Subacute Symptoms of Sports-Related Concussion: Outpatient Management and Return to Play

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Participation in contact and collision sports is on the rise worldwide. Consequently, the incidence of sports- and recreation-related concussions has been estimated at 1.6 to 3.8 million cases per year in the United States. For many clinicians, the care from the time of acute injury through the management phases to the decision-making involved in returning the athlete to play is challenging. Although most athletes with concussions become symptom-free within 10 days, some symptoms—subtle and not so subtle—and neurocognitive deficits may persist. Recently, one study reported that 35% of concussed athletes experienced neurocognitive deficits that persisted for several days after the symptoms had resolved. Previous articles have focused on the acute care of the athlete in the first few days of injury. This article concentrates on athletes with persistent symptoms after the first few days and those with modifying factors that must be considered when returning the athlete to play.

The recent Zurich consensus statement defined concussion as “a complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces.” This functional disturbance is most often short-lived but may occasionally have prolonged symptoms. The panel recognized the similarity of mild traumatic brain injury with sports-related concussion. However, because the injury constructs were different, the terms should not be used interchangeably. Although the sports-related concussion may be an entity early on the spectrum of traumatic brain injury, it is not...
always clear when the injury crosses from mild to moderate traumatic brain injury. Much of the recent experience in dealing with mild traumatic brain injury comes from the military experience. In Afghanistan and Iraq, the signature injury has been mild traumatic brain injury. This condition was previously recognized as “shell shock,” the signature injury of World War I. The military criteria for return to duty criteria have many similarities to the sports criteria for return to play.

CONCERNS FOR RETURN TO PLAY DECISIONS

One well-accepted criterion for return to contact/collision sports is the resolution of all concussive symptoms both at rest and with exercise. Often the subtleness of symptoms lead to confusion and uncertainty in decision making. Ultimately, clinicians have three major categories of concern: second impact syndrome (SIS), a prolonged recovery from sequential concussions, and chronic traumatic encephalopathy.

Although rare, SIS is a devastating injury with a mortality rate of at least 50% and a nearly 100% morbidity rate. The injury occurs in adolescent and young athletes who sustain a second concussive event while still symptomatic from a prior event. SIS may occur with either mild or significant trauma as the first or second event. Except for in boxing, it has not been reported in athletes older than 20 years. The timing between events can occur as early as the same game or several weeks later. SIS is believed to be caused by a rapid loss of vascular autoregulation with massive intracerebral swelling. Some controversy exists regarding the existence of SIS, because some would call it “diffuse cerebral swelling” that can occur in the younger individual with an initial minor traumatic brain injury. However, most authorities concur that an initial incident precedes the catastrophic second event and is marked by incomplete recovery of symptoms. Often the vagueness of the symptoms combined with an intense desire to return to play leads to unfortunate decisions.

The second concern regarding return to contact or collision sports after a concussion is the possibility of a prolonged recovery from a second concussion. Studies have shown that high school and collegiate-level American football players with a history of concussion have a three- to sixfold increased risk of sustaining a second concussion. Repeat concussions are most likely to occur in the first 10 days after the initial concussion. Collins and colleagues showed that athletes with a history of concussions were more likely to experience significant on-field symptoms of amnesia and confusion during repeat concussions. These symptoms may be related to a more prolonged rate of recovery. A longer recovery from second concussions was also shown in terms of balance recovery. One study stratified collegiate athletes based on single versus multiple concussions. The athletes who experienced more than a single event took longer to recover visual–kinetic integration than those who experienced a single event.

Finally, concern exists over the cumulative effects of repeated traumatic brain injury, including the potential for dementia pugilistica or chronic traumatic encephalopathy (CTE). This entity has been recognized since the early 1900s. Initially recognized in boxers, it has been shown in retired National Football League (NFL) players and several other collision sports. The neuropathology of CTE has similar findings to those of Alzheimer disease, including cell drop-out and neurofibrillatory tangles. In CTE, however, the major areas of involvement are the septum pellucidum, the substantia nigra, and the cerebellum, and the condition is often associated with diffuse axonal loss. This involvement results in loss of intellect, memory, and balance and symptoms similar to those of Parkinson disease.

No finite number of head injuries is equated with the development of CTE. These neuropathologic changes are often not recognized for several years after the injuries.
Hence, who is going to develop these problems is difficult to predict. However, Collins and colleagues\textsuperscript{14} showed that athletes with multiple concussions often manifest deficits on neurocognitive testing. These subtle neurocognitive deficits may help identify which athletes with multiple concussions should consider retirement. Further investigation is necessary before this can be determined.

**EVALUATION OF THE ATHLETE WITH PERSISTENT POSTCONCUSSIVE SYMPTOMS**

Athletes with a concussion should undergo a full evaluation, including a history of the injury and all initial findings. Careful consideration should be given to injuries outside the spectrum of concussion. Persistent or progressive symptoms should prompt consideration of neuroimaging to exclude other potential causes of the patient’s symptoms. At 1-week postinjury, MRI is the most sensitive imaging tool and lacks exposure to ionizing radiation.

The cervical spine should also be thoroughly evaluated for signs of injury. Cervical spine tenderness should initiate at least plain radiographs, with flexion and extension lateral radiographs. In the adult, further evaluation may require CT scanning. In the child athlete, upper cervical spine injuries may be evaluated with an MRI.

The sports-related concussion complex involves careful evaluation of symptoms, physical findings, cognitive impairment, and behavioral changes. The subtlety of concussion may be determined in any of these realms. The initial symptoms at injury that are somewhat predictive of a longer postconcussive course are the total symptom load and possibly amnesia and confusion.\textsuperscript{20,21}

**Symptom Assessment**

Persistent symptoms may be clumped into three categories: somatic, emotional, and cognitive. Somatic symptoms include headaches, balance issues, and sleep disturbance. Emotional symptoms are often depression and anxiety. Cognitive symptoms include concentration and memory problems. A symptom checklist, such as the sideline concussion assessment tool 2 (SCAT 2), is critical in maintaining a complete evaluation log (Fig. 1). The checklist is used both to quantify symptoms as they resolve and to flag some symptoms that require direct treatment, such as sleep disturbance. A baseline symptom checklist is useful, because many symptoms, such as lack of concentration, may predate the injury.

Various postconcussive symptoms are possible, including headaches, photophobia, dizziness, and problems with memory and concentration. Headaches are the most common symptom but do not always correlate with concussion severity.\textsuperscript{22,23} Fogginess, or the sense of being out of touch, correlates highly with problems in memory performance and reaction time, and is predictive of increased time to recovery.\textsuperscript{24} Diminished sleep has also been correlated with poor recovery of cognitive function.\textsuperscript{25} Specifically, attention deficits are increased in patients with postconcussive sleep dysfunction.\textsuperscript{26}

**Physical Findings**

A thorough neurologic examination is important to assess for a focal brain deficit masking as a concussion. However, the concussion examination may elicit several findings, including vestibular and balance problems, caused by the lack of integration of the vestibular and visual systems. One sensitive tool for postural balance is the Balance Error Scoring System (BESS).\textsuperscript{27} This test is easy to administer in the office and may stay abnormal up to several days after injury. It consists of posture in three
**SCAT 2 Symptom Score**  
**How do you feel?**

You should score yourself on the following symptoms, based on how you feel now.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Pressure in head&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Neck Pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling like &quot;in a fog&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Don't feel right&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Confusion</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>More emotional</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sadness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nervous or Anxious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total number of symptoms** (Maximum possible 22)

**Symptom severity score**  
(Add all scores in table, maximum possible: 22 x 6 = 132)

Do the symptoms get worse with physical activity? Y N  
Do the symptoms get worse with mental activity? Y N

**Overall rating**

If you know the athlete well prior to the injury, how different is the athlete acting compared to his / her usual self? Please circle one response.

- no different
- very different
- unsure

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Fig. 1. SCAT 2 symptom score.

stances: double leg, single leg, and tandem stance on a firm and a foam surface. Having a baseline score of the BESS is very helpful.

**Cognitive (Neuropsychological) Assessment**

It is well established that resolution of symptoms and neurocognitive function do not always coincide. This finding has been shown in American football players at both the
The simple sideline tests, such as the Maddocks questionnaire or the Standardized Assessment of Concussion (SAC), provide good initial information with respect to confusion and amnesia. However, they do not give information on performance in the more subtle cognitive domains. Initial interest in advanced neuropsychological testing for sports-related concussion started in the 1980s at the University of Virginia. The traditional “paper and pencil” testing led to the more efficient computer-based testing, which allows for more accurate assessment of some cognitive functions, such as reaction time, which is inherently better suited to computerized assessment. The other measured cognitive domains include visual memory, verbal memory, and processing speed. The currently available commercial products for computer-based testing include ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing), Headminder, CogState, and ANAM (Automated Neuropsychological Assessment Metric).

Neuropsychological testing is valuable in the assessment of the concussed athlete, but it is not a stand-alone tool and may not always be available. It is only one part of the multifactorial assessment of the athlete. Symptoms, physical findings (balance testing), previous concussions, and comorbid neurologic issues must all be considered in returning the athlete to competition. It is best used if a baseline was established before injury. Baseline tests should always be evaluated for validity of performance. It is important for clinicians to question the athletes about difficulties with any segment of the test.

The test is often administered when the athlete becomes symptom-free. It may be used earlier in athletes with prolonged symptoms and in younger athletes, because it could help determine whether academic accommodations and cognitive rehabilitation are needed. When used in the younger athlete, testing must be sensitive to the maturation of cognitive function throughout adolescence. Neural maturation will necessitate repeated baselines every 6 months. A neuropsychologist may be very helpful in interpreting testing in this population, especially if learning disabilities exist.

For most sports-related concussions, the return of neuropsychological function is usually within the first 2 weeks, and often in the first 7 to 10 days. Furthermore, in the general population with mild traumatic brain injury, neuropsychological function will recover by 90 days postinjury in most people. In the sports population, Makdissi and colleagues showed that initial presentation of symptoms is somewhat predictive of duration of cognitive defects. Athletes that presented with more than four symptoms, a headache lasting longer than 60 hours, and the report of fogginess or fatigue took longer to recover. Furthermore, computer-based neuropsychological testing recovery lagged behind symptom recovery and was more sensitive than paper and pencil neuropsychological testing.

**MANAGEMENT OF CONCUSSIVE SYMPTOMS**

Management of the postconcussive state follows some general guidelines. Athletes are kept at cognitive and physical rest until the symptoms resolve and then follow a graded pathway of increasing exercise activity until they are able to return to play. However, persistent symptoms may hinder this process. Clinicians must monitor the symptoms, because they may require intervention.

**Physical Rest, Cognitive Rest, and Education**

Rest from all physically strenuous activity is recommended, not just from those activities that confer an increased risk of trauma to the head. A more difficult area for the athlete, parents, and teachers to understand is the importance of cognitive rest. These
activities include many that are not as well understood, such as computer games and text messaging.

Academic accommodations will help the scholar athlete achieve cognitive rest. It is crucial for these athletes to understand that their visual and verbal memory processing is slowed and that academic performance will be affected. Early in the recovery period, the athlete may be kept out of school completely. As symptoms resolve, a gradual academic return is initiated, perhaps beginning with half days and no tests or reading assignments, followed by progression to limited reading and untimed tests. Much of this is dependent on the severity of the symptom score.

Rest from exercise is paramount in the early stages of recovery. Most symptoms will have cleared after the first 7 to 10 days. In cases of prolonged symptoms lasting more than 6 weeks, Leddy and colleagues\textsuperscript{37} showed that subsymptom threshold levels of exercise are safe with close monitoring for recurrence of symptoms. Prolonged concussions often are associated with depression and anxiety.\textsuperscript{38} Subthreshold exercise may diminish this effect.

Education for the athlete, parents, coaches, and teachers plays a major role in the recovery of sports-related concussion. Education should center on the description of cognitive deficiencies and the natural history of concussion syndrome.\textsuperscript{39} Involving a psychologist at this point to provide cognitive behavior therapy is very helpful. Education is the cognitive component, and the behavioral component involves working with maladaptive behavior and moods that interfere with recovery.

\textit{Medications}

Several principles of medication use in the setting of sports-related concussion should be understood. First, few well-designed studies have examined the use of medications specifically for sports-related concussion.\textsuperscript{40} Second, no evidence shows that medications speed the recovery of sports-related concussions. They can be useful in mitigating the symptoms but not the overall recovery time. Finally, the general principle is to have the athlete discontinue the interventional medications before returning to sports. However, this is not always possible when dealing with underlying emotional issues, and the clinician will need to exhibit caution in these circumstances. The medications used to treat the symptoms of sport-related concussion are discussed in greater detail elsewhere in this issue.

\textbf{RETURN TO PLAY CRITERIA}

Before returning to play, the athlete must prove to be symptom-free at rest and with exertion. Once the symptoms have resolved, a well-accepted progression should occur before returning to contact sports:

Symptom-free state $\rightarrow$ light aerobic activity $\rightarrow$ sport-specific activities $\rightarrow$ noncontact training drills $\rightarrow$ medical clearance and full contact practice $\rightarrow$ game play.

This progression follows several principles. If any symptoms recur, the athlete is to go back one step and wait at least 1 day after symptoms resolve before progressing again. The timing between steps may be increased based on certain modifying factors, as discussed below.

\textit{Modifying Factors in Concussion Management}

\textit{Age}

The young athlete is managed based on similar principles as the older athlete. Given the immaturity of the brain, however, the young athlete may require more time to recover than the adult patient.\textsuperscript{41} Therefore, the time between the steps for return to
play that are listed earlier is increased for young athletes. In addition, the long-term neuropsychological effects of repetitive concussions are not well understood. Computer-based neurocognitive testing can be performed, but should be compared with age-matched controls, and requires frequently repeated baseline examinations. Interpretation may require a trained neuropsychologist, especially if learning disabilities are involved. Preinjury learning disabilities have been associated with increased cognitive disability after concussion. This symptom is possibly related to diminished cognitive reserve. Cognitive rest is crucial in the young athlete and neuropsychological testing can help modify academic involvement.

Concussion Recurrence

Although a specific number of concussions has not been established to mandate seasonal or permanent retirement, experts understand that repetitive concussions are associated with more significant neurocognitive deficits. The factors that prompt the consideration of conservative management include less time between concussions, progressively less force resulting in injury, and increasing duration of concussion recovery. In the future, neuropsychological testing may be helpful in these settings to determine fine changes as harbingers of permanent injury.

Symptom Description

Some symptoms may predict longer recovery. Interest has been shown in amnesia as one type of marker. But total symptom load is a more likely predictive of a prolonged recovery. Fogginess and mental slowness most likely represent impaired cognitive function. Loss of consciousness for less than 1 minute has not been found to a useful predictor of prolonged recovery.

Comorbidity of Learning Disabilities and Migraines

Learning disabilities in the premorbid state predict more significant cognitive injury, which makes neuropsychological testing more difficult to interpret. Involvement of a trained neuropsychologist should be considered to help interpret difficult cases. Because these athletes will exhibit more significant cognitive deficits, precautions should be taken when they return to play.

Occasionally, headaches triggered by concussive injury can complicate recovery. Athletes with preinjury migraines might be considered recovered when their migraine symptoms return to preinjury levels. However, for athletes without a history, migraines may be initiated by a sports-related concussion, often confusing the decision to return the athlete to play. Clinicians must determine whether the patient has postconcussive headaches, which indicate incomplete recovery, or whether a primary migraine was triggered by the injury. In these difficult situations, it is useful to document a good description of the headache. If the headache is not exacerbated by exercise, the patient has a positive family history of migraines, all other concussion symptoms have resolved, and neuropsychological testing has returned to baseline, the clinician might consider a primary diagnosis of migraines, and therefore consider returning the athlete to play.

The subacute symptoms of sports-related concussion can be difficult to treat. Fortunately, they are usually short-lived and self-resolving. The cause of the symptoms may occasionally be confusing. A multidisciplinary approach to recovery and return to play decisions is ideal. Recent consensus statements offer useful guidelines to assist clinicians in the management of concussed athletes.
REFERENCES


