Concussion
Head Injury

Anyone who watches football on TV has seen incidences of concussion. The player "had his bell rung," the announcer will say flippantly after a particularly violent collision. For years this casual attitude toward concussions was common. Coaches and teammates would urge the injured player to "shake it off" and return to the game after a brief rest.

Fortunately, in the wake of premature retirements of star athletes such as Steve Young after a series of concussions, awareness of the potential seriousness of concussions has risen. Concussions, even mild ones, are not a lighthearted matter. Neurosurgeons and other brain injury experts emphasize that although some concussions are less serious than others, there is no such thing as a "minor concussion."

Prevalence of concussions

Concussions are a common occurrence in sports. More than 300,000 American athletes, most of them in high school or college, sustain concussions or other mild to moderate brain injuries each year, according to the Centers for Disease Control (CDC).

Fully one-third of these brain injuries occurs in football. Reasonable estimates find that from 4 to 20 percent of college and high school football players will sustain a brain injury over the course of one season. The risk of concussion in football is three to six times higher in players with a previous concussion.

Concussions also can occur in car accidents, bicycle mishaps and in falls around the home, especially among toddlers and the elderly. Because a concussion is a jarring of the brain, a healthcare professional needs to be consulted and proper period of rest is necessary. But in most cases a single concussion should not cause permanent damage.

What is a Concussion?

A concussion is an injury to the brain, usually caused by a blow to the head that results in temporary loss of normal brain function. Most people assume that concussions involve a loss of consciousness. Not true. In most cases, the person with a concussion never loses consciousness.

The formal medical definition of concussion is: a clinical syndrome characterized by immediate and transient alteration in brain function including alteration of mental status and level of consciousness, resulting from mechanical force or trauma.

Concussion means a change in mental status. Those with concussions often cannot remember what happened immediately before or after the injury. They may slur their speech or exhibit confusion. Paramedics and football trainers who suspect a concussion ask injured people what year it is or direct them to count backward from ten in an attempt to detect altered brain function.

A concussion can affect memory, judgment, reflexes and muscle coordination. The speech and balance of the injured person may also be impaired.

Confusion is a particular hallmark of concussion. The three principal features of confusion are:

* Inability to maintain a coherent stream of thought
* A disturbance of vigilance with heightened distractibility
* Inability to carry out a sequence of goal-directed movements

The specific symptoms of a concussion include: headache, vision disturbance, dizziness, loss of balance, confusion, memory loss, ringing ears, nausea and difficulty in concentrating. If any of these occur after a blow to the head, a healthcare professional should be consulted.

What is the exact cause of a concussion?

The brain normally floats inside the skull, cushioned gently by the surrounding spinal fluid. The brain consists of a gelatin-like substance, vulnerable to outside trauma. The skull protects the brain against trauma but does not absorb the impact of a violent force.

An abrupt blow to the head, or even a rapid deceleration, can cause the brain to slosh inside the skull and bounce against the inner wall of the skull. There is a potential for tearing of blood vessels, pulling of nerve fibers and bruising of the brain substance.

Sometimes the blow can result in microscopic damage to the brain cells without obvious structural damage visible on a CAT scan. This damage can lead to brain swelling. Since the brain cannot escape the rigid confines of the skull, severe swelling can compress the brain and its blood vessels and limit the flow of blood. Without adequate blood flow, the brain does not receive the necessary flow of oxygen and glucose and can suffer a stroke. Brain swelling after a concussion has the potential to amplify the severity of the injury.A blow to the head also can cause a more serious injury to the brain. A contusion is a bruise of the brain involving bleeding and swelling in the brain. A contusion visible on a CAT scan often implies the brain underwent a greater degree of force than a concussion.A skull fracture occurs when the bone of the skull breaks. Sometimes the broken skull bones cause bleeding or other injuries by cutting into the brain or its coverings.

A hematoma is a blood clot that collects in or around the brain. If active bleeding persists, hematomas can rapidly enlarge. Like brain swelling, the increasing pressure within the rigid confines of the skull due to an enlarging blood clot can cause serious neurologic compromise and even threaten a person"s life. A hematoma can be a surgical emergency. Hematomas that are small can sometimes go undetected initially but cause symptoms and require treatment several weeks later.

The warning signs of a serious brain injury are:

* Lengthy period of unconsciousness
* Altered level of consciousness such as persistent drowsiness
* Long-lasting confusion
* Convulsions
* Repeated vomiting
* Persistent nausea
* Dilated (enlarged) pupils
* Drainage of bloody or clear fluids from the ears or nose
* Seizures
* Muscle weakness on one or both sides
* Walking and speaking abnormalities

* Unusual sleepiness
* Changes in behavior such as irritability

Seek medical help if these warning signs occur.

Three Grades of Concussion

There is no universal agreement on the grades of severity for a concussion. There are at least 16 different guidelines for concussion evaluation and return to play. Most guidelines recognize three different grades of concussions and share similar recommendations for return to play.

The two sets of guidelines most adhered to in the United States were formulated by the American Academy of Neurology and by Robert C. Cantu, MD, Chief, Neurosurgery Service, and Director of Service of Sports Medicine, Emerson Hospital, Concord, Massachusetts. Dr. Cantu has worked for more than 30 years as a neurosurgeon and football team physician.

Grade 1
According to Dr. Cantu, a Grade 1 concussion involves no loss of consciousness but the person suffers from impaired intellectual function, especially in remembering recent events and in assimilating and interpreting new information. Grade 1 concussion occurs most frequently (more than 90 percent of concussions) and often escapes medical attention. It is difficult for a physician on the sideline to recognize the player has sustained a Grade 1 concussion. A teammate often will notice the injured player may lose the snap count or forget what play was called.

According to the American Academy of Neurology (AAN), a Grade 1 concussion involves momentary confusion, no loss of consciousness and the disappearance of concussion symptoms or mental status abnormalities in less than 15 minutes.

Grade 2
A Grade 2 concussion involves loss of consciousness for less than five minutes or a period of post-traumatic amnesia that lasts more than 30 minutes but less than 24 hours.

According to the AAN, a Grade 2 concussion involves momentary confusion, no loss of consciousness and concussion symptoms or mental status abnormalities that last more than 15 minutes.

Grade 3
A Grade 3 concussion involves a loss of consciousness longer than five minutes or post-traumatic amnesia that lasts longer than 24 hours.

According to the AAN, a Grade 2 concussion involves momentary confusion, no loss of consciousness and concussion symptoms or mental status abnormalities that last more than 15 minutes.

Surgical lesions

When discussing head-injured patients, neurosurgeons often use the term "mass lesion", which refers to an area of localized injury that may cause pressure within the brain. The most common mass lesions seen after TBI are hematomas and contusions.

A hematoma is a blood clot within the brain or on its surface. A contusion may be thought of as an area of "bruised" brain. When examined under a microscope, cerebral contusions are comparable to bruises in other parts of the body. They consist of areas of injured or swollen brain mixed with blood that has leaked out of arteries, veins, or capillaries.

Hematomas and contusions can occur anywhere within the brain. Those hematomas between the skull and the dura, which is a thick membrane that surrounds the brain, are called epidural hematomas.

Contusions are seen most commonly at the base of the front parts of the brain, but they can occur anywhere.

Subarachnoid hemorrhage appears as diffuse blood spread thinly over the surface of the brain. This is seen commonly after head injury. If this is the only abnormality present on a CT scan, then observation for a short period may be the only treatment needed.

Diffuse injuries

The hematomas and contusions described above generally occur in only one or a few specific parts of a patient's brain, and they are usually easily seen on a computerized tomography (CT) scan. However, TBI can also produce microscopic changes that cannot be seen on CT scans and that are scattered throughout the brain. This category of injuries is called diffuse brain injury, which can occur with or without an associated mass lesion.

One type of diffuse brain injury is diffuse axonal injury. This refers to impaired function and gradual loss of some axons, which are the long extensions of a nerve cell that enable such cells to communicate with each other even if they are located in parts of the brain that are far apart. If enough axons are injured in this way, then the ability of nerve cells to communicate with each other and to integrate their function may be lost or greatly impaired, possibly leaving a patient with severe disabilities.

Another type of diffuse injury is ischemia, or insufficient blood supply to certain parts of the brain. It has been shown that a drop in blood supply to very low levels may occur commonly in a significant percentage of head-injured patients. This is important because a brain that has just undergone a traumatic injury is especially sensitive to even slight reductions in blood flow. For the same reason, changes in blood pressure during the first few days after head injury can have an adverse effect.

Skull fractures

No treatment is required for most linear skull fractures, which are simple breaks or "cracks" in the skull. Of greater concern is the possibility that forces strong enough to cause a skull fracture may also have caused some damage to the underlying brain. Fractures of the base of the skull are worrisome if they cause injury to nerves, arteries, or other structures. If a fracture extends into the sinuses, there may be leakage of cerebrospinal fluid (CSF) from the nose or ears. Most such leaks will stop spontaneously. Sometimes, it may be necessary to insert a lumbar drain, which is a long, thin, flexible tube that is inserted into the CSF space in the spine of the lower back. This provides an alternate route of CSF drainage so that the dural tear that is responsible for the CSF leak in the base of the skull has time to seal.

Depressed skull fractures are those in which part of the bone presses on or into the brain. These may require surgical treatment. The damage caused by depressed skull fractures depends upon the region of the brain in which they are located and also upon the possible coexistence of any associated diffuse brain injury.

Assessment

Like all trauma patients, persons with head injury need a systematic yet rapid evaluation in the emergency room. Cardiac and pulmonary function are the first priority. Next, a rapid examination of the entire body is performed.

Neurological examination

An accurate neurological examination is important to categorize the severity of a patient's injuries and to plan further evaluation and possible treatment. The standard for objectively assessing the severity of head injury is the Glasgow Coma Scale (GCS). This scale assigns points to each patient based upon three categories: verbal function, eye opening, and best motor (movement) response. Patients with a GCS score of 13-15 are usually classified as having mild head injuries. Those with a GCS score of 9-12 have moderate head injuries, and those with a score of 3-8 are usually described as having severe head injuries. Any patient who is not obeying commands (for example, to follow instructions to hold up two fingers) is also often considered to have a severe head injury, even if the GCS score may be slightly higher than eight.

In addition to the GCS, the ability of the pupils to become smaller in bright light is also important after head injury. In patients with large mass lesions or with high intracranial pressure (ICP), one or both pupils may be very wide or "blown". The presence of a wide, or dilated, pupil on only one side suggests that a large mass lesion may be present on the same side as the dilated pupil.

Radiologic assessment

CT scanning is the gold standard for the radiologic assessment of a head-injured patient. A CT scan is easy to perform and is an excellent test for detecting the presence of blood and fractures, which are the most important lesions to identify in emergency situations. Plain x-rays of the skull are recommended by some people as a way to evaluate patients with only mild neurologic dysfunction. However, most centers in the United States have readily available CT scanning, which is a more accurate test. For this reason, the routine use of skull x-rays for head-injured patients has declined.

Magnetic resonance imaging (MRI) is not commonly performed for acute head injury because it takes longer to perform an MRI scan than a CT scan, because MRI is not as useful as CT for acute trauma, and because transporting an acutely injured patient from the emergency room to the MRI scanner is difficult. However, after a patient has stabilized, MRI may demonstrate the existence of lesions that could not be detected by CT. Such information is generally more useful for determining prognosis than for influencing treatment.

Treatment

The standard treatment for concussion is rest. For a headache, acetaminophen (Tylenol) can be taken. Post-concussive headaches are often resistant to stronger narcotic based medications. Most one-time concussions are mild and result in no long-term damage to the brain.

Surgery

Many patients with moderate or severe head injuries are taken directly from the emergency room to the operating room. In many cases, surgery is performed to remove a large hematoma or contusion that is significantly compressing the brain or raising the pressure within the skull. After surgery, these patients are usually observed and monitored in the intensive care unit (ICU).

Other head-injured patients may not go to the operating room immediately, but instead are first taken from the emergency room to the ICU. However, contusions or hematomas may enlarge over the first hours or days after head injury, so that some patients are not taken to surgery until several days after an injury. Sometimes these delayed hematomas are discovered when a patient's neurologic exam worsens or when the ICP increases. On other occasions, a routine follow-up CT scan that was ordered to see if a small lesion has changed in size indicates that the hematoma or contusion has enlarged significantly. In many of these cases, removing the lesion before it enlarges and causes neurologic damage may be safest for the patient.

Medical

At the present time, there is no drug or "miracle treatment" that can be given to prevent nerve damage or promote nerve healing after TBI. The best treatment that can be performed in an ICU is to prevent any secondary injury to the brain. The "primary insult" refers to the initial trauma to the brain, whereas a "secondary insult" is any subsequent development that may contribute to neurologic injury. For example, as mentioned above, an injured brain is especially sensitive and vulnerable to decreases in blood pressure that might otherwise be well tolerated. Thus, one way of avoiding secondary insults is to try to maintain the blood pressure at normal or perhaps slightly elevated levels. Likewise, increases in ICP, decreases in blood oxygenation, increases in body temperature, increases in blood glucose, and many other disturbances can potentially worsen neurologic damage. Thus, the prevention of secondary insults is a major part of the ICU management of head-injured patients.

Various monitoring devices may assist the physicians in caring for the patient. Placement of an ICP monitor into the brain itself can help detect excessive swelling of the brain. One commonly used type of ICP monitor is a ventriculostomy, which is a narrow, flexible, hollow catheter that is passed into the ventricles, or fluid spaces in the center of the brain, to monitor ICP and also to drain CSF if the ICP increases. Placement of an oxygen sensor into the jugular vein can detect how much oxygen is in the blood that is coming from the brain and in this way can give an indication of how much oxygen the brain is using. This may be related to the degree of brain damage. Many other monitoring techniques are currently under investigation to see if they can help to improve outcome after head injury or provide other critical information about caring for these patients.

When an Athlete Suffers a Concussion

The question of when an athlete who suffers a concussion can return to the game depends on the severity of the injury. According to Dr. Cantu, an athlete who suffers a Grade 1 concussion may return to the game if he or she is asymptomatic at rest and exertion within 20 minutes of the injury. If post-concussion symptoms persist for more than 20 minutes, an athlete should be withheld from competition until free of symptoms at rest and exertion for at least one week.

A second Grade I concussion mandates removal from competition for at least two weeks, and return is permissible only if the athlete is asymptomatic during rest and exertion for at least one week.

If headache or other associated symptoms either worsen in the first 24 hours or persist longer than a week, a CT scan is recommended.

Three Grade 1 concussions should end a player"s season.

Following a Grade 2 concussion, an athlete may return to competition in a week if he or she feels no symptoms either during rest or exertion. After a second Grade 2 concussion, return to play should be deferred for at least a month and termination of the season should be considered.

After a Grade 3 concussion, the athlete must not be allowed to play for at least a month. Return is allowed only if the athlete has felt no symptoms during rest or exertion for at least a week. Two Grade 3 concussions should end a player"s season.

According to the AAN, athletes who suffer a Grade 1 concussion during a sports competition may return to play after 15 minutes if they show a complete recovery (no symptoms at rest or with exertion). The injured player should be examined immediately and at five-minute intervals until the symptoms disappear.

A second Grade 1 concussion in the same game should result in the player leaving the game for good. Before the player can return to competition, he or she should show no symptoms at rest and exertion for a week and undergo a neurologic exam.

A player who suffers a Grade 2 concussion should be not allowed to play again that day. The player should be examined at frequent intervals. A trained person should re-examine the player the next day. Before the player can return to competition, he or she should show no symptoms at rest and exertion for a week and undergo a neurologic exam.

A player who suffers a second Grade 2 concussion should show no symptoms at rest and exertion for two weeks and undergo a neurologic exam.

A player who suffers a Grade 3 concussion should be taken by ambulance to the nearest emergency department if still unconscious or if worrisome signs are detected. A thorough neurologic exam should be performed promptly and admission to the hospital should be done if signs of pathology are detected or if the player"s mental status remains abnormal.

A player who suffers a Grade 3 concussion should not return to play until he shows no symptoms at rest and exertion for two weeks and undergoes a neurologic exam. A second Grade 3 concussion should mean a rest of at least one month.

Post-concussion Syndrome

People who suffer a head injury may suffer from poor memory and concentration, headache, fatigue and dizziness for weeks or months. This is known as post-concussion syndrome. Athletes should not return to play while experiencing these symptoms. Players who suffer repeated concussions should consider ending participation in the sport.

Second Impact Syndrome

Athletes who return to play too soon after a head injury are in danger of serious harm and even death. Second Impact Syndrome occurs when an athlete who suffers a mild head injury returns to play before the brain has fully healed and incurs a relatively minor second hit. The result can be a rapid, catastrophic increase in pressure within the brain. The athlete may suffer paralysis, mental disabilities and epilepsy or death.
The CDC reports an average of 1.5 deaths per year from sports concussions. In every case, a concussion, usually undiagnosed, had occurred prior to the final one.

Avoiding Head Injuries

To avoid head injury, take these precautions:

* Players should always wear appropriate safety gear when participating in sports and recreational activities.
* Make sure the playing surface is conducive to safe play. The ground surface should be soft and free of debris, rocks, holes and ruts.

Parents should select leagues and teams that have the same commitment to safety as they do. Make sure the team coach has had training in first aid and CPR.