

What are the most appropriate return-to-play guidelines for concussed child athletes?

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ABSTRACT

Objective: To examine concussion literature for specific guidelines regarding return to play (RTP) following sport-related concussion in child athletes. To make recommendations regarding the most appropriate RTP guidelines for child athletes following sport-related concussion.

Design: A literature review of concussion literature.

Intervention: A literature search was conducted using Medline and Embase databases from 1998 to 2008. More than 60 articles and two websites were reviewed.

Results: There is a paucity of research on sport-related concussion in child athletes, particularly younger children (age 5–12 years). In particular, there is no research on RTP guidelines for child athletes following sport-related concussion. Child athletes take longer to recover from concussions than adults. Concussion symptoms may resolve before cognitive function has completely recovered. Concussion assessment and management in children can be confounded by their growth and development, as well as the lack of trained medical personnel involved with youth sports. There are no child-specific assessment tools for concussion.

Conclusions: RTP decisions in children should be made cautiously and should be individualised. No concussed child athlete should be allowed to RTP the same day. Physical and cognitive rest is very important to allow for the resolution of concussion symptoms. Child athletes should remain symptom free for several days before starting a medically supervised stepwise exertion protocol. Further research is needed to elucidate the effects of concussion in children and to determine the most appropriate RTP guidelines. Child-specific concussion assessment tools need to be developed to improve concussion assessment and management in children.

Sport-related concussions are common injuries among children and adolescents participating in sport and recreational activities. Much interest has been generated in the past decade regarding the diagnosis and management of sport-related concussions, particularly with respect to return-to-play (RTP) guidelines. There is evidence to support the fact that concussions in children and adolescents are different from adults. In particular, it appears that children and adolescents take longer to recover from concussions. Improper diagnosis and management of concussions in young athletes may result in second impact syndrome, long-term cumulative sequelae, or potential coma or death. RTP decisions can be especially problematical in this age group. The purpose of this review is to present the current state of affairs regarding RTP guidelines following sport-related concussions in paediatric athletes.

METHODS

A literature search was conducted using Medline and Embase databases from 1998 to 2008. The search strategy combined terms relating to “concussion” (concussion, brain concussion) with terms related to RTP (return to: play, sport, competition, participation, activity, game, recovery of function, time factors, convalescence) and was limited to the paediatric population. Concussion guidelines in general were also searched. A further search was conducted combining the terms “sport-related concussion” with “athletes”, “adolescent” and “children”. The reference lists of articles obtained, in addition to the author's own personal archive of references, were also searched for relevant articles. More than 60 articles and two websites were reviewed. Articles were included if they contained information about sport-related concussions in young athletes, and in particular if they included RTP guidelines for children and adolescents who had sustained a sport-related concussion.

HOW COMMON ARE SPORT-RELATED CONCUSSIONS IN CHILDREN?

Data from the Centers for Disease Control and Prevention in the USA estimate that traumatic brain injuries in children 0–14 years of age result in 435 000 emergency department visits annually.¹ One descriptive epidemiological study in the USA indicated that concussions represent 8.9% of all high school athletic injuries and 5.8% of all collegiate athletic injuries.² A retrospective review of emergency medical records in Canada indicated that 3% of all sport-related injuries were head injuries and that the majority of these injuries occur in the paediatric age group.³ Sport-related head injuries comprised 18.2% of head injuries in children less than 10 years of age, 53.4% in children 10–14 years of age and 42.9% in 15–19 year olds.³ Concussions occur most commonly in contact sports, such as hockey and football, as well as soccer, basketball, lacrosse and wrestling.^{2 4}

HOW IS CONCUSSION DIFFERENT IN CHILDREN?

Susceptibility to concussion

Concussions (as defined by the Concussion in Sport Group) result in deficits in attention/concentration, reaction time, processing speed and memory on neuropsychological assessment.^{5–8} Evidence indicates that younger athletes are more susceptible to concussion than older athletes. Younger athletes appear to take longer to recover from concussion and have more significant neurocognitive effects from concussion.^{7–10} A prospective case-control study comparing neurocognitive

Supplement

What is already known on this topic

- ▶ Children take longer to recover from concussions than adults.
- ▶ Symptoms may resolve before cognitive deficits have recovered.
- ▶ Growth and development during childhood can confound concussion assessment and management.

What this study adds

- ▶ Paucity of research on RTP guidelines in children.
- ▶ RTP decisions must be cautious and individualised in children with concussions.
- ▶ Highlights the need for further research in children regarding concussion.

recovery after sports-related concussion in high school athletes and college athletes demonstrated that high school athletes had prolonged memory dysfunction.⁸ High school athletes performed significantly worse than age-matched controls at 7 days after injury, whereas college athletes showed recovery by day 3 after injury. Another prospective case-control study in high school athletes demonstrated similar findings.⁷ Concussed athletes demonstrated impairments in reaction time, processing speed and memory functioning. Reaction time and processing speed returned to baseline by 6 days post-injury, but memory dysfunction was evident up to 7–10 days post-injury.⁷ Persistent deficits in verbal memory up to 14 days post-concussion were also demonstrated in a prospective study of high school and collegiate athletes.¹⁰ This study also showed persistent neurocognitive deficits in some athletes whose symptoms had been reported to have resolved.

Self-report of symptoms

Other studies indicate that neurocognitive deficits may persist even when physical symptoms have been reported to have resolved. A prospective case-control study demonstrated that high school athletes with mild concussions had significantly lower memory scores 7 days post-injury compared with their baseline scores, even though they had reported that their post-concussion symptoms had resolved by day 4 post-injury.¹¹ Another prospective case-control study in high school and college athletes compared symptomatic concussed athletes with asymptomatic concussed athletes and controls. The study found that athletes who reported resolution of their concussion symptoms still demonstrated poorer performance than control subjects on tests of verbal memory, visual memory, reaction time and processing speed.⁹ These findings are supported by another prospective case-control study in high school and collegiate athletes that found that although only 64% of athletes reported symptoms, 83% showed decreased performance on neurocognitive tests.¹² These studies indicate that prolonged recovery periods following concussions in younger athletes puts them at greater risk of the catastrophic effects of repeated head injuries than older athletes,³ and that self-report of symptoms may be inadequate in diagnosing concussion and evaluating recovery.⁹

Maturation and growth

An important difference between children and adults is that children are growing and maturing physically, cognitively,

socially and emotionally. Neuropsychological tests indicate that children undergo rapid cognitive development. Substantial improvement in performance on tests of reaction time, working memory and new learning occur between the ages of 9 and 18 years, with the largest changes demonstrated between 9 and 15 years of age.^{13–14} This process of development can confound concussion assessment because maturational improvements may mask injury-related cognitive impairment.

During childhood and adolescence, cognitive and psychosocial development plays a role in injury management.¹⁵ Children aged 6–11 years are not able to think in terms of the future. Their thinking is very concrete and they cannot think through the consequences of their actions. Their attention spans are still limited and they are easily distracted.¹⁶ During early adolescence (12–14 years), thinking is concrete and children fail to comprehend the long-term consequences of head injuries. As a result, they may not seek medical attention and may not adhere to treatment recommendations. Middle adolescence (15–16 years) is marked by increasing independence and separation from parents. Peers and media greatly influence adolescents and sport participation can be very important to impress peers and gain social acceptance. It may be difficult to secure the cooperation of injured athletes at this stage of development to adhere to treatment recommendations. During late adolescence (17–19 years), thinking becomes more abstract and adolescents mature in their understanding of personal and social relationships. They have a greater appreciation of the potential long-term consequences of head injuries and may be more cooperative with treatment recommendations.^{15–16}

Medical supervision

Another difference between children and older athletes is that there is generally no medical supervision at children's sporting activities. Typically, coaches are less experienced, there are no athletic trainers/physiotherapists and no team physicians. In addition, a large proportion of children participate in recreational activities with no adult supervision. The lack of trained supervision may result in the underrecognition and underreporting of concussions in children and adolescents.¹⁷ The lack of medical involvement during children's sporting activities also makes baseline testing (neuropsychological tests, balance tests) nearly impossible in this age group.

Younger children (aged 5–12 years)

To date, there have been no studies of sport-related concussions in younger children (5–12 years of age). It is not known how this population recovers from concussion and whether they have even slower recovery periods than older children and adolescents. There is evidence to suggest that the developing brain is more vulnerable to injury. A prospective study comparing children who had sustained a head injury at less than 7 years of age and children who sustained a head injury at greater than 7 years of age found that younger children

Ongoing research

- ▶ New diagnostic methods (functional magnetic resonance imaging, positron emission tomography, single-photon emission computed tomography).
- ▶ Paediatric version of ImPACT.

Unanswered questions

- ▶ Evidence-based RTP guidelines.
- ▶ Optimal length of asymptomatic period before starting stepwise exertion protocol.
- ▶ Quick assessment tool for children 5–11 years of age.
- ▶ Duration and nature of subclinical cognitive impairment.
- ▶ Recovery from concussion in younger children (5–12 years of age).
- ▶ Effect of gender on concussion and recovery.

performed worse on intellectual testing than older children.¹⁸ There is a definite need for more concussion research in younger children.

WHAT ABOUT MULTIPLE CONCUSSIONS?

Repeated concussions may result in long-term consequences. A prospective study looking at neuropsychological evaluation in high school athletes with no history of concussion, asymptomatic athletes with one previous concussion, asymptomatic athletes with two or more previous concussions and athletes who had sustained a concussion within the previous week indicated that asymptomatic athletes with two or more previous concussions had similar performances to recently concussed athletes.¹⁹ Both groups had decreased performance on measures of attention and concentration.¹⁹ Another prospective study comparing high school athletes with no previous history of concussions with high school athletes who had sustained three or more previous concussions showed that athletes with a history of three concussions were 9.3 times more likely than athletes with no previous history to demonstrate three to four abnormal on-field markers of concussion severity, including loss of consciousness, anterograde amnesia and confusion.²⁰

Recurrent concussions present another problematical area of management. Assessment of these individuals should include details of previous concussions, such as completeness of recovery, interval between concussions and the mechanism of injury in each concussive injury. Concerning features include prolonged recovery courses, shorter intervals between injury, subsequent concussions while still symptomatic from a previous concussion and progressively less force required to cause concussion.^{21–22} In this setting, strong consideration should be given to changing to a position or sport with less risk of head injury.^{22–24}

WHEN IS A CONCUSSED ATHLETE READY/ALLOWED TO RTP?

This is one of the most difficult areas in concussion management, particularly with children and adolescents. There is a lack of information on concussion and recovery from concussion in children, particularly in younger children. There has been more research in the adolescent age group (14–18 years). Due to the relative paucity of information in children, most RTP guidelines for concussed children are modelled on adult guidelines, with the assumption that recovery following concussion is standard across all ages. Currently, there are no evidence-based RTP guidelines that have been validated in children.

Concussion in sport agreement statements based on expert opinion agree that a symptomatic athlete, regardless of age, should be withheld from competition.^{5–6, 22} Athletes should be assessed by a physician with expertise in managing concussions. An athlete should return to activity only once signs and

Information resources for patients/parents

- ▶ http://www.thinkfirst.ca/concussion_education.asp
- ▶ <http://www.cps.ca/english/statements/HAL/HAL06-01.htm>
- ▶ http://www.cdc.gov/ncipc/tbi/coaches_tool_kit.htm
- ▶ <http://www.casm-acsm.org/documents/PragueGuidelines.pdf>
- ▶ http://www.hockeycanada.ca/index.cfm/ci_id/7699/la_id/1.htm

symptoms of a concussion have completely resolved at rest and during exertion and a neurological and cognitive assessment are normal. Recently, an even more conservative approach has been advocated for younger athletes. In particular, it is recommended that any concussed young athlete be immediately removed from play and not allowed to return that day.^{22–25} Symptoms may initially clear but recur later that day or the next day, making it imperative that a concussed athlete not be allowed to return to the same game or practice. “When in doubt, sit them out!”

The standard of care in this area is to preclude any symptomatic athlete from participating in sporting activity. Concussed athletes should rest, both physically and cognitively, and avoid any activities that may exacerbate symptoms (physical exertion, video games, computer games, TV, reading).^{6, 22} Cognitive rest in children and adolescents may require school absence for a period of time to allow symptoms to resolve. Symptom checklists, such as the one included with the sport concussion assessment tool (SCAT), can be helpful to monitor the resolution of symptoms associated with concussion, although paediatric-specific lists need to be developed.^{6, 21–25} Medical follow-up visits should be arranged within 7–10 days to monitor progress.²¹

Many guidelines and authors advocate that neuropsychological testing should be performed before RTP. Ideally, baseline testing should be done so that post-injury assessments can be compared with an athlete’s own performance levels. Neuropsychological testing in child athletes can pose several difficulties, including having to repeat baseline testing every 4–6 months to account for maturational improvements in test performance. In child athletes, baseline neuropsychological testing is not recommended because of the financial costs, time and energy required to implement them, and the difficulty of administering baseline tests in a sporting population that typically does not have available medical involvement.^{6, 21–22, 24} Neuropsychological testing should be considered as part of the management of concussions that are complicated but is not recommended as routine in typical concussions that resolve in the expected timeframe.^{6, 21–22} It should not be the sole basis of management decisions and RTP decisions.^{6, 20–24}

Tips for non-specialists

- ▶ If you suspect a paediatric athlete has sustained a concussion, keep them out of sports until they are asymptomatic.
- ▶ Athletes should be symptom free for several days before starting a medically supervised stepwise exertion protocol.
- ▶ If you are uncomfortable managing a sport-related concussion in a young athlete, refer to a sport medicine specialist.
- ▶ Neuroimaging is not indicated in concussion unless there is concern regarding intracranial injury.

Supplement

Box 1 Stepwise exertion protocol

1. No activity
2. Light aerobic activity (walking, stationary bike)
3. Sport-specific activities and training (running in soccer, skating in hockey)
4. Non-contact training drills
5. Full-contact practice training
6. Game play

WHAT GUIDELINES SHOULD BE USED TO RETURN A CONCUSSED ATHLETE TO PLAY?

Several agreement statements regarding the management of sport-related concussion have been published in the literature.^{6 22} However, no guideline has been evaluated by a double-blinded prospective study of concussed young athletes.²⁶ Agreement exists that more conservative RTP decisions be used in the paediatric age group.⁶ The decision to RTP must be taken cautiously and individualised for each athlete.^{23 26} Caution is justified because of the cumulative effects of repeated concussion^{19 20} and because of the increased vulnerability to additional injury.^{18 20 27} Athletes who have sustained previous concussions have been found to be three to six times more vulnerable to future injury.²⁷ Although very rare, second-impact syndrome has been documented exclusively in younger athletes less than 19 years of age and is thought to occur when athletes return to sport while still symptomatic from a previous head injury.²⁸

The most accepted protocol for RTP is a stepwise exertion protocol recommended by the Concussion in Sport Group^{5 6} and adopted by other groups (box 1).^{4 15 22–25} Once an athlete has become symptom free at rest, he/she can progress through a stepwise progression of increasing exertion (box 1). The athlete should take 24 h to proceed through each step and must remain symptom free before moving to the next step. This progression must be medically supervised. If any symptoms recur, the athlete should rest for 24–48 h and try to progress again.

How long the athlete should be symptom free before starting the exertion protocol has not been determined. The Canadian Paediatric Society guidelines suggest that athletes should be symptom free for several days before attempting to start the exertion protocol.²²

Overreliance on current published guidelines can be problematic because of the variance of recommendations, lack of validation and the extent of individual variation in presentation and recovery from concussion. Guidelines can provide a reference point, but it is important to assess each athlete individually using clinical signs and symptoms and appropriate follow-up rather than strict adherence to published guidelines.²⁶ Until prospective studies on large numbers of young athletes have been performed to elucidate further how these athletes respond to concussion and recover from these injuries, caution must be exercised when returning concussed athletes to play.²⁶ Fig 1 summarises RTP suggestions for concussed children.

CONCLUSIONS

There are limited published data on the acute and long-term consequences of concussion in young athletes, particularly in children aged 5–12 years. Current RTP recommendations are based on adult guidelines, with no prospective validation studies available in young athletes. RTP decisions need to include many variables, including the nature of the injury, the history of previous concussions and physical and cognitive function.

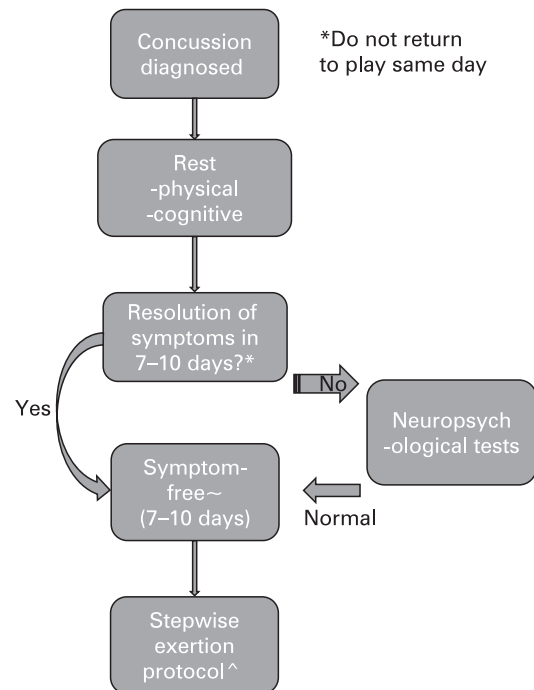


Figure 1 Return to play. Rest until symptom free. Assessment of symptoms: sport concussion assessment tool (SCAT); post-concussion symptom scale; normal neurological exam; normal cognitive assessment. *Need child-specific, validated assessment tools. ~How long should children be symptom free before starting stepwise exertion protocol? Stepwise exertion protocol should be medically supervised.

Because of the variability of signs and symptoms and the length of recovery from concussion in younger athletes, injured athletes should be assessed and managed on an individual basis. Athletes must be completely symptom free at rest and with exertion before returning to sport participation. There is a great need for an objective, validated assessment tool to assess concussion and recovery in younger athletes that can easily be administered in the office/clinic. Future research should include studies assessing the diagnosis of concussion in children, objective assessment of concussion symptoms in children, the appropriate length of time for children to be symptom free

Summary points

- ▶ An athlete who has sustained a concussion must be removed immediately from play.
- ▶ An athlete with a concussion should not be allowed to RTP until they are asymptomatic.
- ▶ Concussed athletes should rest, both physically and cognitively, until symptom free.
- ▶ Symptoms of concussion should be resolved for several days before returning to activity.
- ▶ RTP decisions must be individualised.
- ▶ RTP should follow a medically supervised stepwise exertion protocol.
- ▶ If symptoms recur, an athlete should rest for 24–48 h and try again.
- ▶ More research is required in paediatric athletes to determine how they respond and recover from concussions and to determine evidence-based RTP guidelines.

before starting a progressive exertion programme and validation of RTP suggestions for children.

Competing interests: None.

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