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Considerations for Return-to-Play and Retirement Decisions After Concussion

Robert C. Cantu, MD, Johna K. Register-Mihalik, PhD, ATC

Abstract: Return-to-play and retirement decisions after concussion are often difficult and complex. The complexity of these decisions may be influenced by many factors, including the number, proximity, and severity of previous concussions; gender; age; sport played; exposure to head impacts; and predisposing or pre-existing conditions. These circumstances and conditions can confound the decisions concerning return to play and retirement. Clinicians should carefully weigh how these circumstances and conditions influence quality of life and how they interact with the effects of concussion. Furthermore, clinicians should consider past and potential exposures to both subconcussive and concussive impacts during the athlete's lifetime when deliberating a return to play or retirement. The purpose of this overview is to highlight and discuss these issues as they factor into the return-to-play and retirement decisions after a concussive injury in an effort to provide clinicians with evidence-based information that can be used in the decision-making process.

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INTRODUCTION

Traumatic brain injury (TBI) is one of the most burdensome public health problems in the United States. The disabilities after mild TBI, such as concussion, can lead to many problems that result in decreased quality of life, including emotional, physical, academic, cognitive, and social deficits. According to the Centers for Disease Control and Prevention [1], an estimated 1.6-3.8 million sports-related brain injuries occur each year, and this estimate is likely quite low [2]. Adding to the concussion burden is the complexity involved in both the evaluation and return-to-play decision. Recent attention, including legislative action, has focused on increased awareness and better management of this injury. The complexity of the return-to-play decision may be influenced by many factors, including the number, proximity, and severity of previous concussions; gender; age; sport(s) or activity played; total exposure to head impacts; and predisposing or pre-existing conditions. One of the primary return-to-play considerations is that no athlete should return to play while symptomatic after a concussion. Furthermore, concussion often presents with an individualized history and set of postinjury issues that need to be considered in the return-to-play decision. The purpose of this overview is to highlight and discuss these issues as they factor into the return-to-play and retirement decisions after a concussive injury.

CONCUSSION HISTORY

Unlike many other sports-related injuries, concussion can be difficult to identify at the onset and may go unrecognized [2], which places individuals at risk for future and more complicated injury. This lack of reporting of previous injuries may lead to an unknown number of concussions for individuals and adds to the complexity of the return-to-play decision. Recently, reports have surfaced that more care is being sought for concussions in emergency departments than in the past and that the relative incidence of concussion across sports has increased overall [3]. Although sports have significantly changed during recent years, much of this increase is likely due to efforts across all levels of sports to better understand, identify, and manage these injuries. Furthermore, results of research suggest that having a trained observer, that is, an individual whose job is to watch for concussions,

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may help identify even more of these injuries and ultimately lead to better management and return-to-play decisions. Echlin et al [2,4] found that the trained observer was able to identify significantly more concussions than even an athletic trainer or physical therapist.

Identification of initial injuries is essential for the prevention of recurrent injuries, especially injuries that may occur before the resolution of the initial injury. In cases of multiple concussions, recent literature illustrates possible negative outcomes and long-term deficits. Some studies of retired professional football athletes suggest that clinical depression, mild cognitive impairment, and overall decreased quality of life all may be consequences of multiple concussions [5,6]. In high school athletes, persons with a history of multiple concussions have been reported to have decreased grade point averages [7] and increased on-field severity of subsequent injuries [8]. The regular presence of headaches, including migraines, also has been shown to be associated with recurrent concussions. One report suggests that high school and college athletes with a history of 3 or more concussions are more than 3 times more likely to experience headaches on a regular basis [9]. Currently it is theorized that multiple hits in the same game or on the same play should be considered because they may lead to worsened outcomes and a longer time to return to participation after a concussion. This theory is based on the idea of the proximity of exposure and lowering the threshold for injury. Whereas many concussion injury thresholds have been proposed in the medical literature, ongoing real-time head impact monitoring has demonstrated very low sensitivity and specificity of these thresholds. However, of the injuries that have been recorded when using these technologies, evidence is mounting that higher-magnitude head impacts are more likely to cause injury [10,11]. The severity and recovery period of previous injuries should be considered. If, with each injury, the severity and length of recovery increases, then a more conservative return or disqualification may be a consideration. The lengthened recovery may be evidence that the brain is more vulnerable and unable to withstand the forces and stresses in the same manner as before the injuries occurred (ie, a lower threshold). No specific number of concussions mandates that an individual should definitively be retired from a sport.

EXPOSURE TO HEAD IMPACTS

More recent literature has identified long-term issues related to head-impact exposures. These findings extend beyond just impacts related to concussive injury and to the potential issues concerning multiple subconcussive blows sustained during a person's life. One major issue regarding these types of blows is chronic traumatic encephalopathy (CTE) [12]. CTE was first clinically described in boxers in 1928 by Martland [13], who used the term "dementia pugilistica." The condition was characterized by mental deterioration and

confusion, slowing of speech, and parkinsonian symptoms. Its first neuropathologic description was published in 1954 by Brandenburg and Hallervorden [14]. It is characterized by a diffuse tauopathy with τ -immunoreactive neurofibrillary tangles and neuropil threads.

The name change to CTE reflects its occurrence in sports other than boxing that entail repetitive head trauma. In 2005, Omalu et al [15] reported the first case in a retired 17-year National Football League all-pro center. Since 2008, more than 70 brains have been studied at the Veterans Administration Boston University Center for the Study of Traumatic Encephalopathy brain bank, and 14 of 15 National Football League cases were positive for CTE. We also have found CTE in former professional hockey players, a professional wrestler, and boxers [12,16]. We found CTE in 17-, 18-, and 21-year-old football players. We documented the presence of CTE in athletes with no known recorded history of concussion, which reinforces that the condition results from total brain trauma from both concussive and subconcussive impacts. We believe this finding explains why the sports with the highest total number of head impacts, such as boxing and football, have more reported cases of CTE than do sports with the same incidence of concussion but far fewer total subconcussive brain impacts, such as ice hockey.

Thus when making return-to-play decisions and, especially, retirement decisions, it is not only important to consider how many prior concussions have been incurred but how many subconcussive impacts have been received based on the sport, position, and style of play.

GENDER AND SPORT-RELATED ISSUES

Results of studies also have suggested that female athletes, specifically female soccer and basketball athletes, may be at greater risk for concussion than male athletes [17,18]. Based on these findings, the assumption has been made that female athletes are generally at greater risk, but very few explanations for these gender differences have been examined. These findings may be related to reporting issues; anthropometric issues, such as neck strength; or physiological predispositions. Although differences in male and female incidences have been discussed, the literature is ambiguous on how gender affects recovery and outcomes [19-21]. Given these potential differences, the outcomes for each individual should be weighed more heavily than gender when making return-to-play and retirement decisions.

Another consideration in return-to-play decisions is what sport or activity the individual participates in. Collision sports (ie, sports in which contact is an integral part of the sport and/or how the game is played) and some contact sports (ie, sports in which incidental contact occurs but is not a requirement for participation) have some of the highest initial and repeated concussion rates among all sports [22,23]. However, concussion can occur in any sport, and

the issues concerning return to play are common no matter the sport. The return-to-play decision may become more difficult when the sport involves collision or extreme contact. For athletes with concussions that result in prolonged outcomes or that occur with complications, such as intracranial hemorrhaging, return to a collision sport may be contraindicated.

AGE ISSUES

Although college athletes also have a relatively high incidence of concussion, high school athletes are of particular concern because their brains are in an earlier stage of development than are the brains of college or professional athletes. These young athletes also have the potential for a higher number of future exposures than do college or professional athletes, which creates an increased risk for recurrent concussion and cumulative effects. Furthermore, they may have delayed recovery patterns immediately after injury [24]. Return-to-play and retirement decisions within this age group often are complicated by the potential effects that may occur as a result of having such a young person discontinue an activity. Excelling in a sport may play a major role in the self-esteem of some persons, especially those who are high school age; being required to stop playing may result in a reactive depression, and less constructive activities may be pursued. However, being more conservative with younger athletes may be beneficial in efforts to prevent future injuries and exposure to head impacts, and this long-term goal is more important than short-term emotional responses.

POSTCONCUSSION SYNDROME AND PROLONGED SYMPTOM PRESENTATION

The complexity of return-to-play decisions are further complicated in persons presenting with prolonged symptoms or who are classified as having postconcussion syndrome (PCS). Traditionally, PCS has been defined as the presence of signs and symptoms directly related to a head injury that last longer than 3 months. More recently, PCS in the athletic population has been described as symptoms that last for more than a month [21]. Both criteria highlight symptoms that last for a prolonged period, well beyond the more typical 7- to 10-day recovery period after concussions. When symptoms occur for this extended period, neuroimaging such as a computed tomography or magnetic resonance imaging may be required to rule out other causes that may lead to these symptoms. Although the amount of research concerning nontraditional imaging and its role in concussion assessment is increasing, it is not yet fully validated or intended for clinical decision making after a concussive injury. In the future these techniques may take on a larger clinical role. Further, neuropsychiatric tests also may be warranted to identify any coexisting conditions, such as depression, that

may complicate return decisions. Return to activity should be deferred until all signs and symptoms have resolved, first at rest and then with progressive exertion to maximal activity, and until all diagnostic testing, including neurocognitive and neuropsychiatric testing, has returned to baseline or above. In cases of severe or prolonged PCS, retirement, especially from collision sports, should be considered.

POTENTIAL COMPLICATIONS OCCURRING CONCURRENTLY WITH CONCUSSION

Another important consideration after concussion is the occurrence of concurrent injuries, such as intracranial hemorrhage or contusion. These hemorrhages, whether subdural, epidural, intracerebral, or subarachnoid, should be factored into return-to-play and retirement decisions. After these injuries, thorough consultation and deliberation should occur before the decision is made. Subdural hematomas are the leading catastrophic head injury in persons who participate in sports [25] and can lead to severe complications and death if not managed properly. Furthermore, persons with a subdural hematoma may take longer than those with an epidural or subarachnoid hemorrhage to present with deteriorating signs and symptoms. This possible delay highlights the importance of not allowing athletes to participate while they are symptomatic and not allowing them to continue to participate on the same day of a suspected concussion. Other intracranial hemorrhages may present with a more rapid onset, and the presence of any of these abnormalities should be considered when deciding on the timing of a return to participation or whether an individual should be allowed to return at all. After any of these intracranial hemorrhages, a return to a collision sports is discouraged, but a return to other noncollision sports can be considered if recovery is complete. In special circumstances, if return to play is considered, it should be at a time point far removed from the time of injury (>1 year), and all imaging, neurocognitive, balance, and other clinical measures should be at baseline performance for that individual.

No return-to-play discussion can be presented without a discussion of second impact syndrome, which occurs when an individual sustains a second impact that happens while the brain is in a vulnerable condition after an initial impact, usually a concussion. This relatively rare catastrophic condition, although primarily seen in younger athletes, also has been reported in young adults [26]. Second impact syndrome occurs when the brain loses autoregulation of blood flow, which leads to cerebral vascular congestion, increases intracranial pressure, and results in brain herniation. The condition results in 50% mortality and 100% morbidity [26]. Second impact syndrome, along with the consideration of the young developing brain, is one of the driving forces behind the recommendation that no athlete at any age, but especially no athlete younger than 18 years, be allowed to return to play

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on the same day as an injury and that athletes with a suspected concussion be seen by a medical provider before they participate in sports again. Finally, participating in sports again after second impact syndrome is contraindicated and most likely is not possible, because rarely does an athlete fully recover from this event [26].

PRE-EXISTING CONDITIONS AND INFLUENCE ON RETURN AND RETIREMENT

In addition to the events and issues that occur after an injury is sustained, individuals also may have pre-existing conditions such as migraines or attention-deficit/hyperactivity disorder, or they may have psychological considerations such as depression or anxiety. These conditions can complicate decision making and should be carefully evaluated and considered when deciding on return-to-play parameters. These conditions may delay recovery and worsen symptom presentation after what initially appears to be an uncomplicated concussion. One important consideration for athletes with these pre-existing conditions is that, before returning to play, they be back to their baseline, which may not have been asymptomatic. Some evidence exists that persons with many of these conditions, such as attention-deficit/hyperactivity disorder, learning disability, dyslexia, and headache disorders, may be at a higher risk for sustaining a concussion and other injuries [27].

SUMMARY

Although many return-to-play and retirement decisions are based on a culmination of factors specific to each individual patient (Table 1), some conditions and situations contraindicate returning to play or any type of participation, especially in collision sports (Table 2). These situations include the following: persistent postconcussion symptoms (including chronic headache), symptomatic neurologic or pain-producing abnormalities about the foramen magnum, permanent central neurologic sequelae from a head injury, hydrocephalus, and spontaneous subarachnoid hemorrhage from any

Table 1. Factors in determining return to play

Intrinsic Factors	Sport-specific Factors	Concussion History
ADD/ADHD	Type of sport	Concussion history
Headache disorders	Style of play	Duration
Psychiatric disorders	Position	Severity
Gender		Injury threshold
Age		History of "subconcussive" blows
Learning disability		
Dyslexia		

ADD = attention deficit disorder; ADHD = attention-deficit/hyperactivity disorder.

Table 2. Contraindications to returning to sports

Persistent postconcussion symptoms
Increasing symptoms in the setting of decreased impacts
Symptomatic neurologic or pain-producing abnormalities about the foramen magnum
Permanent central neurologic sequelae
Hydrocephalus
Spontaneous subarachnoid hemorrhage from any cause
Second impact syndrome

cause. Persons experiencing increasingly more prolonged postconcussion symptoms from increasingly minor head impacts are the athletes for whom return to a collision sport is contraindicated. Furthermore, as indicated in this article, a variety of conditions, outcomes, and factors must be considered during each return-to-play or retirement decision.

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