

# Sports-Related Concussion: Assessment, Management, and RTP

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The perspective of the orthopedic physician on assessing and managing sports-related concussions (SRCs) was provided by Cindy J. Chang, MD, University of California–Berkeley, Berkeley, California, USA.

A concussion is a mild brain injury that has potentially serious consequences if it is not managed appropriately. This message must be stressed to the athlete. Short- and long-term mental and physical health and safety issues include altered athletic performance, postconcussion syndrome (PCS), second-impact syndrome (SIS), and chronic traumatic encephalopathy (CTE).

PCS is associated with a range of physical and cognitive symptoms after a traumatic head injury, including depression and migraines. Symptoms are functional and also may represent psychological or emotional sequelae of the injury. Some of these symptoms are subjective, and some are objective (Table 1). Most initial concussion symptoms resolve in ~7 days, but 10% of athletes may take weeks to months to recover [McCrea M et al. *JAMA* 2003]. Of note, remaining asymptomatic after a concussion is an integral part of all return-to-play (RTP) criteria.

A potential catastrophic consequence of repeat head injury before full recovery from an initial concussion is SIS. Rapid cerebral edema ensues after the second injury because of the loss of autoregulation of cerebral blood flow. While it is difficult to determine the exact prevalence and incidence of SIS, head injury research has produced clear evidence that a severe first-impact head injury leads to rapid and often fatal brain edema. It is possible that a mild concussion, followed by any second stress-inducing injury, might produce the same devastating results [Wetjen NM et al. *J Am Coll Surg* 2010]. CTE appears to be correlated with total brain trauma and may progress to dementia. The average age at onset is 43 years, and the average age at death is 54 years [McKee AC et al. *J Neuropath Exp Neurol* 2009]. The first symptoms include cognitive impairment (short-term memory impairment), behavioral problems (including loss of impulse control), and emotional disorders (depression).

Assessment of an SRC comprises a history and physical examination, including a focused neurologic examination. The Sports Concussion Assessment Tool–3rd Edition (SCAT3) is a standardized approach for medical professionals to assess an athlete with a suspected SRC (Table 2), and the Child SCAT3 is available for children aged 5 to 12 years.

The most important predictors of the severity of the injury are the nature and duration of symptoms, yet these are difficult to use to predict RTP, stated Dr. Chang. Memory difficulty is a better predictor of injury severity than loss of consciousness (LOC), although she noted that asking about LOC is important for educating the athlete and family that only 10% of SRCs involve LOC. Furthermore, rather than ask a yes-no question, such as “Do you have a headache?” she suggests asking “Where does your head hurt?” and “How bad is your headache on a scale of 1 to 10?”

Data collected from more than 2900 college football players suggest a dose-response relationship for the risk of a recurrent SRC, with rate ratios for a repeat concussion of 1.4, 2.5, and 3.0 associated with 1, 2, and  $\geq 3$  previous concussions, respectively [Guskiewicz KM et al. *JAMA* 2003]. After a first concussion, 6.5% of athletes suffer a repeat concussion, and 92% of repeat concussions occur within 10 days of the first concussion, which is thought to be related to impaired cerebral blood flow during this time frame. Furthermore, a history of concussions is associated with an increased likelihood of LOC, increased symptom scores, and increased symptom duration with a recurrent injury.

Imaging studies, neuropsychological testing (NPT), and balance tests are additional tools to evaluate SRCs. Imaging studies are recommended when there is a prolonged disturbance of the

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**Table 1. Symptoms of Postconcussion Syndrome**

Subjective	Objective
Headache	Deficit in sustained attention and concentration
Dizziness	<ul style="list-style-type: none"> <li>Unable to concentrate in class</li> </ul>
Vertigo	<ul style="list-style-type: none"> <li>Unable to complete homework or reading assignments</li> </ul>
Nausea	Deficit in rapid assimilation of new material
Blurred vision	<ul style="list-style-type: none"> <li>Unable to recall new information that was presented in class</li> </ul>
Noise and light sensitivity	<ul style="list-style-type: none"> <li>Forgetful in activities of daily living</li> </ul>
Fatigue	
Problems sleeping	
Tinnitus	
Problems with balance or coordination	
Irritability	

**Table 2. Components of the Sports Concussion Assessment Tool–3rd Edition**

Glasgow Coma Scale
Maddocks score (sideline questions)
Symptoms evaluation
Cognitive assessment <ul style="list-style-type: none"> <li>Orientation</li> <li>Immediate memory</li> <li>Concentration</li> </ul>
Neck examination <ul style="list-style-type: none"> <li>Range of motion</li> <li>Tenderness</li> <li>Upper and lower extremity sensation and strength</li> </ul>
Balance examination
Coordination examination
Delayed recall

conscious state, focal neurologic deficit, or worsening symptoms or whenever suspicion of an intracerebral structural lesion exists. While NPT can objectively detect cognitive impairment, Dr. Chang cautioned her colleagues to look at the nuances of NPT, not just the numbers. She also noted that NPT is usually performed by a neuropsychologist or sports medicine specialist trained

**Table 3. Graduated Progression Protocol for Return to Play**

Rehabilitation Stage	Functional Exercise	Objective
1. No activity	Complete physical and cognitive rest	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, such as 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 in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

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to interpret the results and that it can require significant resources and time. The Balance Error Scoring System is a recommended postural control test that is part of SCAT3.

A referral should be made for athletes with an SRC who have symptoms that are prolonged or worsening, who develop secondary symptoms, or who are unable to progress in their activity levels. A referral should also be made if requested by athletes or their families. Criteria for RTP include resolution of symptoms, normalization of NPT and balance tests, and successful completion of the progression protocol (Table 3). Each step of the protocol should take 24 hours, although if symptoms occur, the athlete should return to the previous level before progressing.

Physicians must know the prevailing legislation and policies governing management of SRCs in their athletes, stated Dr. Chang. These include state concussion laws and the guidelines of the local school, National Collegiate Athletic Association, and professional sports leagues. One very important component is the removal of the athlete from play or practice for the rest of the day if suspected of having an SRC (high school) or if diagnosed with one (National Collegiate Athletic Association, professionals).