

Clinical Considerations for Concussion Management in Adaptive Athletes

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The risk of concussion is present in both adaptive and non-disabled sports. However, one must keep in mind the unique challenges in recognizing/diagnosing and managing concussion in para-athletes. An important factor for consideration in para sport groups is the coexisting underlying medical conditions, which can mimic signs and symptoms of concussion. This analysis will discuss key clinical factors for adaptive athletes with a diagnosis of sports-related concussions focusing on sideline testing, management, and mental health implications.

Sports-related concussion (SRC) is a mild traumatic brain injury from biomechanical forces (a blow to the head, fall, or sudden jolt), resulting in the brain moving rapidly within the cranium [1]. When a concussion is suspected, the athlete should be promptly removed from play for assessment. SRC is a clinical diagnosis based on signs and symptoms.

Accurately identifying SRC in para-athletes presents a unique challenge because para-athletes may have common signs and symptoms of SRC at baseline. In a SRC diagnosis, it is crucial to ensure symptoms are only related to the triggering event.

This becomes a challenge in assessing adaptive athletes who often have underlying neurological conditions that present at baseline with symptoms emulating SRC. The emphasis on having annual baseline testing to compare any new injury findings is an important factor when evaluating SRC for adaptive athletes.

Evidence has been shown to support the hypothesis that certain risk factors including experiencing two or more adverse life events in the past year, sports related concussion; high self-stigma; inadequate social support and low psychological safety conferred a greater risk for poorer mental health outcomes for elite para-athletes [2].

Assessment of concussion in para-athletes with previous history of PTSD or other mental health diagnosis makes it challenging as the post-traumatic stress symptoms may mimic symptoms of concussion including emotional distress or cognitive symptoms. As such, misdiagnosis is certainly a challenge but on the other hand, assessments skewed due to the other emotional/mental health factors affecting cognition at baseline could result in under diagnosis of concussion later. Henceforth an accurate assessment of baseline functioning and symptom profile will help navigate the challenges of accurately diagnosing concussion [3].

Understanding disabled athletes unique experience of SRC symptoms and its subsequent effects such as its impact on mental health is critical for ensuring successful recovery and seamless return to the sporting activity [4].

It has been shown that multiple SRCs have detrimental long-term effects with reports of depression, anxiety, attention deficit hyperactivity disorder and impulsivity [5,6]. An area that has not been prominently discussed is whether SRC in adaptive athletes have long-lasting mental health implications.

History and Exam Findings

History and exam findings of SRC can generally be categorized into physical, cognitive, emotional, and sleep disturbances [7].

SRC typically presents with physical symptoms that vary from person to person. However, common symptoms include headaches, nausea, dizziness, light and sound sensitivity, and exercise intolerance. Specifically, visual-vestibular abnormalities may present as acute changes to the athlete's speech, balance, and expressed emotion. Nausea, accompanied by repeated episodes of vomiting with worsening headaches, should prompt the emergent transfer to the hospital for neuroimaging.

Cognitive abilities refer to skills relating to or involving conscious intellectual activity including thinking, reasoning, or remembering. Cognitive impairment may present with difficulty concentrating, recalling new information, and becoming disoriented. Athletes often report the sensation of "not feeling right." This can impact an athlete's ability to maintain attention, analyze situations, develop creative solutions, retain novel data, and adapt to the surrounding environment. Any abrupt worsening in an athlete's mental status may suggest more serious conditions, warranting immediate transfer to a medical facility for next-level care.

Regulation of emotion lies primarily in the prefrontal cortex of the brain, another region highly susceptible to SRC. Therefore, post concussive mood changes in athletes can be common in response to an injury. These changes can

present pseudobulbar symptoms and other mood effects such as anger, anxiety, and irritability.

Another important metric in the evaluation of SRC is changes in the quality and patterns of sleep [8,9]. These changes can present as a variety of symptoms ranging from fatigue to insomnia. SRC can disrupt sleep because of the potential damage to the brain's regions responsible for regulating sleep-wake cycles, disrupt the production of sleep-regulating hormones, and lead to post-traumatic stress or anxiety, all of which can affect sleep. After a concussion or head injury, the brain experiences inflammation and chemical changes that can interfere with normal brain functioning, including

its circadian rhythm. This disruption makes it harder to fall asleep, stay asleep, or feel rested. Concussions can also impact the brain's production of melatonin, the hormone regulating when it is time to sleep. When melatonin levels are thrown off, restorative rest is negatively affected, just when your brain needs it most for healing [10].

Crucial signs and timely removal

Proper recognition and removal of an athlete from play is essential in protecting the athlete and improving recovery from SRC. Certain signs and symptoms should lead to immediate removal and timely evaluation on or by the field by a medical professional trained in SRC. Primary assessment should first rule out airway, breathing, and circulation emergencies. Signs like seizures lasting more than two minutes, loss of consciousness after impact, and postural instability should be treated as emergencies. In addition, The Sports Concussion Assessment Tool 6 (SCAT 6) identified red flags including neck pain or tenderness, double vision, weakness or tingling in the arms and legs, severe/increasing headache, seizure, vomiting, deteriorating conscious state, and visible deformity of the skull. According to SCAT 6, the recognition of any of the above signs should prompt medical professionals to thoroughly evaluate the athlete and potentially transport them to the nearest hospital or medical facility [11].

Specific notes for para-athletes

It is worth noting that SRC may look different in para-athletes than in nondisabled athletes. It is common for para-athletes to experience a greater total number of symptoms and increased symptom severity. For example, some wheelchair athletes may experience ataxia at baseline and many blind footballers experience intensified sleep disturbances post SRC. A peer-reviewed, cross-sectional study examining baseline symptom reporting and modified balance in adaptive athletes yielded valuable insights. This study examined 21 athletes from a collegiate adaptive sport program. Athletes completed baseline Immediate Post-Concussion Assessment and Concussion Testing (ImPACT) and the Wheelchair Error Scoring System (WESS) prior to their sport season. Compared to normative values from collegiate athletes, 81% of wheelchair athletes reported more baseline symptoms. Able-bodied collegiate athletes reported 1.67 (male) and 1.93 (female) symptoms while adaptive athletes reported 4.55 (M) and 5.50 (F) symptoms [12]. These findings emphasize the importance of regular and frequent baseline testing to map out what is typical for the specific athlete and how to create a personalized approach for assessment.

Testing

Common tools for SRC evaluation include SCAT 6, WESS, the Vestibular/Ocular Motor Screening (VOMS), the Dizziness Handicap Inventory (DHI), and Clinical Reaction Time (RTclin).

SCAT 6 is a standardized evaluation for concussions and requires at least 10–15 Min to perform with nondisabled athletes. This may be an underestimation for para-athletes with baseline cognitive dysfunction. The test targets neurologic symptoms that focus on cognitive function and balance. While not validated for adaptive athletes, it may still serve as a valuable clinical tool with modifications applied where necessary [13,14]. WESS is a validated assessment tool adapted from the standard Balance Error Scoring system (BESS) for wheelchair athletes. WESS tests balance through three different positions: sitting on flat surface, sitting on a balanced disc, and performing a wheelchair wheelie. Vestibular system testing is typically paired with balance assessments as both reflect on the functionality of vestibulocochlear system. The VOMS utilizes multiple individual tests of the vestibular and ocular system to determine if the SRC affected these systems and whether early vestibular physical therapy would be beneficial. Also, adaptive athletes with prior SRC diagnoses tend to report greater VOMS effects like impaired vision, balance, and movement than those without SRC history. Therefore, it is all the more important to have regular and frequent baseline assessments. The DHI is a self-reporting questionnaire that investigates an athlete's ability to perform daily tasks while experiencing dizziness. Impaired reaction time is one of the most sensitive tests for SRC as it prolongs shortly after injury. RTclin is a simple sideline test that may be assessed by a variety of means. One method is the drop stick test, which uses a rubber disk attached to a plastic rod marked in standardized increments. The quicker an athlete can catch the falling stick at random dropping points, the better their reaction time, which is reported in milliseconds [15].

Following the physical signs, it is important to discuss the testing options for SRC, beginning with the athlete's typical condition testing. As emphasized previously, adaptive athletes often have more complex diagnoses that present in unique ways. Therefore, a personalized management plan should be employed for these athletes. The frequency of baseline testing depends on the stability of their underlying medical condition. For athletes with no functional capacity changes, annual preseason baseline testing is appropriate. However, for athletes whose physical capacity and cognitive function can change significantly, repeated baseline testing is required until a new normal value is established.

Initial evaluation to elicit history of mental health symptoms, Substance abuse and psychological stressors followed by specific screening questionnaire is recommended. The sports mental health assessment tool SMHAT 1 or sports mental health recognition tool SMHRT 1 has been utilized to assess mental health symptoms in elite athletes and para-athletes. Although these are not validated for athletes with intellectual impairments. The use of Patient Health Questionnaire 4 is valid and suitable tool for continuous mental health evaluation [16].

Other screening tools that are available for Depression (PHQ 9), anxiety (GAD-7) or PCL 5 for PTSD can also be utilized. For overall mental health, screening Multiple Mental Domains (M3 checklist) or mental health symptoms (GHQ-28) could be used as a screening tool.

Limitations and future directions

A timely diagnosis for SRC is crucial for proper treatment and successful recovery in athletes. As previously described, a systematic evaluation combining several different tools are typically needed to give medical professionals a sound diagnosis. Recent published literature suggests that, under certain circumstances, cognitive function testing may lack accuracy. For example, 45% of athletes with concussions that participated in the 10-word list of the Standardized Assessment of Concussion (SAC) scored the same/better as their baseline score [17,18]. However, additional literature suggests that assessments focused on testing balance and oculomotor more effectively [14]. Although RTclin has been shown to be comparable to computer-based tests, it should not replace the computer-based tests if available, but it is an important tool in assessing functioning pre and post-concussion. It is recommended that other forms of reaction tests be investigated for utilization in the future [19].

Management Considerations

The Concussion in Para Sports Group (CIPS) suggests the main components of a SRC recovery would consist of a brief rest period, an active rest period, and then a gradual return to activity. Recommended resting period is 24–48 hrs. It is important to consider that adaptive athletes in wheelchairs or prosthetics expend more energy compared to nondisabled athletes in Activities of Daily Living (ADL). As such, this should be taken into consideration while caring for the para-athlete to ensure existing SRC is not exacerbated. Following the rest period, athletes can gradually increase their ADL on the condition that SRC symptoms do not surface. Submaximal physical activity tests like the Buffalo Concussion Treadmill Tests (BCTT) can be used to assess exercise tolerance in athletes at this stage. While BCTT cannot best assess wheelchair athletes, hand cycling or adaptive rowing test can serve as appropriate alternatives. Once an athlete can perform ADLs without aggravating symptoms, they can be cleared to a Return to Play (RTP) program [20].

Mental health

Literature search suggests there are significant mental health challenges in athletes after the SRC recovery process. Therefore, there is a strong interest in investigating the ways in which concussion influences mental health [21–23]. A range of psychiatric and behavioral problems can be observed after concussion [24]. For example, repeated concussions are linked

to depression and personality changes including severe irritability, impulsivity, and apathy. TBI studies completed in the past showed that mild TBI, previously viewed as innocuous, is now associated with suicidality, PTSD, and Major Depressive Disorder (MDD) [25,26]. It is important for healthcare professionals to understand that post-concussive symptoms can overlap with psychiatric conditions such as PTSD, depression, and anxiety. Moreover, PTSD is more common after TBI compared with other injuries, with evidence that the diffuse axonal injury may directly contribute to this etiology. Therefore, behavioral-psychiatric disorders can be viewed as both risk factors and outcomes of TBI.

Affective changes associated with concussion/mild TBI include mood swings, irritability, aggression, and anxiety. The dysregulation of these emotions can greatly impact athletes' quality of life. There is evidence that demonstrates that patients with TBI of all severities are at elevated risk for affective disorders. A noteworthy point is that military personnel are at high susceptibility to PTSD and MDD following TBI [27–29]. This is a particularly important factor to consider when adaptive sports athletes are veterans.

A cohort study with 1567 US Army soldiers found an increased rate of reported severe irritability among those who have sustained TBI. Several cross-sectional studies also found links between TBI and suicidality. For example, a study with 108,930 male Marines found that TBI was associated with risk of completed suicide [30].

These mental health complications following TBI raise important considerations for wheelchair athletes as a significant portion of adaptive athletes are Veterans. This physical-psychosocial dynamic is further complicated as many Veterans already endure persistent psychological effects from both combat and noncombat experiences. A survey including over 3,100 veterans showed a 7% lifetime prevalence of PTSD. Thus, there is the possibility that wheelchair athletes who suffer TBI may be at an elevated risk of experiencing mental health disorders and/or experience more intense mental health impacts [25].

Provision of psychologically safe environments has shown to improve athletic performance at both individual and team level. Developing and maintaining supporting environments that enhance psychological safety is likely to be associated with indicators of better mental health among those athletes [31].

CBT treatment can be used for persistent symptoms of mood disturbance but if the athlete has intellectual impairments, the process by which this occurs would need to be adapted and modified [32].

As a well-studied sleep supplement, melatonin may have potential to become a more widely used therapeutic agent

for those experiencing sleep disturbances post-concussion. A peer-reviewed meta-analysis studied 595 articles and 9 studies that has reported outcomes of using melatonergic agents to treat sleep disturbances in TBI patients. As a result, 251 participants who received melatonin, Circadin (long-releasing melatonin), and Ramelteon (melatonin receptor agonist) reported significant improvement in sleep quality, sleep duration, and sleep efficacy [33].

In addition, Pharmacological intervention with psychotropic medications should also be considered particularly if they are already prescribed those medications and the severity of the symptoms has increased.

Conclusion

Adaptive athletes are more likely to present with a baseline symptom than nondisabled athletes. Therefore, both SRC testing and management require more personalized approaches. There should be increased attention on vestibular, balance, and reaction time tests as they combine efficacy with accuracy. Additionally, adaptive athletes' mental and behavioral health may be disproportionately impacted by concussion. Further research on mental health interventions for adaptive athletes is needed.

It is obvious to professionals working with adaptive athletes the challenges they have with concussion and the associated mental health symptoms. Unfortunately, there is very little research into screening, assessment and recommendations for management. This article provides a framework to consider and perhaps future directions for research on mental health interventions for adaptive athletes.

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