chapter 9

Head Injuries

Objectives

After completing this chapter, the student will be able to do the following:

- Describe the anatomy of the head.
- Understand that head injuries can be prevented.
- Understand the urgency involved with caring for brain injuries.
- Describe the types of head injuries.
- Understand the long-term effects of head injuries.

When an athlete has a head injury, the AT must act quickly to lessen the chance of death and permanent injury. In this chapter, we provide information to assist the student in understanding head injury and its prevention.

ANATOMY OF THE HEAD

The skull is composed of 28 bones that protect the brain (see figure 9.1). A suture line is the area where two bones in the skull come together. The single moveable bone in the skull is the mandible, or lower jaw.

The Brain

The brain is made of billions of cells. It weighs only about 3 pounds (1.4 kg), but it requires 20% of the

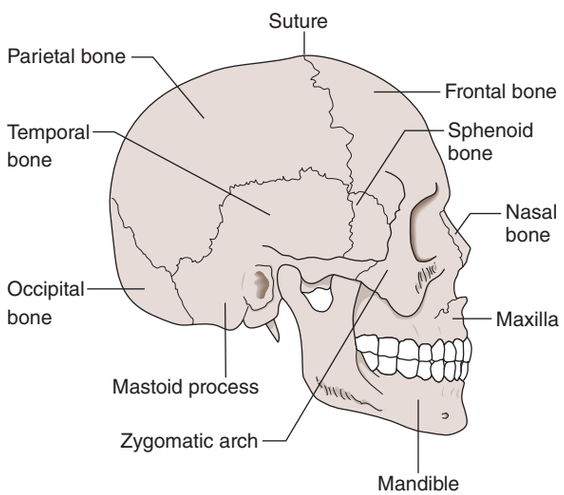

Figure 9.1 Bones of the skull.

total body oxygen and 15% of the blood supply. Brain cells grow and develop until age 18. After that, brain cells can be destroyed but not reproduced. Depriving the brain of oxygen will cause unconsciousness and then death—the pupils of the eyes will dilate within 60 seconds (dilation is an indication of the inability to control the muscle of the iris of the eye). After four to six minutes without oxygen, biological brain death occurs, which means that large numbers of cells are dead.

The brain is divided into lobes, each named after the bony structure of the skull that covers it: occipital lobe, temporal lobe, parietal lobe, and frontal lobe (see figure 9.2). Each lobe is responsible for specific body functions. The brain attaches to the spinal cord at the brain stem via a crossover, so the right side of the brain controls the left side of the body and vice versa. Preserving brain function is of the utmost importance to injured athletes. Their quality of life—that is, their degree of recovery—depends on how the brain injury is handled.

Cerebrospinal fluid bathes the brain and spinal cord in chemicals for proper functioning, helps maintain regular pressure around the brain and spinal cord, and protects the brain from impacts. The fluid is clear amber in color. In instances of severe head injury, cerebrospinal fluid may drain from an opening in the skull, the nose, or an ear, and it should be allowed to do so. Stopping the drainage will only increase the pressure within the skull and cause more brain damage.

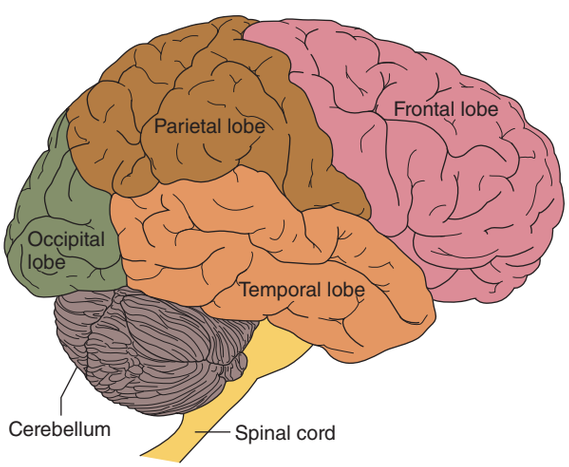

Figure 9.2 Brain areas.

FYI

The functions of the brain are based on location.

Frontal lobe: voluntary muscle movement, emotion, eye movement
Parietal lobe: sensation
Occipital lobe: vision
Temporal lobe: hearing, speech
Cerebellum: equilibrium, muscle actions, some reflexes

The Scalp

The scalp is the part of the skin that covers the skull, and it contains a large number of blood vessels, muscles, and hair. Skin protects against infections while hair protects the skin from the sun and keeps dirt and sweat away from the eyes. The blood vessels are so numerous in the scalp that even a small laceration will bleed profusely. Cartoonists draw a large lump when a character is hit in the head. This can also happen to athletes; a blow to the head may cause the many blood vessels to break open and bleed under the skin, causing a lump, or **hematoma**.

The scalp has the ability to decrease the force of an impact to the skull due to the additional padding it provides and the increased elasticity created by the tension of the connective tissue between the scalp and the skull. It is believed that without the scalp, the skull could be fractured with as little as 40 pounds (18 kg) of pressure. With the scalp, it may take 425 pounds (193 kg) of pressure before a fracture will occur. An athlete can sustain a serious head injury without a break in the scalp, however, so the AT should not be fooled by a lack of bleeding.

PREVENTING HEAD INJURIES

Head injuries are prevented by helmets, mouth guards, rules, and common sense. A commonly forgotten piece of equipment in the battle to prevent

head injuries is the mouth guard, which can prevent not only dental injuries but also concussions. If an athlete is not wearing a mouth guard, an impact to the chin can drive the mandible into the maxilla and cause the brain stem to twist slightly, resulting in loss of consciousness. A mouth guard provides spacing and shock absorption between the mandible and maxilla so that the force of the impact will not be transmitted to the brain stem. For a mouth guard to be effective, however, the athlete must be wearing one, and it must be in good condition. A mouth guard that has been chewed up or cut off will not prevent the knockout impact.

Wearing a helmet and face mask is also important in preventing head injuries. In the early years of football, players did not wear helmets. Today, a properly fitted helmet helps protect a player's head from direct impacts. The helmet prevents head injuries but not injuries of the face; thus, the face mask was introduced. With the head and face protected, athletes began to use the helmet as a weapon to punish opposing players. Using the head to make contact with another player is referred to as *spearing*. As spearing continued as a form of tackling, a progressive increase in the number of neck injuries resulting in permanent injury or death occurred—the helmet and face mask protected the head from direct impact but resulted in other forms of injury. Spearing has since been deemed a penalty, an offense severe enough to get a player ejected from the game.

Athletes should be taught the proper skills so that injury can be prevented. Coaches and ATs must teach athletes that they cannot lead with the head when trying to stop an opponent; this is crucial in preventing head injuries. At the beginning of each season, a film outlining sport safety should be shown. The AT should document attendance at this safety film; recording the date and an outline of the discussion should provide some legal protection if an athlete does sustain a serious head injury. The AT should also document days when safety skills are taught at practice and take attendance. She should explain the signs and symptoms of head injuries and proper care of helmets.

HEAD INJURY MECHANISMS

Injury to the brain can be caused by rotation of the head, but the most common mechanism is impact. The region most susceptible in the skull is the temporal region because the bone is thinnest there. **Contrecoup** injuries occur when the head is moving and receives a blow. On impact, the brain sloshes to the side opposite the blow, where it is stopped by the skull, and that is where the injury occurs. An athlete may complain of a headache opposite the impact, which is evidence of a contrecoup injury. Rotation of the head after an initial impact can cause the brain stem to stop functioning normally. The nerve receptors are overloaded with information to the brain, and brain overload causes unconsciousness. The unconscious state allows for a sorting of the impulses before the athlete returns to consciousness.

What Would You Do If . . .

You have been instructed to walk an athlete with a first-degree concussion into the locker room. Another athlete insists you can cure a concussion by cracking his neck. The athlete with the concussion says, "Yes, please make me better."

TREATING HEAD INJURIES

Potentially life-threatening head injuries include lacerations, skull fractures, intracranial hematomas, concussions, and chronic traumatic encephalopathy. This section discusses the evaluation of each of these types of injuries.

Laceration

A laceration to the scalp will bleed profusely because of the large number of blood vessels in the scalp. Direct pressure applied to the wound

will eventually stop the bleeding, but application of multiple gauze pads is usually necessary. Lacerations of the scalp may require suturing.

Skull Fracture

Skull fractures occur when there is significant force against the head. Types of skull fractures include depressed, linear, compound, and penetrating. A depressed fracture pushes a portion of the skull inside toward the brain. There will be bleeding under the skin or even a laceration requiring bleeding control. A linear fracture goes across the skull. Although no bones are moved out of place, there are tears in the blood vessels on the inside of the skull. A compound fracture will result in a portion of the skull sticking through the scalp and profuse bleeding. A penetrating fracture involves an object that has gone through the scalp, skull, and likely the brain. A skull fracture will discolor the area behind the ear; this discoloration is called a **battle sign**. Any skull fracture is significant and requires the immediate attention of a physician.

Intracranial Hematoma

An **intracranial hematoma** is severe bleeding within the brain caused by a blow to the head, particularly over the temporal or parietal regions. The hematoma causes a significant increase in pressure on the brain, and rapid death can occur. Sometimes an athlete is thought to have a concussion and is allowed to go home. If she has a hematoma, she may die during the night. If an athlete is found in a coma, the chances of survival are only 40%. Survival depends on early examination by a physician and prompt surgical care. Physicians usually drill a hole in the skull to allow drainage of the blood and attempt to repair the bleeding vessel. If the athlete is not in a coma, the physician must give medication to put her into a coma. The comatose state keeps the athlete calm and allows the brain to heal without movement.

Symptoms of an intracranial hematoma include headaches, nausea, vomiting, loss of consciousness, paralysis of extremities on the opposite side of the injury, and battle sign. If an intracranial hematoma is suspected, EMS should be contacted for immediate transportation to the hospital. The onset of these symptoms may be gradual, so the athlete must be continually monitored. With the first indication of a condition that is worsening, the athlete must be taken immediately to the hospital. An athlete with a possible head injury should be monitored for at least 24 hours, and he must be awakened every couple of hours to check his status.

RED FLAGS

Call 911 for any of the following:

- Rise in blood pressure and drop in pulse rate
- Pupil on same side of head injury is enlarged
- Athlete is unconscious
- Athlete has difficulty speaking
- Difficulty using extremities
- Balance issues

The signs of a hematoma are a rise in blood pressure with a drop in pulse rate. The pupil on the same side as the head injury will be enlarged. The athlete may have difficulty speaking, difficulty using the extremities on the side opposite the hematoma, stiffening of posture, rapid eye movements, unconsciousness or coma, and lack of coordination. Depending on the severity of the hematoma, the athlete may fully recover or she may suffer permanent brain impairment or death.

Concussion

A **concussion** is the temporary impairment of brain function caused by impact to the head or by a rotation force. A rotation of the head during the impact will send a massive number of impulses to the brain all at once. The brain, not knowing what to do with all the impulses, is overwhelmed, and the athlete may be confused or dazed or may even lose consciousness. Other symptoms of a concussion include nausea, dizziness, headache, vomiting, difficulty speaking, ringing in the ears (**tinnitus**), loss of balance, unconsciousness, difficulty remembering things before or after the impact (**amnesia**), possible battle sign, and disorientation.

The potential problems related to concussions in sport prompted NATA to create a position statement on the management of sport-related concussions

(Guskiewicz et al. 2004). The position statement provides guidelines for ATs, including the idea that ATs must be sensitive to both the causes of concussions and how concussions are presented when an athlete is injured. Also, ATs must recognize not only the common signs of a concussion (balance problems, loss of memory, and difficulty concentrating) but also the symptoms (headache, tinnitus, and nausea).

The NATA position statement also recommends that ATs collect baseline measures of mental function. This preinjury testing often involves using computers to assess an athlete's attention, reaction time, information-processing speed, concentration, and memory. The use of computer programs allows an AT to identify even subtle deficiencies in brain function. Such information can help determine when an athlete can safely return to play following a concussion.

Predisposing Risk Factors for Concussion

During the preparticipation physical, the AT can assess the risk factors each athlete may have in conjunction with concussions. Athletes are at a higher risk of concussion if they have a history of concussions or migraines, are under the age of 24, are female, or play collision team sports (Scopaz and Hatzenbuehler 2013). Once the AT has background knowledge of those who are more susceptible, he should conduct a concussion assessment after the trauma, even if it is not associated with the head.

Baseline Testing

A noncomputerized cognitive test that is often used by ATs is the Standardized Assessment of Concussion (SAC) (McCrea 2001). The SAC requires an AT to obtain information from the athlete that relates to orientation (e.g., does she know what day of the week it is?), immediate memory (e.g., remembering five words), concentration (e.g., can she reverse the order of a string of numbers?), and delayed recall (e.g., can she remember the initial five words given during the immediate memory test?). The SAC test also has a neurological screening section whereby the AT examines loss of consciousness, memory loss, strength, sensation, and coordination. An athlete is given 1 point for a correct response and no points for an incorrect response. The SAC score has 30 possible points. The SAC form creates a record of an athlete's cognitive function and can be used as a pretest so the post-traumatic score can be compared. A score of 25 on the SAC is also used as one criterion for returning an athlete to play.

Along with noncomputerized cognitive testing, computerized assessment is done prior to participation in sport. The test takes about 30 minutes. The assessment consists of memory questions, problem solving, response time, and attention span. The same test is administered in the event of a concussion. The pre- and postconcussion tests are compared. The computerized test is one element used to determine the significance of the injury. The assessment may be administered several times to determine when the athlete has returned to the pretest level.

Every athlete must receive baseline testing, since one never knows when or how a concussion will occur. Typically, baseline tests take place at the preparticipation physical examination (see chapter 6).

Grading Concussions

The severity of concussions is graded in the same manner as sprains and strains—as mild, moderate, or severe. According to the guidelines established by the American Academy of Neurology, the signs and symptoms of a mild, or first-degree, concussion include no loss of consciousness and the athlete's symptoms (e.g., dizziness) or abnormalities (e.g., loss of balance) being resolved in less than 15 minutes. A moderate, or second-degree, concussion will cause no loss of consciousness, but the athlete's symptoms and abnormalities last longer than 15 minutes. If the athlete is unconscious for any length of time, she has sustained a severe, or third-degree, concussion. The unconscious athlete may experience rapid eye movements that look like fluttering, and her pupils may be unequal in size. The pupil on the side of the head injury will be enlarged if the head injury is serious. The athlete may be in a coma, but she can hear what is being said, and it is important that someone talk to her while the AT is working. The AT will detect increased blood pressure, decreased pulse rate, and signs of shock. A severe concussion can lead to death or paralysis. The AT must be cautious when dealing with a concussion because other injuries may have occurred during the impact.

He should also consider the possibility of a neck injury and keep the athlete's head still.

Other grading systems exist for concussions. The Cantu grading system, similar to that of the American Academy of Neurology, uses a mild, moderate, and severe system. Grade 1 means no loss of consciousness occurs, loss of memory lasts less than 30 minutes, and postconcussion signs and symptoms last less than 24 hours. A grade 2 concussion involves loss of consciousness for less than a minute or post-traumatic loss of memory between 30 minutes and 24 hours and postconcussion signs and symptoms lasting one to seven days. A grade 3 concussion will show loss of consciousness of over a minute, memory loss longer than 24 hours, or postconcussion signs and symptoms lasting longer than seven days (Bailes and Hudson 2001).

When the athlete is removed from the playing field, it is not uncommon for teammates to hit the player on the head and say, "Hang in there." Although they are trying to be supportive, they're actually contributing to the concussion. Athletes must be instructed ahead of time to keep their hands off so that only the AT touches the injured athlete.

Assessing the level of consciousness should be done using the Glasgow Coma Scale, or GCS (see table 9.1). The scale is used to determine the severity of the brain injury. The scale assesses AVPU, which stands for **a**lert, **v**erbal, **p**ain, and **u**nresponsiveness. The scale is broken into three areas: motor response, verbal response, and eye opening. Each

Head Injury Classification

- Severe head injury—GCS score of 8 or less
- Moderate head injury—GCS score of 9 to 12
- Mild head injury—GCS score of 13 to 15

Adapted from: American Academy of Orthopedic Surgeons 2011.

Table 9.1 Glasgow Coma Scale

Response	Grading scale	Score
Eye opening		
Spontaneous eye opening	4	
Eyes open to speech	3	
Eyes open to pain	2	
No eye opening	1	
Verbal		
Oriented	5	
Confused conversation, able to answer questions	4	
Inappropriate words	3	
Incomprehensible speech	2	
No response	1	
Motor		
Obeys commands for movement	6	
Purposeful movement to painful stimulus	5	
Withdraws in response to pain	4	
Flexion in response to pain (decorticate posturing)	3	
Extension in response to pain (decerebrate posturing)	2	
No response	1	

From the Centers for Disease Control and Prevention.

category has a grading scale, and the final score is determined by adding all the scales together. The final score is assessed against the chart to determine the athlete's prognosis. The higher the number on the grading scale, the greater the chance of returning to normal.

A concussion with or without the loss of consciousness should make the AT wonder about other injuries that may have occurred. It is best to use a backboard for any athlete with a moderate or severe concussion. In the event that an athlete has lost consciousness, he must be referred to a physician the day of the injury.

An athlete who has suffered a concussion will need to be monitored by a physician to determine when it is safe to reenter competition (see figure 9.3). The NATA position statement on concussion management states that an athlete should be monitored every five minutes after the concussion until the condition clears or the athlete is referred for advanced care. In general, an athlete will not be allowed back into competition after the first concussion until there are no remaining signs or symptoms. Specifically, the athlete will have no headache, nausea, dizziness, or amnesia and will have regained full coordination and normal blood pressure. After a second concussion within a year, the athlete must have at least one month free of all signs and symptoms before returning. A third concussion in one year puts the athlete out of competition for one year, starting the day of the third concussion. An athlete who has suffered a concussion should be told about the signs and symptoms of concussions and the implications of repeated impacts. An athlete who has suffered one concussion is four times more likely to suffer another.

Decisions about returning to participation should be made by the AT and a team physician. In general, athletes who have suffered a concussion should not return to participation until completing a progression of physical activity and follow-up assessments that begin only after he is free of all concussion symptoms (see table 9.2). Assessments should be compared with previous SAC tests (if performed). The progression of activity involves engaging in exercises such as stationary biking, push-ups, sit-ups, and low-level running. The AT must reassess the athlete to determine if the concussion symptoms reoccur during activity. If symptoms occur at this time, the athlete is not ready to progress to other activities, and more rest is required. If the athlete is symptom free at this time, he can then participate in sport-specific activities that do not pose a risk of further injury, such as noncontact activities. These activities should be done for several days, with reassessments performed by the AT. At this point, the athlete can perform **neurocognitive testing** to make sure he is back to normal. Once this is the case, he can return to full sport activity, assuming clearance has been obtained by a physician. In general, a minimum guideline is for an athlete to be symptom free for at least seven days before returning to contact activities.

What Would You Do If . . .

The AT has instructed you to take the blood pressure of an athlete with a head injury every five minutes and let her know about any changes. The first blood pressure is 160/92. The athlete is responsive but talks about a headache. The next blood pressure is 126/84. The athlete then vomits.

Postconcussion Syndrome

Postconcussion syndrome is the persistence of symptoms after a concussion. Symptoms may include headache, ringing in the ears, dizziness, and confusion. The athlete should be seen by a physician for a follow-up evaluation. Returning to play too soon following a concussion increases the chance of developing this condition. Postconcussion syndrome usually does not last more than a week or two.

Return Protocols for Academics

The concussed athlete's brain may require rest or alternative learning experiences. The AT will need to engage teaching staff and administrators in postconcussion care. Athletes may have a number of difficulties when returning to the classroom, experiencing reductions in ability to concentrate and understand concepts, attention span, memory, and reaction time (McGrath 2010). The physician

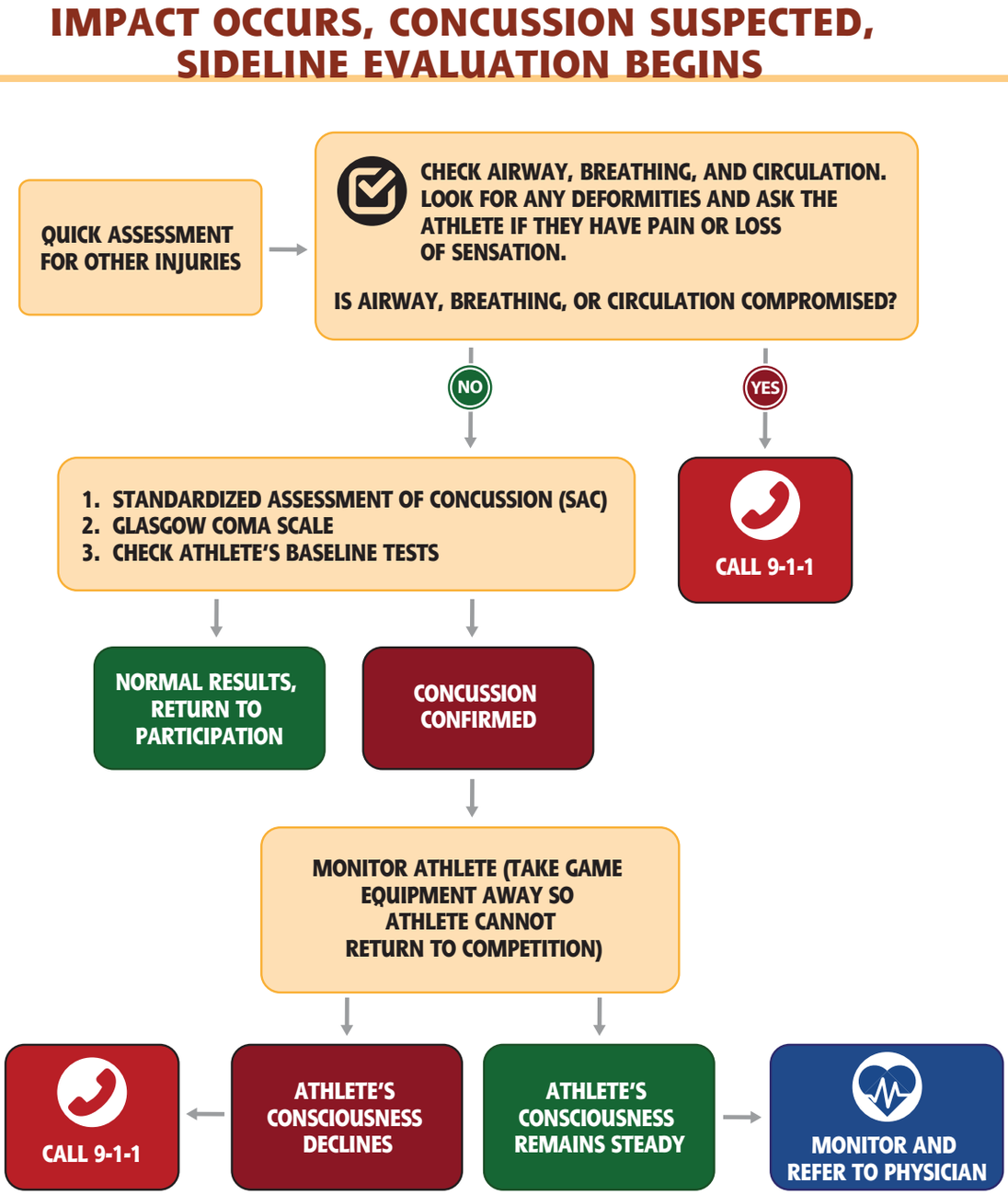

Figure 9.3 Sideline concussion evaluation and process.

may indicate that the athlete may be limited in his capacity to fully return to the classroom.

It has been found that the concussed athlete's brain needs rest to repair the damage (Centers for Disease Control and Prevention 2015). An athlete who returns to the learning environment taxes the injured brain, thus slowing the repair. It is important to follow a progression to allow the healing process to occur.

Nationwide Children's Hospital (2012) uses a five-stage approach to returning the cognitively impaired athlete to school.

Table 9.2 AT Concussion Assessment and Exertion Progression Log

Original assessment		
Return-to-play decisions	**Criteria for return to play**	
Return to play	☐	If athlete had no signs and symptoms of a concussion
Sit out for 15-30 min	☐	If signs and symptoms lasted fewer than 5 min and athlete had no more signs or symptoms and had completed exertional testing
Sit out for rest of game	☐	If athlete had all the signs of a concussion and had any episode of blacking out, can wait to refer but must see physician before return to play
Do not return to play	☐	If athlete was unconscious, call 911 for help

Exertional testing			
Activity	**Pass**	**Fail**	**Comments**
Run	☐	☐	
Jog	☐	☐	
Sprint	☐	☐	
3 broad jumps	☐	☐	
3 sets of 10 vertical jumps	☐	☐	
Figure 8	☐	☐	
Box drills	☐	☐	
Balance drills	☐	☐	
Sport-specific activity, treadmill, elliptical	☐	☐	

Based on McCrea (2001).

1. No school
2. Half day of school with accommodations
3. Full day of school with accommodations
4. Full day of school without accommodations
5. Full day of school and physical activity

The progression through each of these stages depends on how the athlete is improving and functioning. Athletes who have learning disabilities, migraines, or some mental health issues before the concussion may find that it takes longer to recover and thus may progress more slowly through the stages (Centers for Disease Control and Prevention 2015). The physician will determine how quickly the athlete can progress through each of the five stages.

Second-Impact Syndrome

It is thought that damage from concussions and brain injury is cumulative. Therefore, if an athlete is allowed to return to participation before the symptoms of his first concussion have completely subsided and he receives another blow to the head, he can quickly lose brain function and go into a coma. **Second-impact syndrome** can occur when an athlete receives more than one concussion or blow to the head in a relatively short time. Such trauma may disturb the blood supply to the brain and present signs of a minor concussion followed quickly by a semicomatose state. Athletes who have suffered brain injuries must not be allowed to return to participation until they are symptom free and have obtained written permission from a doctor.

The Real World

One afternoon, at 2:35 p.m., our high school dismissed students. My student trainers and I went to work in the training room. It was a fairly busy Monday. My students were preparing athletes for football, soccer, and volleyball, while I was checking a few of the injured athletes. At approximately 2:50 p.m., the athletic director announced over the PA system that I was needed in the parking lot—there had been an accident. By the sound of his voice, I could tell we had a big problem.

I ran out of my training room at full speed. When I hit the doors just outside the athletic office, the athletic director met me, and we ran on together. The accident had occurred at the far end of the parking lot. I surveyed the scene as we approached. Several students were standing around looking at something on the ground. On the right, next to a car, a distraught female student was talking with one of the teachers. I started asking questions as I made my way through the gathering of students. Someone said that a girl had fallen off the hood of the car while it was moving.

The next thing I saw took my breath away. Lying on the ground was a student who had been in my office earlier in the day to arrange for a tutor. She was pale, sweaty, not breathing, and bleeding from her ears, nose, and mouth. I saw a patch of bloody hair on the pavement about 2 feet (.5 m) from us and 8 to 10 feet (2.5-3.0 m) from the car. All I had to do was look at the athletic director, and he got on his radio to his secretary to call an ambulance. Because I suspected both head and neck injuries, I stabilized the student's head and neck. I immediately used the jaw thrust maneuver to open the airway with minimal head movement. When her airway opened, she made a gurgling noise and a bloody froth bubbled from the corners of her mouth. As I continued to stabilize her head and neck, I asked a health teacher, who was at my side, to check the girl's pulse. Her pulse was faint, and her breathing was irregular. She was nonresponsive, and her face was covered with blood. An assistant principal was there with gloves and paper towels, and I had him gently clean her face so I could determine the major source of bleeding. I told the athletic director to keep bystanders back, and I sent the head custodian to the school entrance to direct the ambulance to us. While I was stabilizing the girl's head and neck and maintaining her airway, I was also trying to get a response from her. As we waited for the ambulance, I realized that I did not have gloves on, but it was too late to worry about that. We seemed to wait forever. The girl started to choke, and we had to logroll her just as the ambulance made its way into the parking lot.

I continued to maintain the girl's head and neck while the paramedic checked her vitals. While he was doing this, she became combative. The paramedic got a collar on her, and I fought to maintain her head and neck stability while we put her on the backboard and then the stretcher. The paramedic asked me to ride in the ambulance to continue to maintain her head and neck. I held her head between my forearms while a second paramedic tried to get an IV going. In spite of her restraints, it took several attempts; she was a lot stronger than I ever could have imagined. We were about a block from the hospital when she started to vomit and she aspirated. Now, clearing her airway became the priority. The paramedic yelled at me to grab the suction line as he turned it on. As he was suctioning the bloody vomit from her mouth, I was trying not to vomit on both of them.

We arrived at the emergency room, and I was still maintaining her head and neck. They did a cross-table X-ray, which was negative for cervical spine fracture, and I was allowed to discontinue stabilization. I stayed with the girl in the ER until her parents got there. The doctor told me it was too early to tell how she would be. When I walked out of the ER, I met the athletic director waiting to give me a ride back to school. It was like coming back to the real world. I hadn't even thought about getting back to school or about practice.

The young woman spent two weeks in the ICU being treated for a subdural hematoma. She later returned to school, showing few effects of the injury. I, however, learned that my job extends far beyond the training room—and I always grab a pair of gloves on my way out the door.

Becky Clifton, ATC

Chronic Traumatic Encephalopathy

Repeated trauma to the head can lead to degeneration of the brain entitled **chronic traumatic encephalopathy (CTE)**. CTE is a condition that most often occurs in athletes who participate in contact or collision sports, such as lacrosse, mixed martial arts, boxing, football, rodeo, rugby, and ice hockey.

CTE is sometimes suspected while the athlete is alive when known normal behaviors change. Suicidal thoughts, balance issues, speech difficulty, aggressiveness, loss of memory, dementia, and depression are some signs and symptoms that may occur (Mayo Clinic 2017c; McKee et al. 2009). CTE is not definitively diagnosed until after death when an autopsy is performed on the brain. It is imperative that the AT follow strict guidelines for returning athletes to competition in hopes of preventing CTE.

SUMMARY

Although the brain is well protected by the skull, it is vulnerable to serious injury—the athlete may suffer intracranial bleeding, concussion, postconcussion syndrome, or second-impact syndrome. If the brain lacks oxygen for any appreciable time, cellular death occurs. Typical signs and symptoms of a head injury include vomiting, unequal pupils, skull depression, increased blood pressure, and unconsciousness, any of which call for immediate EMS attention. An athlete who has suffered a head injury must not have any signs or symptoms of the injury and must have clearance from a physician when he returns to participation.

KEY TERMS

Define the following terms found in this chapter:

- amnesia
- battle sign
- cerebrospinal fluid
- chronic traumatic encephalopathy (CTE)
- concussion
- contrecoup
- hematoma
- intracranial hematoma
- neurocognitive testing
- second-impact syndrome
- tinnitus

Go online to the web resource to find quizzes, activities for reinforcement, above and beyond activities, practical skill worksheets, and chapter-specific tasks for the semester-long project.