Concussion: A Review and Update

M. Shane Phillips, MD • American Sports Medicine Institute

Concussion continues to be an important and “hot topic” in sports medicine today. It has been estimated that up to 300,000 sports-related concussions occur each year. In the past, data on concussions, as well as management and treatment guidelines, have been mostly derived from head trauma secondary to motor-vehicle accidents. Medical staff who work with athletes are often faced with the difficult task of using this information and applying it to their athletes. Today, sports-medicine physicians, neuropsychologists, and athletic trainers are all contributing to research that is enabling better recognition of concussions and more scientifically sound return-to-play criteria for athletes. Some of the most important aspects of participating in the care of an athlete with a concussion are to ensure individualized management of the athlete and accurate communication among members of the athletic medical staff.

Concussion is derived from the Latin word concussus, which means to shake violently. One of the early definitions of concussion was from the Congress of Neurological Surgeons in 1966, which stated, “concussions are a clinical syndrome characterized by the immediate and transient post-traumatic impairment of neural function such as alteration of consciousness, disturbances of vision or equilibrium due to brainstem involvement.” Since then, many medical associations have developed definitions of concussion that are related to their particular fields. In an attempt to develop a relationship between athletics and concussion, the Canadian Academy of Sports Medicine in 2001 defined concussion as “any direct hit to the head that causes a change in behavior, awareness and/or physical feeling.” This definition places less emphasis on loss of consciousness and allows for the more subtle findings that might be seen in milder concussions such as “bell-ringers.”

There have been several different proposed mechanisms for the cause of a concussion. An acceleration or deceleration (linear) injury occurs when the individual’s body and head are traveling at a particular speed and strike a solid object or when the object is traveling and strikes the individual’s head. Rotational (angular) injury and impact-loading injuries have also been suggested as mechanisms that might cause a concussion. Research on the pathophysiology of concussions is generating new information that might help the medical staff responsible for caring of athletes. It is now believed that after a concussion, the surviving brain cells are in a period of enhanced vulnerability. Developing tests to determine the amount of time the brain cells are vulnerable to further injury would help in the decisions for return to play, as well as possibly help prevent postconcussion complications such as second-impact syndrome.

Diagnosing a concussion can often be a difficult task because of the subtlety of the signs and symptoms and the reluctance of players to report symptoms to the medical staff for fear that they will be removed from the game. A list of the signs that might be observed by the medical staff is included in the sidebar at right. It is important to closely observe the athletic event because the only clue to injury might be a forgotten play or confusion about an assignment. There are also a wide variety of symptoms the athlete might report to the medical staff (see sidebar at far right). The classic symptoms include loss of consciousness, headache, memory loss, and feeling “foggy.” Because there are at least 25 different grading scales and confusion and lack of consensus surrounding them, accurately describing the signs and symptoms to other members of the medical staff is more important than assigning a particular grade to the concussion. This can help eliminate confusion among individuals who have been trained in or are more familiar with certain grading scales.
Most of the newer developments in concussions deal with more accurate diagnosis and return-to-play criteria. The Maddocks questions and the Standardized Assessment of Concussion (SAC) were developed to provide medical staff with a brief, objective tool for assessing an athlete’s orientation, immediate memory, concentration, and delayed recall after a concussion. The SAC requires approximately 5 min to administer and is designed for use by nonneuropsychologists. A preseason test is given to establish a baseline score for each athlete. Players suspected of having sustained a concussion are then readministered the SAC on the sideline immediately after the injury to determine the immediate neurocognitive effects of the injury and then at various follow-up points to track postinjury recovery.

An additional tool in diagnosing and managing concussion is postural-stability testing. It has been demonstrated that increases in postural sway can follow an acute mild head injury. In an attempt to provide a cost-effective and quantifiable method of assessing balance in athletes, the Balance Error Scoring System (BESS) was developed by researchers at the University of North Carolina. This test is also designed to be performed on the sideline, with the use of only a stopwatch and a 10-cm-thick piece of medium-density foam. Testing involves three different stances completed twice, once each on a firm surface and once each on the foam, for a total of six 20-s trials. Performance is scored on an error-point system, with a standard maximum error score of 10. Follow-up testing can help in monitoring postinjury recovery.

Neuropsychological testing has also become an important adjunct tool in diagnosing and managing concussions. In the past, many factors such as cost of the testing, time needed for testing, and availability of a neuropsychologist to interpret the tests have prevented large-scale testing of athletes. Recently, a computerized neuropsychological test battery was developed specifically for assessing sports-related concussions. The program consists of a self-reported symptom questionnaire and concussion-history form preceding the neuropsychological test. The computer program measures multiple aspects of cognitive functioning in athletes, including attention span, working memory, sustained and selective attention time, response variability, and several dimensions of memory. As a whole, it takes approximately 20 min to complete, and follow-up testing at regular intervals will allow for more accurate determination of recovery from the concussion.

Although most athletes who experience concussions have uneventful recoveries, there are a number who experience chronic cognitive and neurobehavioral symptoms. A postconcussion syndrome might be seen in an athlete who sustains repeated concussions.

### Signs Observed by Medical Staff

- Dazed appearance
- Vacant facial expression
- Confusion about assignment
- Forgetting plays
- Disorientation to game, score, opposing team
- Inappropriate emotional reaction
- Being easily distracted
- Incoordination or clumsiness
- Slowness in answering questions or following instructions
- Loss of consciousness
- Slurred or incoherent speech
- Any change in typical behavior or personality

### Symptoms Reported by Athlete

- Headache
- Nausea
- Balance problems or dizziness
- Double or fuzzy vision
- Sensitivity to light or noise
- Feeling slowed down, “foggy,” or “not sharp”
- Easy fatigability
- Change in sleep pattern
- Concentration or memory problems
- Irritability
- Sadness
- Anxiety
- Feeling more emotional