows for adequate drainage of saliva and blood. A crushed ice pack may be placed over the area to control swelling, but it is important to avoid pressure or compression over the fracture site. The patient should be referred immediately to a physician. Although reduction and internal fixation often are used to immobilize the region, extensive surgery and possible secondary reconstruction occasionally are necessary to treat the condition.

Because the patient is bleeding, universal precautions should be followed during palpation of the maxilla, the mandible, the zygomatic bone, the nasal bone, and the TMJ. As indicated by the apparent malocclusion and inability to close the jaw, the hockey player may have a fractured jaw.

# NASAL CONDITIONS

? A basketball player received a lateral blow to the nose from an opposing player's elbow. The nose is bleeding and has a flattened appearance. What signs and symptoms indicate that this patient needs to be referred immediately to a physician?

Nasal injuries are common in sports during which protective face guards are not worn. Epistaxis, deviated septums, and nasal fractures are common injuries to the nasal region. Box 20.3 identifies the signs and symptoms of nasal conditions that warrant further examination by a physician.

**BOX 20.3 Nasal Red Flags Requiring Further Examination by a Physician**

- Bleeding or CSF from the nose
- Nosebleed that does not stop within 5 minutes
- Loss of smell
- Foreign objects that cannot be removed easily
- Nasal deformity or fracture

## Epistaxis

### *Etiology*

Epistaxis, or nosebleed, is a relatively common injury and is reported to occur in up to 60% of the general population. Although somewhat distressing for the patient, less than 10% of adult patients require definitive medical attention.[37] Anterior bleeds are far more common and may be caused from any the following[38]:

- Picking the nose (most common)
- Facial trauma secondary to blunt facial impact or motor vehicle collision

- Mucosal hyperemia secondary to allergic or viral rhinitis
- Presence of a foreign body (if bleed is accompanied by purulent discharge)
- Chronic excoriation secondary to chronic intranasal drug use

### *Signs and Symptoms*

Anterior bleeding originates from superficial blood vessels on the anterior septum known as the Kiesselbach plexus. Posterior bleeding generally arises from the posterior nasal cavity via branches of the sphenopalatine arteries, leading to significant hemorrhage. Posterior epistaxis may be asymptomatic or may present insidiously as nausea, hematemesis, anemia, hemoptysis, or melena.[37]

### *Management*

Most nosebleeds stop spontaneously after applying mild pressure at the nasal bone for 5 to 15 minutes. The patient should be mouth breathing and leaning forward. Ice can be applied to the dorsum of the nose to reduce bleeding, or ice can be applied to the back of the neck, which activates the mammalian dive reflex, thereby causing peripheral vasoconstriction.[37] A nasal plug, or pledget, may be used but seldom is needed; if used, however, the plug can be coated with topical astringents or soaked with vasoconstrictors, such as tannic acid or a 1% phenylephrine hydrochloride solution (as long as the patient is not allergic to them). The plug should extend externally for at least half an inch. If bleeding continues for more than 5 minutes despite manual pressure and ice, the patient should be referred to a physician.

Patients should be instructed not to blow their nose following significant bouts of epistaxis. Recurrent bouts may need to be treated with nasal cauterization, chemically with silver nitrate sticks, or with electrocautery under local anesthesia.

## Deviated Septum

### *Etiology*

The nasal septum is the partition between the right and left sides of the nose. A deviated septum may be congenital and asymptomatic; however, nasal trauma, such as a nasal fracture or lateral compression on the nasal region, can displace the septum, leading to difficulty breathing. Under normal circumstances, when a patient closes one nostril and attempts to breathe through the other, that nostril closes during inhalation, and breathing is unobstructed. Expiration should be easy and smooth.

## *Signs and Symptoms*

The most obvious sign is a consistent difference in airflow between the two sides of the nose when one nostril is blocked. Inspection with an otoscope can confirm the presence of a deviated septum. If trauma was involved in the injury, a septal hematoma may be visible through the otoscope (**Application Strategy 20.3**).

**APPLICATION STRATEGY 20.3**

### Use of an Otoscope to Inspect the Nose and Ear

To inspect the nose:

1. Use the largest ear speculum available. Tilt the patient's head back and insert the speculum gently into the vestibule of each nostril, avoiding contact with any sensitive area. Hold the otoscope handle to one side to avoid the patient's chin to improve your mobility.
2. Direct the speculum posteriorly and then upward in small steps while visualizing the inferior and middle concha bullosa, the nasal septum, and the narrow nasal passage between them. Some asymmetry of the two sides is normal.
3. Check the nasal mucosa that covers the septum and the concha bullosa for any swelling, bleeding, or exudate. Note any deviation, inflammation, or perforation of the septum.

To inspect the ear:

1. Using the largest ear speculum that the canal will accommodate, position the patient's head so that you can see comfortably through the

instrument.

2. To straighten the ear canal, gently pull the auricle upward, backward, and slightly away from the head. Movement of the auricle and external ear ("tug test") is painful in acute *otitis externa* (inflammation of the ear canal) but not in *otitis media* (inflammation of the middle ear). Tenderness behind the ear may be present in otitis media.
3. Holding the otoscope handle between the thumb and fingers, brace the hand against the patient's face. Insert the speculum gently into the ear canal, directing it somewhat down and forward and through the hairs, if any.
4. Inspect the ear canal for any discharge, foreign bodies, redness of the skin, or swelling. Cerumen, which varies in color and consistency from yellow and flaky to brown and sticky or even to dark and hard, may partially or entirely block the view.
5. Inspect the eardrum, noting its color and contour.

Adapted from Bickley LS, Szilagyi PG. *Bates' Guide to Physical Examination and History Taking*. Philadelphia, PA: Lippincott Williams & Wilkins; 2007.

### *Management*

If a deviated septum is suspected, the patient should be referred to a physician for further care. Surgery often is indicated to drain a septal hematoma and repair the deviated septum; this may involve reshaping the nasal cartilage and bone (i.e., septoplasty or submucous resection). Correction of a deviated septum usually does not change the outer appearance of the nose.

## Nasal Fractures

### *Etiology*

The nose is the most prominent facial feature and is the most commonly fractured bone in the adult face.[39] Persistent or profuse bleeding may indicate a complex nasal fracture with an injury to the ethmoid artery that requires direct visualization.

## *Signs and Symptoms*

Epistaxis is almost always present, and the nose may appear to be flattened and lose its symmetry, particularly with a lateral force. Because of its prominence, the nose is particularly susceptible to lateral displacement.[39] Severity can range from a slightly depressed, greenstick fracture (seen in adolescents), to total displacement and/or disruption in the bony and cartilaginous parts of the nose. The nasal airway can be obstructed with bony fragments, or the fracture can extend into the cranial region and cause a loss of CSF. There may be crepitus over the nasal bridge and ecchymosis under the eyes.

## *Management*

If the only injury is to the nose, the patient should be evaluated to ensure that no septal hematoma (i.e., blood from an acute injury that accumulates beneath the septal perichondrium) has formed, which would require immediate referral to a physician for incision and drainage. The nose should then be viewed by standing behind and above the patient while looking down an imaginary line to determine if the nose is centered. Using a small mirror, the injured patient should look at the nose to determine if it appears to be normal. Treatment involves controlling bleeding, applying ice to limit swelling and hemorrhage, and referring the patient to a physician for further examination. A custom acrylic face shield, a helmet with face mask, or other protective device should be worn during contact sports for 4 weeks after injury.[33] **Application Strategy 20.4** provides guidelines for the assessment and care of a nasal injury.

**APPLICATION STRATEGY 20.4**

### Evaluation and Management of a Nasal Injury

1. Check ABCs. Bony fragments may occlude the airway.
2. Determine responsiveness.
3. Check for signs of a concussion and/or skull fracture.
4. History
   - Primary complaint (e.g., pain, dizziness, disorientation, nausea,

vision disturbances, or tinnitus)
   - Mechanism of injury
   - Disability from injury (e.g., inability to breathe through one side of nose)
5. Observation and inspection
   - Obvious deformity or abnormal deviation
   - Bleeding and/or CSF from the nose
   - Check pupil size, pupillary response to light, eye movement, nystagmus, or blurred or double vision, which may indicate an associated cranial injury
   - Abnormal breathing rate and pattern
   - Stand behind the patient and look down an imaginary line to see if the nose is deviated.
6. Palpation
   - Palpate the two nasal bones with the forefinger and thumb (checking for swelling, depressions, crepitus, mobility, etc.).
   - Check the internal structures of the nasal area for any abnormalities.
7. After bleeding is controlled, inspect the internal structures for any abnormalities.
8. Apply ice to control the hemorrhage and refer the patient to a physician for further care.

Signs and symptoms that indicate a serious nasal injury include excessive bleeding or CSF from the nose, a loss of smell, nasal deformity or fracture, or a nosebleed that does not stop within 5 minutes. If present, the patient should be referred immediately to a physician.

## ORAL AND DENTAL CONDITIONS

Following a collision during a high school soccer game, an athlete

complains of significant pain after being hit in the mouth. The inside of the upper lip is bleeding, and one tooth is intruded. How should this injury be managed?

The most commonly injured tooth is the maxillary central incisor, which is positioned front and center and receives 80% of all dental trauma.[40] During sport and physical activity, nearly all such injuries are preventable through regular use of mouth protectors. Mouth protectors prevent injury to the lips, teeth, cheek, tongue, mandible, neck, TMJ, and brain by absorbing shock, spreading impact, cushioning the contact between the upper and lower jaws, and keeping the upper lip away from the incisal edges of the teeth. Although certain sports (e.g., football, boxing, field hockey, lacrosse) require mouth guards, few coaches or league officials require these devices in other contact and collision sports. **Box 20.4** identifies the signs and symptoms of oral and dental conditions that warrant further examination by a physician.

**BOX 20.4 Oral and Dental Red Flags Requiring Further Examination by a Physician**

- Lacerations involving the lip, outer border of the lip, or tongue
- Any individual complaining of a persistent toothache or sensitivity to heat and cold
- Loose teeth either laterally displaced, intruded, or extruded
- Inability to close the jaw
- Chipped, cracked, fractured, or dislodged teeth
- Malocclusion of the teeth

## Periodontal Disease

### *Etiology*

Periodontal disease (gum disease) ranges from **gingivitis**, or mild inflammation of the gums, to **periodontitis**, or inflammation of the deeper gum

tissues that normally hold the teeth in place. Approximately 80% of American adults have some form of gum disease. Gingivitis usually is caused by bacteria that irritate the gums, leading to swelling and bleeding. Bacteria, along with minerals in the saliva, form tartar (calculus), which provides an environment for additional bacteria to accumulate and irritate the gums. If left unchecked, gingivitis can lead to the more serious form of gum disease, periodontitis. This long-term infection eventually can result in loss of the teeth. Thorough daily brushing, regular flossing, and frequent professional cleaning can reduce the risk of developing serious gingivitis.

## *Signs and Symptoms*

Initial signs of gingivitis include tender, swollen, or bleeding gums, particularly when the teeth are brushed. There also may be a change in color of the gums from pink to dusky red. Plaque, which is the soft, white form of salivary salts, protein, and bacteria that covers the teeth and leads to gingivitis, is not readily visible. Signs and symptoms of periodontitis may include swollen or recessed gums; an unpleasant taste in the mouth; bad breath; tooth pain, especially when eating hot, cold, or sweet foods; loose teeth; change in the bite; and drainage or pus around one or more teeth.

## *Management*

Gingivitis usually clears after a professional cleaning by a dentist or hygienist, followed by proper daily oral hygiene. The cleaning removes tartar and plaque from the teeth, which eliminates the source of irritation to the gums, allowing the gums to heal. If gingivitis has progressed to periodontitis, more extensive treatment is necessary; the dentist may try to remove the pockets of bacteria between the gums and teeth and may recommend antibiotics. Other nonsurgical treatments may include scaling, sometimes done with an ultrasonic device, to remove tartar and bacteria from the tooth surfaces and beneath the gums. A technique known as root planing is used to smooth the root surfaces, discouraging further accumulation of tartar. In advanced stages of periodontitis, surgery may be necessary.

# Dental Caries (Tooth Decay)

## *Etiology*

Dental caries, also known as tooth decay and cavities, are caused primarily by plaque. When plaque collects and hardens, tartar is formed. Bacteria within the plaque contain acids that begin to dissolve the tooth enamel. These problems can cause openings in the tooth enamel, which then allow bacteria to infect the center of the tooth (the pulp). This condition can be accelerated by ingesting acid-rich foods or foods that are high in sugar and starch. Combined with poor oral hygiene, this condition can lead to a painful tooth cavity. If neglected, the infection can spread from the pulp to the root of the tooth and, finally, to the bones supporting the tooth. An **abscessed tooth** is a painful infection at the root of a tooth or between the gum and a tooth. Although primarily caused by severe tooth decay, the condition also can result from gingivitis or trauma to the tooth, such as when a tooth is broken or chipped.

## *Signs and Symptoms*

A tooth with a cavity typically presents with pain during chewing and sensitivity to hot or cold foods and beverages. If a tooth abscess is present, a throbbing pain or a sharp or shooting pain is common. Other symptoms may include fever, a bitter taste in the mouth, bad breath, swollen neck glands, general discomfort, uneasiness or ill feeling, redness and swelling of the gums, a swollen area of the upper or lower jaw, or an open, draining sore on the side of the gum. If the root of the tooth dies as a result of infection, the toothache may stop. This does not mean the infection has healed, however; the infection remains active and continues to spread and destroy tissue. If any symptoms are present, the patient should be referred immediately to a dentist.

## *Management*

In mild tooth decay, the dentist scrapes the region and applies a filling. If a more serious condition is present, a radiograph may be obtained to assess the presence of a tooth abscess and bone erosion. To eliminate infection, the abscess may need to be drained via a procedure known as a root canal. Root

canal surgery also may be recommended to remove any diseased root tissue after the infection has subsided; subsequently, a crown may be placed over the tooth. The tooth also may be extracted, allowing drainage through the socket. A third way to drain the abscess is by an incision into the swollen gum tissue. Antibiotics are prescribed to help fight the infection. Warm saltwater rinses and over-the-counter pain-reducing medications can be used to relieve pain and discomfort associated with an abscessed tooth.

## Mouth Lacerations

### *Etiology*

Trauma to the facial region can lead to lacerations of the lips, tongue, or internal buccal cavities. Most lacerations are minor and treated the same as in other lacerations.

### *Signs and Symptoms*

Bleeding is often profuse. The lacerated tissue may appear swollen with jagged edges.

### *Management*

Management involves applying direct pressure to stop the bleeding, cleaning the area with a saline solution, applying Steri-Strips if needed, and covering the wound with a dry, sterile dressing. Lacerations that extend completely through the lip or that involve the outer lip or large tongue lacerations require special suturing. A badly scarred tongue can affect taste and can interfere with speech patterns. Tongue lacerations require careful cleansing with water or a mouthwash to avoid infection and referral to a physician for possible suturing. The patient should not be permitted to return to participation until the wound is healed. If sutures are applied, protection is continued for at least 7 days.

## Loose, Subluxated, or Luxated Teeth

### *Etiology*

Direct trauma to the mouth can lead to a loose, a subluxated, or a luxated tooth.

Many injuries to the dental area can be prevented by wearing a mouth guard.

## *Signs and Symptoms*

A loosened tooth may be partially displaced, intruded, extruded, or avulsed (Fig. 20.19). In many cases, oral bleeding may also be present.

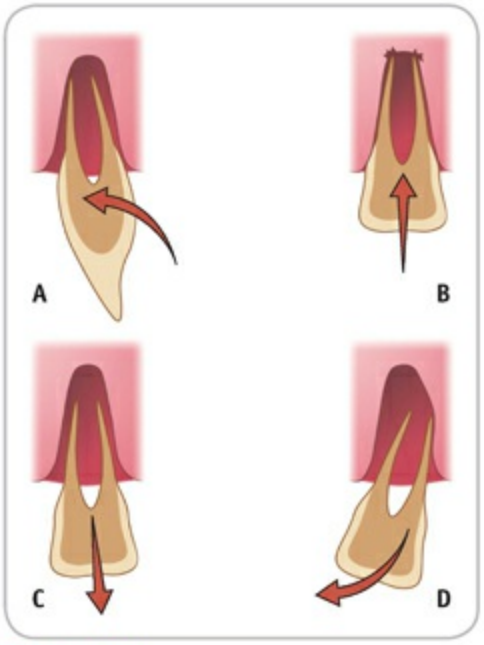



**Figure 20.19. Loose teeth.** Loose teeth may involve partial displacement **(A)**, intrusion **(B)**, extrusion **(C)**, or avulsion **(D)**.

## *Management*

When the tooth has been displaced outwardly or is laterally displaced, the clinician should try to place the tooth back into its normal position without forcing it. Teeth that are intruded should be left alone; any attempt to move the tooth may result in a permanent loss of the tooth or damage to any underlying permanent teeth. The patient should be referred to a dentist immediately. A dental radiograph can rule out damage under the gum line and ensure the tooth is properly replaced. The damaged tooth is then splinted to the surrounding teeth for 2 to 3 weeks. Teeth that have been totally avulsed from their sockets often can be located in the patient's mouth or on the ground. These teeth can be saved, but time is of the essence. A dislocated tooth should be held by the crown. It is important not to rub the tooth or remove any dirt. If the tooth is

rinsed in milk or saline and replaced intraorally in the tooth socket within 30 minutes, the prognosis for a successful replanting is 90%. It should be noted that tap or drinking water can damage the periodontal ligament cells on the root surface and compromise implantation procedures. Implantation that occurs after 2 hours results in a 95% failure rate.[40] Semirigid fixation for 7 to 10 days may be followed by root canal therapy. Contact drills and competition are restricted during this period of time, and an appropriate face or mouth guard should be worn to prevent further injury.

# Fractured Tooth

## *Etiology*

As in other facial injuries, direct trauma can fracture a tooth. Use of a protective mouth guard can reduce the incidence of dental fractures. With any dental injury, a concussion or other head or neck injury should be ruled out.

## *Signs and Symptoms*

Fractures may occur through the enamel, dentin, pulp, or root of the tooth. Fractures involving the enamel cause no symptoms and can be smoothed by the dentist to prevent further injury to the lips and the inner lining of the oral cavity. Fractures extending into the dentin cause pain and increased sensitivity to cold and heat. Fractures exposing the pulp or root of the tooth lead to severe pain and sensitivity.

## *Management*

The patient should be referred to a dentist who will apply a sedative dressing over the exposed area and, later, will attach a permanent, composite resin crown. Fractures exposing the pulp involve more extensive dental work. If the pulp exposure is small, a pulp-capping procedure, whereby calcium hydroxide is placed on the area, can bridge the exposed area and, if successful, can eliminate the need for a root canal. Another treatment involves removing a portion of the pulp in the root canal, leaving the uninjured pulp in the root. This has been successful in younger patients whose roots have not yet fully formed.

The final method of treatment is a total root canal.

The clinician should not attempt to move the intruded tooth, because the action could result in a permanent loss of the tooth or damage to any underlying permanent teeth. The patient should be referred immediately to a dentist.

## EAR CONDITIONS

A wrestler was not wearing protective headgear during practice. He is now complaining about a burning, aching sensation on the outer ear. It appears to be somewhat inflamed and sensitive to touch, but no swelling is apparent. How should this injury be managed, and what signs might indicate a more serious problem?

Several conditions may affect the ear. Foreign bodies in the ear usually are harmless and easily removed with a speculum. Trauma to the ear can lead to auricular hematoma, and an infection of the ear can lead to localized inflammation of the auditory canal (**otitis externa**), impacted cerumen, swimmer's ear (**otitis media**), or a tympanic membrane rupture. Box 20.5 identifies the signs and symptoms of ear conditions that warrant further examination by a physician.

### BOX 20.5 Ear Red Flags Requiring Further Examination by a Physician

- Bleeding or CSF from the ear canal
- Feeling of fullness in the ear; vertigo
- Bleeding or swelling behind the ear (Battle sign)
- Foreign body in the ear that cannot be easily removed
- Hematoma or swelling that removes the creases of the outer ear

- Popping or itching in the ear
- Tinnitus or hearing impairment
- Pain when the ear lobe is pulled

# External Ear Conditions

## *Etiology*

**Auricular hematoma**, or cauliflower ear, is a relatively minor injury caused when repeated blunt trauma pulls the cartilage away from the perichondrium. A hematoma forms between the perichondrium and cartilage of the ear and compromises blood supply to the cartilage, leading to a painful and throbbing injury. This condition, which is common in wrestlers, can be prevented by wearing proper headgear.

## *Signs and Symptoms*

The outer ear will appear red, puffy, and swollen. If left untreated, the hematoma forms a fibrosis in the overlying skin, leading to necrosis of the auricular cartilage that results in the characteristic cauliflower ear appearance (Fig. 20.20).

**Figure 20.20. Cauliflower ear deformity.** The hematoma results in the skin being pulled away from the ear cartilage.

### *Management*

Immediate treatment involves icing the region to reduce pain and swelling. An ice pack should be applied for 20 minutes. If the swelling is still present, the hematoma must be aspirated by a physician to avoid pressure and permanent cartilage damage. Once aspirated, a pressure dressing should be applied for 7 to 14 days. The patient should not take aspirin or nonsteroidal anti-inflammatory drugs for several days; however, antibiotics are recommended for 7 to 10 days because of a high risk for infection.[33] It is imperative that the patient wear protective headgear to prevent reoccurrence.

## Internal Ear Conditions

### *Etiology*

A blow to the ear, pressure changes (as seen in diving and scuba diving), and infection may injure the external auditory meatus and eardrum. Although typically seen in water sports, damage to the internal ear may occur in any sport, such as in soccer when a player is hit on the ear by a ball.

### *Signs and Symptoms*

A patient with an internal ear condition may experience intense pain in the ear, a feeling of fullness, nausea, tinnitus, dizziness, or hearing loss.

### *Management*

The patient should be evaluated immediately by a physician. Most minor ruptures of the eardrum heal spontaneously; larger ruptures may require surgical repair.

## Impacted Cerumen

### *Etiology*

Cerumen, or ear wax, is produced by the ceruminous glands, which are modified apocrine glands in the external auditory canal. Cerumen is a sticky substance thought to trap insects and foreign material in the ear canal. In many patients, the ear is naturally cleansed as the cerumen dries and then falls out of

the external auditory canal. In others, however, cerumen builds up excessively and becomes compacted, a condition that can impair hearing.

### *Signs and Symptoms*

Impacted cerumen causes some degree of hearing loss or muffled hearing. Pain generally is not present because no infection is present.

### *Management*

Removal of the excess ear wax can be accomplished by irrigating the ear canal with warm water. A cotton tip applicator should not be used because this may increase the impaction or damage the eardrum. If irrigation is not successful, referral to a physician is necessary to remove the cerumen with a curette.

## Otitis Externa

### *Etiology*

**Otitis externa** is a bacterial infection that involves the lining of the external auditory canal. Because of its prevalence among patients who participate in water activities, it is commonly called swimmer's ear. Otitis externa frequently occurs in patients who fail to dry the ear canal after being in water, resulting in a change of the pH of the ear canal's skin.

### *Signs and Symptoms*

In acute conditions, pain is the predominant symptom. In chronic cases, such as those seen with excessive use of a cotton swab, itching is a more common complaint, with discomfort and pain being secondary. There may or may not be a discharge of pus. Gentle pressure around the external auditory opening and pulling on the pinna causes increased pain. If left untreated, the infection can spread to the middle ear, causing balance disturbances or hearing loss. Commercial ear plugs may not be helpful in preventing this condition.

### *Management*

Custom ear plugs from an audiologist or otolaryngologist may be necessary.

The condition also can be prevented by using ear drops to dry the canal. The majority of ear drops contain an acidifying agent, either aluminum acetate or vinegar. An effective homemade remedy is equal parts of white vinegar (acetic acid), 70% alcohol, and water. One or two drops after water exposure or showering is the standard recommendation. If no improvement is seen, the patient should be referred to a physician, who may prescribe drops containing broad-spectrum antibiotics.

# Otitis Media

## *Etiology*

Localized infections of the middle ear (**otitis media**) often occurs secondary to upper respiratory infections. These infections often are caused by bacteria, but they also may be caused by viruses. Bacterial and viral infections have the same signs and symptoms.

## *Signs and Symptoms*

When the mastoid area is pressed, the patient will complain of pain and a sense of fullness in the ear. Swelling of the mucous membranes may cause a partial or complete block of the eustachian tube (the connection between the middle ear and the pharynx), resulting in the inhibition of hearing. The tympanic membrane may appear red and bulging. Serous otitis often is associated with otitis media and an upper respiratory infection; an amber-colored or bloody fluid is seen through the eardrum and is associated with complaints of ears popping.

## *Management*

A physician may prescribe an antibiotic for 10 days if there is an infection, or decongestants may be used to shrink the swollen mucous membranes. If the middle ear of a patient with otitis media is completely filled with fluid, air travel should be discouraged. If the ear is filled with fluid and air and the eustachian tube is not working properly, the air bubbles will expand on ascent and contract on descent. Both ascent and descent cause severe pain and may

rupture the eardrum. In addition, rupture of the membranes separating the middle ear from the inner ear could occur, with catastrophic results. Therefore, air travel is not recommended until the middle ear has returned to normal appearance and function.

## Tympanic Membrane Rupture

### *Etiology*

The tympanic membrane vibrates when sound waves strike it, starting the process of converting sound waves into nerve impulses that travel to the brain. Damage to the eardrum interrupts the hearing process and may impair hearing. The eardrum also acts as a barrier to keep outside material, such as bacteria, from entering the middle ear. A ruptured (perforated) eardrum is a tear or a hole in the eardrum, which can allow bacteria to more easily reach the middle ear and cause infection. A ruptured eardrum may be caused by an infection (e.g., otitis media); direct trauma (e.g., being slapped or being hit by a ball on the external ear); changes in pressure (e.g., rapid ascent or descent in a plane or underwater); loud, sudden noises (e.g., explosion); or foreign objects in the ear (e.g., cotton swab or bobby pin pushed too far into the ear canal).

### *Signs and Symptoms*

A ruptured eardrum initially can be very painful. Other signs and symptoms include sharp, sudden ear pain or discomfort; tinnitus; clear, pus-filled, or bloody drainage from the ear; sudden decrease in ear pain followed by drainage; and hearing loss. Use of an otoscope may identify the damaged area.

### *Management*

The patient should be referred immediately to a physician for further care. Most small-to-moderate perforations of the tympanic membrane heal without treatment within a few weeks, although some may take months. If the tear or hole in the eardrum does not heal by itself, treatment may involve an eardrum patch or surgery. Closing the perforation is essential to prevent water from entering the ear while showering, bathing, or swimming, which could cause

middle ear infections. Hearing is improved, and any tinnitus is diminished. Repair of the perforation also prevents the development of a skin cyst in the middle ear (cholesteatoma), which can cause chronic middle ear infections and damage the ear structure.

Ice should be placed on the wrestler's ear to control swelling. If any hemorrhage or edema between the perichondrium and cartilage appears to flatten the wrinkles or creases of the ear, the patient should be referred immediately to a physician for follow-up care. Protective ear wear should be worn by all wrestlers at every practice and during competitions.

## EYE CONDITIONS

While moving through the circuit training area in an exercise facility, an adult exerciser received a significant blow to the eye from another exerciser's elbow. What signs and symptoms indicate a serious condition?

The eyes are exposed daily to potential trauma and injury, yet many eye injuries could be prevented by wearing protective eyewear. This is especially true in racquetball and squash, in which players are confined to a limited space with swinging racquets and balls traveling at high speeds. Patients who require corrective lenses should use strong plastic or semirigid rubber frames and impact-resistant lenses. If glasses are not required, the American Academy of Pediatrics and the American Academy of Ophthalmology recommend that protective eyewear and/or face masks should be worn during participation in sports with a high risk of injury.[41] Sport participants with only one good eye should consult an ophthalmologist to determine what mandatory protective eyewear should be worn to prevent further injury. **Box 20.6** identifies the signs and symptoms of eye conditions that necessitate further examination by a physician.

**BOX 20.6 Eye Red Flags Requiring Further Examination by a Physician**

- Visual disturbances or loss of vision
- Blood in the anterior chamber
- Unequal pupils or bilateral, dilated pupils
- Embedded foreign body
- Irregular eye movement or failure to adjust tolight
- Individual complaining of floaters, light flashes, or a "curtain falling over the eye"
- Severe ecchymosis and swelling (raccoon eyes)
- Itching, burning, watery eye that appears pink
- Suspected corneal abrasion or corneal laceration
- Displaced contact lens that cannot be easily removed

# Periorbital Ecchymosis

## *Etiology*

The eye globe is well protected within the orbital rim, but in many sports, the external eye region is susceptible to direct trauma from flying implements, balls, and competitor's elbows. The area is highly vascular and, when impacted, can produce capillary bleeding into the tissue spaces.

## *Signs and Symptoms*

Impact forces can cause significant swelling and hemorrhage into the surrounding eyelids. This discoloration is called **periorbital ecchymosis**, or, more commonly, a black eye. The impact can also lead to subconjunctival hemorrhage or faulty vision.

## *Management*

Trauma to the eye requires inspection for obvious abnormalities, palpation of the orbit for a possible orbital fracture, and assessment of pupillary response to light by shining a concentrated light beam into the eye and noting the bilateral rate of constriction. The ability of a patient to focus clearly on an object must be assessed. The anterior chamber of the eye should be inspected for any obvious bleeding (see "Hemorrhage into the Anterior Chamber" section). Treatment involves controlling the swelling and hemorrhage by using crushed ice or ice water in a latex surgical glove; it is essential that the glove does not have rosin or other powdered substances on it. Because of possible leakage, chemical ice bags should not be used. This condition requires referral to an ophthalmologist for further examination to rule out an underlying fracture or injury to the globe.

# Foreign Bodies

## *Etiology*

Dust or dirt in the eye is a frequent occurrence in all sports. At times, the debris can be potentially dangerous.

## *Signs and Symptoms*

Foreign debris in the eyes can lead to intense pain and tearing. The patient may attempt to remove the substance by rubbing the eye or tearing the eye to flush the object out. Depending on the pain level, the patient may resist any attempt to open the eyelids to view the eye.

A foreign object that is impaled or embedded should not be touched, and removal should not be attempted. Activation of the emergency plan is warranted, including summoning EMS. Medically trained patients will stabilize the object and provide rigid protection for the orbit. In the cornea, a fluorescein stain may reveal the object's location, and topical anesthetics may be necessary to facilitate the physician's examination.

## *Management*

The foreign body, if not embedded or on the cornea, should be removed and the eye should be inspected for any scratches, abrasions, or lacerations (**Application Strategy 20.5**).

APPLICATION STRATEGY 20.5

### Removing a Foreign Body from the Eye

1. Examine the lower lid by gently pulling the skin down below the eye. Ask the patient to look up and inspect the lower portion of the globe and eyelid for any foreign object.
2. Examine the upper lid by asking the patient to look downward.
3. Grasp the eyelashes and pull downward.
4. Place a cotton-tipped applicator on the outside portion of the upper lid.
5. Pull the lid over the applicator and hold the rolled lid against the upper bony ridge of the orbit.
6. Remove the foreign body with a sterile, moist gauze pad. If you are unable to successfully remove the foreign object, patch both eyes with a sterile, oval gauze pad (without adding pressure), and refer the patient to a physician for immediate care.

## Sty

### *Etiology*

A sty (hordeolum) is an infection of the sebaceous gland at the edge of the eyelid and is typically caused by *Staphylococcus* bacteria. Blepharitis is an inflammation of the eyelash follicle along the edge of the eyelid. A sty may be brought on by improper or incomplete removal of eye makeup, use of outdated or infected cosmetics, poor eyelid hygiene, inflammatory diseases of the eyelid, stress, and hormonal changes.

### *Signs and Symptoms*

The condition presents as a red nodule that will progress into a painful pustule within a few days. The nodule will be tender to the touch and may elicit a scratchy sensation on the eyeball. There may also be crusting of the eyelid margins, burning in the eye, droopiness of the eyelid, blurred vision, and mucous discharge in the eye.

### *Management*

Treatment involves the application of warm, moist compresses. If the pustule does not improve within 2 days, physician referral is required because a prescription topical ointment may be necessary.

## Conjunctivitis (Pinkeye)

### *Etiology*

**Conjunctivitis** is an inflammation, often resulting from chlorine irritation or bacterial infection of the conjunctiva.

### *Signs and Symptoms*

The condition leads to itching, burning, and watering of the eye, causing the conjunctiva to become inflamed and red and giving a "pink eye" appearance.

### *Management*

This bacterial condition can be highly infectious, so the patient should be referred immediately to a physician for medical treatment.

## Corneal Lacerations

### *Etiology*

A corneal laceration is a partial- or full-thickness injury to the cornea. A partial-thickness injury does not violate the globe of the eye (abrasion). A full-thickness injury penetrates completely through the cornea, causing a ruptured globe. Lacerations to the cornea are caused by sharp objects, such as fingernails, darts, skate blades, or broken glass.

### *Signs and Symptoms*

With an abrasion, there is a sudden onset of pain, tearing, and photophobia. Blinking and movement of the eye only aggravate the condition. An examination may not reveal a foreign object, but the patient continues to complain that something is in the eye. With a laceration, severe pain, discomfort, decreased visual acuity, or distortion or displacement of the pupil

is present. The pupil should be inspected for symmetry with the opposite eye. Lacerations of the cornea often penetrate iris tissue, causing distortion and displacement of the pupil.

### *Management*

With an abrasion, the initial management involves covering the eye with a dry, sterile dressing. A corneal abrasion is best seen by using a fluorescein dye strip. Soft contact lenses should be removed before applying the dye, because these lenses absorb the dye and can be ruined. The orange color of the dye is augmented by using a blue light, which changes the orange dye to a bright green and illuminates the abrasion. Treatment usually involves a topical ointment, such as 2% homatropine, to reduce pain, relax ciliary muscle spasms, and prevent secondary bacterial infection. It may be advantageous to wear an eye patch for 24 to 48 hours. If used, the patch must be tight enough to ensure that the lids are closed beneath the patch and firm enough to prevent the lids from opening and closing.

If a laceration is suspected, any pressure on the globe should be avoided to prevent extrusion of the intraocular contents. The eye should be covered using a protective shield with the pressure exerted on the bony orbit, not on the soft tissue. This condition warrants immediate referral to a physician. The patient should be moved in either a supine or an upright position. (Avoid a prone or head-down position.) As such, it may be necessary to activate the emergency plan, including summoning EMS, for transportation to the nearest medical facility.

## Subconjunctival Hemorrhage

### *Etiology*

Direct trauma also can lead to **subconjunctival hemorrhage**. It is often referred to as red eye. The condition is seen more common in patients with high blood pressure or in those taking blood thinners.

### *Signs and Symptoms*

Several small capillaries rupture, making the white sclera of the eye appear red, blotchy, and inflamed. This condition is not as serious as it may appear to be.

### *Management*

This relatively harmless condition requires no treatment and resolves spontaneously in 1 to 3 weeks. If blurred vision, pain, limited eye movement, or blood in the anterior chamber is present, however, immediate referral to an ophthalmologist is warranted.

## Hemorrhage into the Anterior Chamber

### *Etiology*

Hemorrhage into the anterior chamber (**hyphema**) usually results from blunt trauma caused by a small ball (e.g., squash or racquetball), hockey puck, stick (e.g., field hockey or ice hockey), or a swinging racquet (e.g., squash or racquetball). The small size of the object enables it to fit within the confines of the eye orbit, thereby inflicting direct damage to the eye.

### *Signs and Symptoms*

Initially, a red tinge in the anterior chamber may be present, but within a few hours, blood begins to settle into the anterior chamber, giving a characteristic meniscus appearance (Fig. 20.21). Frequently, it occurs in microscopic quantities, and visual acuity may not be affected. Such bleeding indicates that an intraocular injury has occurred, however, and the source of the bleeding must be identified to prevent recurrent bleeding, which can lead to both massive and destructive results.

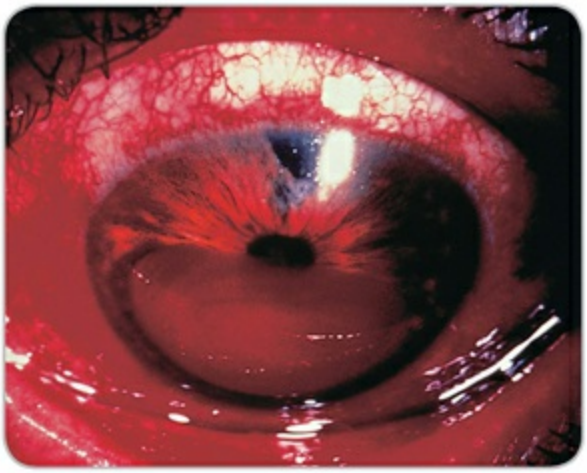


**Figure 20.21. Hyphema.** Blood in the anterior chamber of the eye signals a serious eye injury.

### *Management*

Both eyes should be patched. Because this condition necessitates immediate referral to a physician, it may be necessary to activate the emergency plan, including summoning EMS, so that the patient can be transported in a semireclining or a seated position. The condition requires hospitalization, bed rest, bilateral patching of the eyes, and sedation. The initial hemorrhage usually resolves in a few days, with good prognosis for full recovery.

## Detached Retina

### *Etiology*

Damage to the posterior segment of the eye can occur with or without trauma to the anterior segment. A detached retina occurs when fluid seeps into the retinal break and separates the neurosensory retina from the retinal epithelium. This can occur days or even weeks after the initial trauma.

### *Signs and Symptoms*

Detachment almost always begins at the retinal periphery, resulting in a positive scotoma (a blind spot perceived by the patient) at the edge of the visual field. As the detachment progresses and the scotoma enlarges, the patient frequently describes the condition with phrases like “a curtain fell over my eye” or “I keep seeing flashes of lights going on and off.” An

ophthalmoscope may be used to view the optic disc and retinal vessels (Application Strategy 20.6).

## APPLICATION STRATEGY 20.6

### Using the Ophthalmoscope

1. Darken the room. Switch on the ophthalmoscope light and turn the lens disc until you see the large round beam of white light. Shine the light on the back of your hand to check the type of light, its desired brightness, and the electrical charge of the ophthalmoscope.
2. Turn the lens disc to the zero diopter (a diopter is a unit that measures the power of a lens to converge or diverge light). In the zero diopter setting, the lens neither converges nor diverges light. Keep your finger on the edge of the lens disc so you can turn the disc to focus the lens while examining the fundus.
3. Hold the ophthalmoscope in the right hand to examine the right eye, and in the left hand to examine the left eye. This prevents bumping the patient's nose and provides more mobility and a closer range for visualizing the fundus. There may be some initial difficulty using the nondominant eye to view the fundus, but this should pass with practice.
4. Hold the ophthalmoscope firmly braced against the medial aspect of your bony orbit, with the handle tilted laterally at about a 20° slant from the vertical. Check to make sure you can see clearly through the aperture. Instruct the patient to look slightly up and over your shoulder at a point directly ahead on the wall.
5. Place yourself about 15 in away from the patient and at an angle 15° lateral to the patient's line of vision. Shine the light beam on the pupil and look for the orange glow in the pupil, the *red reflex*. Note any opacity interrupting the red reflex.
6. Place the thumb of your other hand across the patient's eyebrow. (This technique helps keep you steady but is not essential.) Keeping the light beam focused on the red reflex, move in with the ophthalmoscope on the 15° angle toward the pupil until you are very close to it, almost touching

the patient's eyelashes.

Try to keep both eyes open and relaxed, as if gazing into the distance, to help minimize any fluctuating blurriness as your eyes attempt to accommodate.

It may be necessary to lower the brightness of the light beam to make the examination more comfortable for the patient, to avoid *hippus* (spasm of the pupil), and to improve your observations.

Adapted from Bickley LS, Szilagyi PG. *Bates' Guide to Physical Examination and History Taking*. Philadelphia, PA: Lippincott Williams & Wilkins; 2007.

### *Management*

If a detached retina is suspected, both eyes should be patched. Immediate referral to an ophthalmologist is required, because surgery often is necessary.

## Orbital Blowout Fracture

### *Etiology*

A blowout fracture is caused by the impact from a blunt object (one usually larger than the eye orbit). On impact, forces drive the orbital contents posteriorly against the orbital walls. This sudden increase in intraorbital pressure is released in the area of least resistance, typically the inferior orbital floor (roof of the maxillary sinus). The medial orbital wall may also be involved. The result is that the globe descends into the defect in the floor.

### *Signs and Symptoms*

An examination may reveal **diplopia**, absent eye movement, numbness on the side of the fracture below the eye, and a recessed, downward displacement of the globe. The lack of eye movement becomes evident when the patient is asked to look up and only one eye is able to move (**Fig. 20.22**).

**Figure 20.22. Orbital blowout fracture.** An orbital fracture can entrap the inferior rectus muscle, leading to an inability to elevate the eye.

### *Management*

Ice should be applied to the area to limit swelling; however, do not add additional compression or pressure over the suspected fracture site. The patient should be referred immediately to a physician. Tomograms or radiographs are necessary to confirm a fracture, and surgery may be indicated to repair the defect in the orbital floor.

## Displaced Contact Lens

Hard contact lenses can slow the progression of **myopia** (nearsightedness). In sports, however, soft contact lenses are preferred, both because eye accommodation and adjustment time are less and because the lenses can be easily replaced and worn for longer periods of time.

Hard contact lenses frequently are involved in corneal abrasions. Foreign objects get underneath the lens and damage the cornea, or the cornea may be injured while putting in or taking out the lens. If irritation is present, the lens should be removed and cleaned. In an eye injury, patients may be able to remove the lens themselves. Pain or photophobia may preclude them from doing this, however, and it may become necessary to assist them. **Application Strategy 20.7** demonstrates a full assessment of an eye injury.

Dilated pupils, any abnormal eye movement, throbbing pain or

headache, and vision disturbances such as diplopia, sensitivity to light, and loss of all or part of a field of vision indicate a serious eye injury that warrants immediate referral.

## APPLICATION STRATEGY 20.7

### Eye Evaluation

1. Check ABCs.
2. Determine responsiveness.
3. History
   - Determine primary complaint. Ask about the level of pain, discomfort, extent of voluntary eyelid movement, and extent of vision.
   - Determine mechanism of injury. Objects larger than the eye orbit may lead to orbital fracture. Objects smaller than the eye orbit may lead to direct trauma to the eye globe. Did the trauma result from blunt trauma, a sharp object, or a projectile?
4. Observation and inspection
   - Look for obvious deformity or abnormal deviation in the surrounding eye orbit.
   - Observe ecchymosis and extent of swelling in the eyelids and surrounding tissue. If the eyelid is swollen shut and the patient cannot voluntarily open it, do not force it open, which may cause further damage.
   - Observe any bleeding from deep lacerations of the eyelid.
   - Observe the level of both pupils and the eye globe for anterior or posterior displacement, presence of any corneal lacerations, and bleeding in the anterior chamber.
   - Inspect pupil size, accommodation to light, and sensitivity to light with a penlight.
5. Palpation
   - Carefully palpate the bony rim of the eye orbit and cheek bone for any swelling, depressions, crepitus, or mobility.

- Control any bleeding.

6. Special tests
   - Determine the eye vision. Compare the vision of the uninjured eye to the injured eye. Is it blurred or sensitive to light? Does the patient have double vision? Can the patient distinguish how many fingers you are holding up in all four quadrants of vision? Can the patient distinguish objects that are close from objects that are far away?
   - Determine eye movement. Move your finger through the six cardinal planes of vision. Do the eyes move in a coordinated manner? If one eye moves upward and the other remains in a stationary position, the inferior rectus muscle may be entrapped because of an orbital fracture.
   - Vision disturbances, such as persistent blurred vision, diplopia, sensitivity to light, loss of all or part of a field of vision, dilated pupils, any abnormal eye movement, and throbbing pain or headache, indicate a serious eye injury that warrants immediate referral.

## SUMMARY

1. Wearing protective equipment can significantly reduce the incidence and severity of head and facial injuries.
2. Minor injuries, such as nosebleeds, contusions, abrasions, lacerations, and minor concussions, can be handled easily on the field by the clinician. If complications arise or the condition does not improve within a reasonable amount of time, the clinician should immediately consult a physician about the injury.
3. Signs that indicate a possible skull fracture include deformity, unequal pupils, discoloration around both eyes or behind the ears, bleeding or CSF leaking from the nose and/or ear, and any loss of sight or smell.

4. Signs or symptoms of increasing intracranial pressure following head trauma include a severe headache, pupil irregularity or irregular eye tracking, confusion or progressive or sudden impairment of consciousness, rising blood pressure and falling pulse rate, and drastic changes in emotional control.
5. Signs and symptoms of a concussion include headache, dizziness or vertigo, lack of awareness of surroundings, nausea and vomiting, deteriorating level of consciousness, disturbance of vigilance with heightened distractibility, inability to maintain coherent thought patterns, and inability to carry out a sequence of goal-directed movements.
6. Patients who have sustained a concussion should not return to play the same day but instead should follow stepwise graduated RTP protocol.
7. Injuries that indicate increasing intracranial pressure, memory dysfunction, or gross observable poor coordination require immediate referral to a physician.
8. Fractures to the facial bones often result in malocclusion.
9. The nose is particularly susceptible to lateral displacement from trauma. Simultaneously, the trauma also may lead to a concussion.
10. When a loose tooth has been displaced outwardly or laterally, the clinician should try to place the tooth back into its normal position without forcing it. Teeth that are intruded should be left alone; any attempt to move the tooth may result in a permanent loss of the tooth. The patient should be referred to a dentist immediately.
11. A dislocated tooth should be located, rinsed in milk or a saline solution, and replaced intraorally within the tooth socket. The patient should be seen by a dentist within 30 minutes for replacement of the tooth.
12. Cauliflower ear is common in wrestlers but is completely preventable by wearing proper headgear at all times when on the mat.
13. Otitis externa is a bacterial infection involving the lining of the external

auditory meatus, commonly called swimmer's ear. Otitis media is a localized infection of the middle ear.

14. A foreign body in the eye, if not embedded or on the cornea, should be removed and the eye should be inspected for any scratches, abrasions, or lacerations.
15. Direct trauma to the eye can lead to corneal laceration, rupture of the globe, hemorrhage into the anterior chamber, detached retina, or orbital fracture. Loss of visual acuity, abnormal eye movement, diplopia, numbness below the eye, or a downward displacement of the globe should signal a serious condition. The patient should be referred to an ophthalmologist immediately.

## APPLICATION QUESTIONS

1. Concussions are graded after the resolution of all symptoms and dysfunction. Do you think this is advantageous or problematic? Why? (Provide a justification for your response.)
2. A field hockey player has been hit in the head with a ball. The athlete is conscious but dazed. What questions should be asked as part of the history component of an on-the-field evaluation?
3. During hitting practice, a foul tip strikes the head of a baseball player standing near the dugout. The history and observation components of the assessment reveal the following: The skin is not broken; the patient is complaining of an intense headache, disorientation, and blurred vision; and the patient cannot recall what happened. In the continued assessment of this condition, is it advisable to perform neurological testing immediately or only if new symptoms develop and existing symptoms becomes worse? Why?
4. In a collision with the shortstop, a 17-year-old base runner received an elbow to the side of the head. The player was dazed and removed from

the game. Following 15 minutes of ice application to the region, the patient complains of an increasing headache, nausea, and sensitivity to sunlight. She is lethargic and disoriented. What do these symptoms indicate? How will you manage this injury?

5. You are a high school athletic trainer. One of your annual goals is to actively engage coaches, parents, and athletes in assisting with the identification and management of concussions. What strategies could you employ to accomplish this goal?
6. Following a collision during a tackle, an 18-year-old football player remains down on the field. When you reach the athlete, he is conscious, but it is not clear if he momentarily lost consciousness and has since regained it. How would you differentiate between a simple and a complicated subdural hematoma?
7. A 21-year-old female lacrosse player stepped in front of an opposing player who was taking a shot on goal and was struck on the jaw by the ball. Although she was wearing a mouth guard, bleeding from the mouth is apparent and she is unable to close the jaw with the teeth in their proper alignment. What injury should be suspected? How should the condition be managed?
8. A 16-year-old third baseman covering a hit was struck on the side of the nose when the ball bounced upward unexpectedly. His nose is bleeding and appears to be swollen at the bridge of the nose. What signs and symptoms would indicate that this patient needs to be referred immediately to a physician?
9. A 20-year-old wrestler was not wearing protective headgear during practice. He is now complaining about a burning, aching sensation on the outer ear. Upon inspecting the ear, you notice that the area is somewhat inflamed and sensitive to touch, but no swelling is apparent. How should this condition be managed? What signs or symptoms might indicate a more serious problem?

10. An 18-year-old collegiate basketball player was struck in the mouth by an elbow. The inside of the upper lip is bleeding. There are at least three loose teeth, and one tooth appears to be broken in half. How should this injury be managed?

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