Return to Play and Training After Concussion

by Gregory R. Waryasz, M.D., C.S.C.S., and Robert Tambone, M.S.

LEARNING OBJECTIVES

The aim is to define what a concussion is in addition to other common head injuries. The return to play guidelines for concussion are reviewed and discussed.

Key words:
Head injury, Training, Traumatic Brain Injury, Second Impact Syndrome, Postconcussion Syndrome

The risk of concussive injury and other forms of head trauma is a forefront topic among athletes, coaches, physicians, athletic trainers, personal trainers, and athletic organizations throughout all levels of play. A concussion is a complex pathophysiological process resulting from traumatic impact to the cranial region and has no findings on basic imaging studies. The trauma can occur directly to the cranium or can result from indirect trauma, with resultant forces to the head. Although relatively common off the field, the topic of concussion remains specifically germane to high-contact sports, particularly football and ice hockey. People suffer concussions in the general population from motor vehicle accidents, falls, altercations, and a variety of other types of trauma.

Epidemiological findings conducted by the National Football League (NFL) have shown no significant changes in the incidence rate of concussions among the organization’s athletes. There have been more than 750 documented concussion cases in almost 2,000 completed games during the 2002 to 2007 NFL seasons (3). The concussion rate in high school sports has increased since the late 1990s in all sports. The highest concussion rates in high school sports were seen in football, but a comparable concussion rate was seen between men’s and women’s sports (8). Currently, there are no helmets, protective equipment, or mouth guards that are proven to prevent concussions (7).

HEAD TRAUMA IN ATHLETES AND THE GENERAL POPULATION

Head trauma for athletes and other individuals is not limited to concussion. A wide array of neurophysiologic impairments may be attributed to sports-related head injury and other forms of trauma. The dura mater and arachnoid mater may be subject to laceration and tearing, leading to damage of exposed cranial vessels that express fluid into the intracranial region or even the intraparenchymal (cerebral) space. Such injuries lead to an increased intracerebral pressure (ICP) that may progress to cerebral swelling, cerebral hematoma, or even death.

An epidural hematoma occurs when there is an injury to an artery superficial to the dura leading to an accumulation of blood between the dura and skull. The classic injury is to the middle meningeal artery or vein leading to the computed tomographic scan finding of a biconvex hematoma (1). Most athletic subdural...
hematomas occur acutely and are caused by stretching and tearing of the subdural veins, but subdural hematomas also can occur chronically (1). The subarachnoid hemorrhage is a bleed that occurs in the subarachnoid space and commonly develops from ruptured aneurysms or trauma. Intraparenchymal hemorrhage or intracerebral hemorrhage can result from trauma and may lead to widespread brain damage. Most of these cerebral contusions occur as a result of acceleration-deceleration mechanisms, with a transient compression of the brain against the skull (1).

Diffuse axonal injury (DAI) is a condition that results from trauma and can lead to significant neurological impairments. DAI is a shear injury of the white matter fiber tracts. These tracts course from the cortex to the midbrain and brainstem. The characteristic imaging findings are small areas of hemorrhage that represent the disruption of the axons along the neuroaxis (1).

A mechanism may be sufficient enough to cause concussion without causing intracranial bleeding. A concussion may be classified as a complex pathophysiological process resulting from traumatic impact to the cranial region. It can be caused by direct contact or indirect injury to the head, face, or neck and often results in short-lived neurodegenerative impairment, such as mild amnesia or confusion. Resolution of the graded clinical symptoms of concussion generally follows a sequential course. However, many children and adolescents rectify concussive injuries during prolonged periods. Finally, concussions do not appear with characteristic imaging findings are small areas of hemorrhage that represent the disruption of the axons along the neuroaxis (1).

CLASSIFYING CONCUSSIONS

There is no general consensus on the best way to classify a concussion. Classifications have been made to help assist with standardizing management strategies, but they have several flaws. The last Concussion in Sport 3rd International Conference in Zurich 2008 recommended that clinicians stop using classification systems because they are not supported by high-level evidence (9). The Team Physician Consensus Statement from 2011 in Medicine & Science Sports & Exercise emphasizes the importance of a comprehensive history of the concussion, risk factors that can affect recovery, return to play decision making, and characteristics of the specific sport and patient. These factors impact the recovery process of the concussion. The important event history includes the number of concussions, type of impact, loss of consciousness duration, proximity, and severity. The total number of symptoms along with severity of each symptom can factor into the expected recovery. Patient age and preexisting conditions also can alter recovery. Typically, younger patients recover more slowly than adults. Furthermore, patients with preexisting neurological or psychiatric disorders, including depression, migraines, anxiety, attention deficit disorder, and cognitive disabilities, recover slowly as well (7).

CONCUSSION SYMPTOMS

The athletic trainer, personal trainer, group exercise instructor, and other coaches caring for athletes need to recognize symptoms of concussion. Many athletes and participants will not recognize the link between symptoms and a possible concussion. Return of any symptoms during physical activity will cause an athlete to have to reduce his or her current level of physical activity. Coaches can talk to the athlete either after a workout or on the practice field to see if the athlete developed symptoms. Symptoms include, but are not limited to, slurred speech, dizziness, vomiting, photophobia, phonophobia, listlessness, irritability, depression, and worsening headache (Table 1). Any athlete who exhibits any symptoms of concussion should be removed immediately from practice, strength training, or competition. If there is any doubt, the athlete should be sat out until complete resolution of any symptoms.

NEUROCOGNITIVE TESTING

Scientists have been focusing on neurocognitive testing to help determine when athletes may be ready to return to play after a concussion. Neurocognitive testing only is an adjunct to help with return to play; ultimately, athletes must be symptom-free before return to sport. These tests play only an initial part in the determination of when an athlete can safely return to play. There are a few commercially marketed tests available

<table>
<thead>
<tr>
<th>TABLE 1: Signs/Symptoms of Concussion</th>
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<tbody>
<tr>
<td><strong>Headache</strong></td>
</tr>
<tr>
<td>Dizziness</td>
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<tr>
<td>Dizziness</td>
</tr>
<tr>
<td>Dizziness</td>
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<tr>
<td>Vacant stare</td>
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<tr>
<td>“Don’t feel right”</td>
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<tr>
<td>Insomnia</td>
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Patients with concussion can have a variety of symptoms; some of the common symptoms are listed in this Table (2,5).
for purchase, including ImPACT (Immediate Postconcussive Assessment and Cognitive Testing), ANAM, Cogstate Sport, and HeadMinder. One method called ImPACT has been used to establish a baseline for high school and college athletes in high-contact sports (4). ImPACT and other neurocognitive testing measure an athlete’s working memory, attention span, variability in test responses, problem solving, reaction time, and attention time. Nationwide norms have been created in these neurocognitive tests to establish a baseline among athletes, and then testing was readministered to see how to reintroduce athletes to play. After the player’s baseline was established, information on postconcussive procedure and results would be documented to provide relevant information to improve the future standard. Of paramount importance is the fact that neurocognitive tests attempt to better understand proper standards for return to play in an attempt to avoid the potential for catastrophic injury associated with postconcussive impact. Commercially available neurocognitive tests are marketed to be used in conjunction with clinical examination and other medical tools and will not stand alone for diagnosis and management of concussive injury. These tests are important to help determine when an athlete is not being completely truthful about symptoms to attempt to return to play before the athlete is back at his/her cognitive baseline.

**HEAD INJURY PATHOPHYSIOLOGY AND SECOND IMPACT SYNDROME**

Second impact syndrome is a phenomenon marked by diffuse brain swelling that can lead to death. This injury occurs in the absence of a hematoma as a result of a second impact after a concussive event. Return to play guidelines have been implemented to help prevent worsening of symptoms after concussion, a second concussion, and finally second impact syndrome. All people postconcussion are at risk for worse head injury if they return to full activity too early. Head injury leads to altered autoregulation of blood vessels and a release of stress catecholamines. The combination of the body’s inability to autoregulate blood flow to the brain with increased catecholamine release can lead to engorgement of the brain and, eventually, death (11).

**RETURN TO PLAY**

Cognitive and physical rest after a concussion is important to help reduce symptoms and expedite recovery. The return to play criteria (Table 2) were developed for patients with only a concussive type of mild traumatic brain injury. During the acute phase of concussion, athletes should not take part in any physical activity until asymptomatic at rest. Furthermore, athletes may need to stop playing video games, using the computer, watching television, texting, reading, and school work. Most athletes may have to be out of school just a few days, but many require days, weeks, or months before a full recovery. Conservative return to activities is important because cognitive and physical rest helps alleviate concussive symptoms.

When an athlete becomes asymptomatic, he or she can start light aerobic activity, including walking, swimming, or riding the exercise bike. As long as the athlete remains asymptomatic, he or she can progress to light sport-related drills. The next progression is to more complex drills for sports and light resistance training. At this point, an athlete can be evaluated by a physician to obtain medical clearance to return to practice. If the athlete is able to tolerate practice, then he or she can return to competition (6). The progression between phases requires a minimum of 24 hours at each stage.

If at any time during the progression, the athlete develops symptoms, the athlete needs to reduce the type of activity to the lower stage and remain there until asymptomatic for at least 24 hours. When in doubt, it is safer to sit the athlete out of physical activity or reduce the type of physical activity. A general timetable for return to competition is approximately 7 to 10 days after concussive symptoms have

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activity Allowed</th>
<th>Examples</th>
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<tbody>
<tr>
<td>1</td>
<td>No activity</td>
<td>Physical and cognitive rest</td>
</tr>
<tr>
<td>2</td>
<td>Light aerobic</td>
<td>Walking, swimming, stationary cycling (70% maximum heart rate)</td>
</tr>
<tr>
<td>3</td>
<td>Sport specific</td>
<td>Sport drills but no head impact or physical contact</td>
</tr>
<tr>
<td>4</td>
<td>Noncontact training drills</td>
<td>Complex drills, light resistance training</td>
</tr>
<tr>
<td>5</td>
<td>Full-contact practice</td>
<td>Normal training (after cleared by physician)</td>
</tr>
<tr>
<td>6</td>
<td>Return to play</td>
<td>Normal activities</td>
</tr>
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General accepted guidelines/criteria for a stepwise progression to return to play (6).
The 7 to 10 days correspond to a progression of about 1 day per stage.

The current return to play guidelines do not address high-level training methods common in strength and conditioning programs. Athletes should return to normal resistance training and conditioning programs before they are allowed to return to competition. It is possible that an athlete can be asymptomatic with a game-level intensity practice, but not be asymptomatic from a heavy resistance training session. The current guidelines do not address progression through a strength training program. For increased safety, an athlete should be asymptomatic after a normal resistance training session and running/agility workout before being able to return to competition. Athletic trainers and coaches should advocate that Stage 5 should include full return to training activities in the weight room and with running activities.

Practical guidelines for progression through a strength and conditioning program would start with light stationary cycling, swimming, or treadmill walking and progress with intensity toward near at least moderate to heavy strength intensity. Stage 2 or light aerobic would include treadmill walking, swimming, or stationary cycling to only 70% of maximal heart rate. Stage 3 or sport-specific activities could include stretching or simple agility drills. Resistance training can start at Stage 4 with either simple closed or open kinetic chain exercises at a lighter intensity at a lower intensity somewhere approximately 70% of a training max. Stage 5 would include a progression through periodization to moderate to heavy intensity or greater than 80% of a training max during activities. Exercises that require significant coaching or technique monitoring should not be resumed until at least Stage 5. At a time when the athlete would be doing full-contact practice, the athlete also should be able to resume any plyometrics and Olympic lifts at a moderate to heavy intensity. By the time an athlete is ready to return to play, the athlete should be doing the same strength and conditioning activities as the rest of the team or what they would have been doing if the concussion had not occurred. Return to full strength and conditioning activities would correlate to Stage 6.

Safety in resuming strength and conditioning activities can be enhanced by recording training maximum values to help

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**FEATURED BOX**

In the general population, people who have had motor vehicle accidents or other traumatic events often are diagnosed with a concussion. These people may or may not have sought out medical attention for the symptoms they have. They may try to go back to their group exercise sessions or personal training sessions and not follow the correct stepwise progression. The postconcussive individual may seek advice from personal trainers and group exercise instructors. These individuals need to follow the same steps as competitive athletes.

- **Stage 0** is still no activity to support physical and cognitive rest.
- **Stage 1** would be 70% maximal heart rate activity with minimal cognitive effort, such as swimming, walking, elliptical, or cycling.
- **Stage 2** would incorporate an increased amount of cognitive effort and an increase in maximal heart rate. The equivalent of sport-specific drills to the noncompetitive athlete would be increasing maximal heart rate to 75% or 80%.
- **Stage 3** would incorporate light resistance training and more complex drills. People could try to do a resistance machine circuit and less intense group exercise activities. Some people could try a few minutes of yoga or spinning class but know that they should not complete a full class because they need to be eased back into these activities slowly. Certain yoga poses should be avoided, but breathing activities and simple stretches would be a good start for people to ease back into activity.
- **Stage 4** would allow for a return to general classes but less duration of time. People could resume Zumba, aerobics, boot camps, and other more intense classes for part of the class but be aware not to overexert themselves. Breaks in activity would be encouraged. Personal training sessions could resume at a lighter intensity with built-in breaks to allow rest.
- **Stage 5** would include more intense resistance training classes like CrossFit, kettle bell training, and other classes that include Olympic lifts and plyometrics. People probably should participate in only part of the class and then gradually work back toward resuming an entire class.
- **Stage 6** would include participation in an entire class. Personal training at this stage would have no restrictions but generally only be at a moderate to moderate heavy intensity or Stage 5 with progression to heavy intensity or Stage 6.

As with competitive athletes, if people become symptomatic, the person would have to go back a stage and work his or her way back through the progression of the stages.
determine what light-, moderate-, moderate-heavy-, and heavy-intensity values would be for an athlete. Athletes need to display that they can perform a near-maximal effort before being able to be considered completely recovered. In the published return to play model, it was possible to not have had a significant physical test before returning to competition. Stage 5 could have been a practice that does not mimic the intensity of the actual competition. Strength and conditioning programs can more easily reproduce higher level physical stresses in a more controlled environment to ensure that athletes are recovered from the concussion. This may occur when the athlete comes on a heavy or near-maximal weightlifting week. It would be possible for the athlete to develop symptoms at this stage and need to be reevaluated by a physician before participating in competition or other Stage 6 activity.

The safety of performing resistance training is not well established with regard to safety postconcussion. Until clear guidelines are well established, athletes also should have to be back to the baseline strength and conditioning or overall training program before being able to return to competition. Theoretically, this could delay return to play as increased intensity resistance training sessions could cause an athlete to become symptomatic because of the combination of valsalva and resistance training.

**POSTCONCUSSION SYNDROME**

Symptoms of dizziness, headache, and confusion have been known to last for months after concussion. This continuation of symptoms comprises postconcussion syndrome, an exacerbation of the psychological and cognitive symptoms of concussion prolonged during an extended period of time with an unknown underlying mechanism. Postconcussion syndrome often is misdiagnosed because its symptoms often coincide with several other disorders and because it tends to be aggrivated by previous psychological impairments (10).

**References**


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**CONDENSED VERSION AND BOTTOM LINE**

Safe return to competition after a concussion involves a stepwise progression through a variety of gradual increases in physical activity level. Athletes and other postconcussive individuals must be asymptomatic with a step of physical activity before being able to progress to the next level. The same return to play criteria also must be applied to a strength and conditioning or general program to allow for a safe return to all activities. There should never be same-day return to play or full-intensity activity after a concussion.