

# Assessment and management of sport-related concussion in general practice



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## Background

Sport-related concussion (SRC) is a traumatic brain injury that occurs during sport or exercise activity. SRC is a growing health concern in Australia, with increasing public awareness and presentations to general practitioners being increasingly common.

## Objective

This article will focus on the assessment and management of SRC in general practice, including guidance for returning patients to sport. Concussion prevention, potential long-term complications, and the decision-making process regarding retirement from sport are beyond the scope of this article.

## Discussion

Recognising concussion can be difficult, as clinical symptoms and signs of SRC can evolve over a period of hours to days. General practitioners should be aware of the range of clinical concussion presentations. The key principles of management include relative rest, followed by a graduated return to cognitive and physical activity. Involvement of a multidisciplinary team can improve symptoms for those patients whose concussion symptoms are prolonged.

**CONCUSSION** is a form of mild traumatic brain injury resulting from an external force that causes a transient alteration in brain function. Sport-related concussion (SRC) is defined by the Amsterdam 2022 International Consensus Statement on Concussion in Sport as ‘a traumatic brain injury caused by a direct blow to the head, neck, or body resulting in an impulsive force being transmitted to the brain, that occurs in sports and exercise-related activities’.<sup>1</sup> Importantly, symptoms can present immediately, or can evolve hours or days after an initial injury.<sup>2-4</sup>

The pathophysiology of concussion is complex and multifactorial. Physical impact to the body or head leads to acceleration, deceleration, and rotational forces, which might be transmitted to the brain. These forces initiate a neurotransmitter and metabolic cascade, resulting in alterations in cerebral blood flow, cell metabolism and membrane permeability, neuroinflammation and possible axonal injury.<sup>1,5</sup>

SRC affects both male and female athletes across all age groups. Athletes from all levels of sport can be affected, from the recreational sportsperson to the professional elite athlete.<sup>4,6</sup> The risk of concussion can vary, depending on the type of sport and level of participation, training or competition, and athlete sex. Individuals who participate in contact, collision, and combat sports have a

high risk of repeated head trauma and SRC. Female athletes have a higher risk of SRC and a higher risk of prolonged symptoms compared to male athletes.<sup>4</sup> Precise data on the incidence, frequency, and prevalence of concussion in Australia are unknown, but it has been estimated that at least 100,000 SRCs occur in Australia each year.<sup>4</sup>

The Australian Institute of Sport (AIS) Concussion and Brain Health Position Statement provides an excellent overview of the diagnosis and management of concussion, and is applicable to both community-level and elite sportspersons.<sup>4</sup> This position statement recommends that all sports operate on a principle of an ‘abundance of caution’, to provide adequate care to athletes regardless of the level of medical care available at the time of the injury. Where there is any suspicion of SRC, an athlete should be removed from the competition or training environment to avoid further potential injury and should not be allowed to return to sport until cleared by a medical practitioner. If managed appropriately, most episodes of concussion resolve over a short period of time. Relative rest, followed by a gradual return to cognitive and physical activity, is the mainstay of treatment. Following a concussion, complications such as prolonged duration of symptoms and increased susceptibility to further injury can occur, and complex

cases should be referred to a specialist with experience in this area (eg sports physician, neurologist).<sup>4</sup>

## Assessment

The general practitioner (GP) is often the first point of medical contact for the patient with minor head trauma and potential SRC.

Common presentation scenarios include:

- presentation on day of injury (eg child who has sustained a 'head knock' during school sport, or recreational athlete attending an after-hours medical clinic)
- presentation 48–72 hours post-injury (eg athlete who sustained an injury during the weekend, but had been unable to see a GP until the first-available appointment)
- delayed presentation some days/weeks after injury with persistent symptoms that are failing to improve (eg SRC not recognised at the time of injury and no restrictions or management has been implemented)
- patients presenting for initial review days/weeks after a head injury and requesting a medical clearance to return to sport.

If a patient has been seen at a sporting event and diagnosed with SRC by a doctor covering the event, it would be very rare that this initial diagnosis should be overruled. It is important to remember that because concussion is an evolving event and clinical features might change over hours to days, a doctor who was not present at the time of injury should

support a diagnosis of concussion made by a medical colleague; this colleague might have been privy to supporting history and examination findings, and might have directly witnessed the event and assessed the patient at the time of injury.

## Recognition of SRC

SRC should be suspected when, during sport, an event results in a knock to the head or body that has the potential to transmit a degree of force to the brain.

It is important to note that concussion can occur from direct head contact or indirect trauma (ie trunk contact, whiplash injury).

A hard knock is not required; concussion can occur from relatively minor impacts.

Contrary to common belief, more than 90% of concussions do not involve a loss of consciousness.<sup>6,7</sup>

Recognising concussion, particularly when a loss of consciousness has not occurred, can be difficult, as SRC can present with a range of clinical symptoms and signs (Table 1).<sup>8–11</sup> At the time of injury, concussed athletes might exhibit signs of disorientation, clumsiness or balance difficulties, and might have trouble concentrating and answering specific questions.<sup>6</sup> The Maddocks questions have been used as a set of on-field responses designed to briefly assess orientation and memory function.<sup>12</sup>

It is important to understand that concussion is an evolving phenomenon; signs and symptoms can change or have

a delayed onset, reflecting the changing underlying physiological status of the brain. Severity of impact, anatomical location of impact, age, and sex of athlete all play key roles in the neuropathophysiology and clinical presentation of SRC.<sup>6,7</sup> Athletes with SRC might experience new onset of anxiety, fear, or depression associated the injury; persons with underlying mental health concerns might experience an exacerbation of symptoms following SRC. Cognitive symptoms might manifest as impairments in processing speed, attention, memory, and executive functions and, in line with other features, might be present after initial injury, or evolve over hours to days.<sup>7</sup>

## Red flags

Clinical features after head injury that might raise concerns for possible structural injury include, but are not limited to:<sup>6,13–15</sup>

- high-velocity or high-energy impact, especially if collision is with a fixed or unyielding structure (eg head versus goal post)
- immediately and/or prolonged loss of consciousness (more than two minutes), or deteriorating/fluctuating consciousness level
- severe neck pain
- increasing restlessness, agitation, confusion, or unusual/inappropriate behaviours and personality change
- clinical examination findings consistent with focal neurological deficit
- prolonged disorientation or post-traumatic amnesia
- progression of symptoms and deterioration in clinical status (eg severe or increasing headaches, persistent vomiting)
- seizures or convulsions.

Patients in whom a structural head or neck injury is suspected warrant urgent investigation, typically with computerised tomography (CT), to exclude pathology such as intracranial haemorrhage, skull fracture or cervical spine injury. Although patients with significant red flags are often identified at the time of injury by support staff, family or friends as needing urgent medical care and placed into the care of paramedical and emergency department staff, those with slowly progressing symptoms or deteriorating neurological status might present to a GP in the first instance.

**Table 1. Possible symptoms of sport-related concussion**

Headaches	Difficulty remembering
Pressure in head	Fatigue or low energy
Neck pain	Confusion
Dizziness	Drowsiness
Blurred vision	More emotional
Balance problems	Irritability
Sensitivity to light	Sadness
Sensitivity to noise	Nervous or anxious
Feeling slowed down	Sleep disturbance
Feeling like 'in a fog'	Abnormal heart rate
Difficulty concentrating	Excessive sweating

## Clinical history

Currently, there is no specific diagnostic test to confirm a concussion; diagnosis is based on the assessing doctor's clinical judgement. Key components of the clinical history should include the following, where possible:<sup>1,3,6,7</sup>

- details of the mechanism of injury, including estimation of impact forces
- patient recollection of events
- collateral history of the injury event might be gained from others who were present at time (eg parent/carer/spouse/coach)
- medical documentation from event staff/hospital records, if available
- video footage of the injury event and/or patient behaviour following the episode, if available
- symptoms and signs (at time of injury, in immediate hours after, and over the following days)
- previous concussion history (total number sustained, date of most recent concussion prior to this episode, how each concussion was sustained, and recovery time/symptom resolution)
- medical history, including any modifying factors (described below).

## Examination

Key components of the physical examination should include:<sup>10</sup>

- neurological assessment, including the assessment of cranial and spinal nerves, motor function, sensation and deep tendon reflexes
- cervical spine assessment, including tenderness and range of motion
- examination of any other injuries sustained at the time (eg haematoma, wound, soft tissue injury)
- measurement of heart rate and blood pressure in two positions, supine and standing. Symptoms brought on by a postural change should be noted
- multimodal clinical assessment including assessment of cognitive functioning, balance testing and Vestibular/Ocular Motor Screening (VOMS),<sup>16</sup> mental health symptom screening, and sleep assessment.

Assessment of suspected concussion patients can be facilitated by use of the Sport Concussion Assessment Tool (SCAT), currently in its sixth iteration (SCAT6).<sup>17</sup> This tool can be used following suspected concussive injury to assess features including

potential symptoms, cognitive function, neuromotor function and balance. Primary care practitioners are encouraged to become familiar with the SCAT6 tool, as it provides valuable quantification of patient symptoms and signs, which can be monitored (and repeated, if required) over time. It can be used on the day of an injury, should a patient present following a potential concussive injury, or in the days following SRC. In patients aged 8–12 years, it is recommended to use the Child SCAT6 tool; patients aged  $\geq 13$  years can be assessed with the SCAT6 tool.<sup>15,17</sup> Both the SCAT6 and the Child SCAT6 are freely available online to health practitioners (Box 1).

The clinical use of the SCAT appears to diminish after 72 hours following an injury event.<sup>1</sup> A new multimodal tool for ongoing patient assessment after 72 hours has recently been released; the Sport Concussion Office Assessment Tool (SCOAT6) was developed to provide medical professionals with a tool to monitor SRC clinical signs and symptoms over time, allowing individual recovery and the identification of symptoms requiring specific therapeutic interventions or specialist referral. Similar to the SCAT6 tool, the SCOAT6 is available in adult ( $\geq 13$  years) and child (8–12 years) versions.<sup>10,11</sup>

## Investigation

There are no reliable radiological or laboratory investigations that assist with the diagnosis of uncomplicated concussion. Neuroimaging in SRC yields negative findings on conventional structural scans (ie CT or magnetic resonance imaging [MRI]) and is therefore not indicated in the primary care setting.<sup>1</sup> Where there is evidence of altered neurological function or other red flags, or if symptoms persist for a prolonged period of time (more than four weeks), a CT or MRI might be indicated at that stage to exclude serious structural pathologies such as a fracture or an intracranial haemorrhage.<sup>4,7</sup>

Neurocognitive testing might be used for assessment of cognitive deficit and monitor cognitive recovery in the concussed athlete. Athletes participating in elite or professional sport might have access to computerised neurocognitive testing, through their sporting organisation. Most patients presenting with SRC will not have access to computerised neurocognitive

testing; however, multiple paper-based tests are available on the internet for health practitioners (eg Stroop Color and Word test). Baseline neurocognitive testing can be useful for comparison with post-injury scores, but in its absence, many programs have reference ranges that can be applied.<sup>6</sup> Neurocognitive testing provides further evidence of higher cerebral functioning, and together with clinical assessment, can guide return to sport timing, but should not be used in isolation to rule in/out a diagnosis of SRC or as a tool for medical clearance to return to sport.

Serum biomarkers, genetic testing, and other emerging technologies are current areas of research for the diagnosis and management of SRC. Currently, there is no role for these tests outside the research environment.<sup>1,4,6,7,18</sup>

## Management

### Advice

Head injury advice, preferably in written format, should be given to any patient with concussion. Patients with SRC should be

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### Box 1. Resources

- SCAT6 (<https://bjsm.bmj.com/content/57/11/622>)
  - Child SCAT6 (<https://bjsm.bmj.com/content/57/11/636>)
  - SCOAT6 (<https://bjsm.bmj.com/content/57/11/651>)
  - Child SCOAT6 (<https://bjsm.bmj.com/content/57/11/672>)
  - VOMS assessment ([www.ncbi.nlm.nih.gov/pmc/articles/PMC4209316/#SD1](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4209316/#SD1)) (See Appendix 1)
  - Australian Sports Commission – education, guidelines, position statements, and resources available for health professionals and sport support staff ([www.concussioninsport.gov.au](http://www.concussioninsport.gov.au))
  - Sports Medicine Australia (<https://sma.org.au/resources/concussion/>)
  - Australasian College of Sport & Exercise Physicians – Concussion in Sport position statement, resources and webinars ([www.acsep.org.au](http://www.acsep.org.au))
  - Connectivity Traumatic Brain Injury Australia – provide free concussion management guidelines, fact sheets, short courses and sport-specific guidelines ([www.connectivity.org.au/](http://www.connectivity.org.au/))
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in the company of a responsible adult for supervision, for at least 24 hours after a head injury. Any athlete with suspected concussion should not be allowed to drive for at least 24 hours. All patients experiencing concussion symptoms should be advised to avoid alcohol and medications with anticoagulant or sedating effects (eg aspirin, non-steroidal anti-inflammatory drugs, sleeping tablets and sedating pain medications).<sup>6</sup>

Patients who have sustained a SRC might have difficulty processing and retaining large amounts of information and interpreting complex medical jargon. Keep information and instructions as simple as possible and provide written information when able. Patients and carers should be provided with education and reassurance around SRC. Adults should be advised that the majority of concussive symptoms resolve within 10–14 days.<sup>2</sup> In paediatric and adolescent patients, concussion symptoms can take longer to resolve, with evidence showing symptoms might persist for up to four weeks.<sup>1</sup>

### Relative rest

The principles of concussion management involve a brief period of relative rest, followed by a graduated increase in cognitive and physical activity. Relative rest is advised in the acute period following injury (0–48 hours); this includes performing activities of daily living (ADLs), reducing screen time, and commencing light physical activity if tolerated (ie walking).<sup>1</sup> Enforcing strict rest until concussion symptoms have fully resolved

is not beneficial, and might conversely prolong symptoms and delay recovery.<sup>1,3,19,20</sup> Early resumption of ADLs is associated with improved symptom resolution and shorter recovery time. Cognitive stimulation such as reading, using screens, and undertaking learning activities should be gradually introduced after 48 hours.<sup>4</sup>

### Return to cognitive activities

Children and adolescents take longer to recover from concussion than adults, thus a more conservative approach should be taken with those aged <19 years in order to facilitate symptom resolution.<sup>4</sup> Strict rest and total avoidance of cognitive activities should not be recommended; instead, after a period of relative rest as above (24–48 hours), cognitive loading can be progressively increased as symptoms resolve.<sup>1,6</sup> Return to learning is an important consideration for children/adolescents, and although a return to learn and return to sport can occur in parallel, return to learn should take priority. Learning programs might be modified to include additional rest breaks, limiting prolonged screen time, and extending deadlines required for completing difficult cognitive tasks or assessments.

### Return to physical activities

The process of return to sport participation after SRC follows a graduated rehabilitation plan, termed a graduated return to sport (GRTS). This pathway of increasingly difficult and higher risk physical tasks reduces

the immediate likelihood of reinjury by avoiding higher risk activities (ie collision, fall or direct head trauma); it also facilitates the return of full neurological function while gradually exposing the body to more demanding activities, which could potentially trigger symptom recurrence.<sup>1,7</sup> The reasons for implementing a GRTS rather than allowing immediate unrestricted return to activity are to reduce the risk of: secondary musculoskeletal injury; symptom provocation or prolonged symptoms; and repeat head trauma, which might lead to the very rare (and controversial) condition of second impact syndrome (acute onset cerebral oedema in a patient who has not yet fully recovered from the symptoms of the initial SRC).<sup>6</sup> Each graduated return to physical activity will depend on the sport played by the patient, and their pre-existing level of fitness and competition. An example of a GRTS plan is seen in Table 2.

After a brief period of relative rest, the patient can commence light physical activity and, guided by their symptoms, progressively increase exercise intensity and duration. At times, returning to physical activity exacerbates concussive symptoms; this exacerbation during exercise is typically transient and does not delay recovery. Physical activity duration and intensity can be increased, provided that during exercise there is no more than a mild ( $\leq 2/10$  change) and brief (<60 minutes) exacerbation of SRC-related symptoms; activity should be stopped if symptom exacerbation exceeds

**Table 2. Example of graduated return to sport (GRTS) for a sport (eg football)**

Level	Exercise strategy	Goal	Example (football)
1	Symptom-limited activity	Return to activities of daily living (ADLs)	Walking around the house and yard
2	Aerobic exercise 2A - Light (<55% maxHR) 2B - Moderate ( $\leq 70\%$ maxHR)	Increase heart rate (HR)	Brisk walk (10–15 min) Light jog (15–20 min)
3	Sport-specific exercise	Add movement, change of direction, agility tasks	On field light warm-up, passing drills
<b>Medical review to determine readiness to return to at-risk activities</b>			
4	Non-contact training drills	Resume usual exercise intensity/duration, coordination and cognitive tasks	Completing a full training session with ZERO contact training
5	Full-contact training	Restore and assess functional skills, confidence in return to sport ability	Completing a full training session with contact training
6	Return to sport		Cleared to play a match

these values. Once symptoms have resolved, activity can be resumed at the same level the following day.<sup>1</sup> The patient should spend a minimum of 24–48 hours at each level. Patients can progress to the next activity level only if their symptom exacerbation does not exceed cut-offs (>2/10 increase in severity, >1 hour duration) during that time. If symptoms exceed the threshold, activity should be ceased and attempted the following day.<sup>3,6</sup>

In an adult patient, a GRTS takes, on average, a minimum of one week to complete, if the patient experiences no symptoms with return to activity. Typically, however, return to unrestricted sport participation can take up to one month.<sup>1</sup> Athletes should be reassured that a slower return to sport, although frustrating, is necessary to ensure full neurological recovery (as evidenced by the absence of symptoms) and that complete recovery is preferable to a hasty and premature return to sport.

The Concussion and Brain Health Position Statement 2024 requires athletes aged <19 years, and those athletes without a dedicated healthcare professional to guide recovery, to be symptom free for 14 days (at rest) before return to contact or high-risk sporting activities, and not return to competitive contact sport until a minimum of 21 days from the time of concussion.<sup>4</sup> The Position Statement clearly delineates that these 14 days begin once the patient is free of symptoms and does not begin on the day of injury. This cautious approach ensures that paediatric and adolescent athletes, who are still neurologically vulnerable, can clearly perform all ADLs and activities such as non-contact exercise, without symptoms, before they return to the field of play.<sup>4</sup>

An athlete should be reassessed by their doctor prior to commencing Step 4 (Non-Contact Training Drills). Patients who experience SRC-related symptoms with physical exertion during Steps 4–6 should return to Step 3 until all symptoms have fully resolved.<sup>1</sup> Medical review and repeat assessment, ensuring the patient is symptom-free, is required before athletes are cleared to resume contact training and return to sport.

It is important to be aware that some sports have clearly defined GRTS pathways, which include activities and tasks unique to their sport (ie gymnastics, equestrian).

Clinicians are encouraged to perform an internet search for sport-specific concussion resources, or to contact the national sporting organisation for high-level athletes. Some sporting organisations (eg Rugby Australia) have mandatory stand-down periods following SRC. These timeframes cannot be overruled to return to sport faster, within community-level sport. Further concussion information can be found on the website of national sporting organisations.

## Recovery from concussion

### Concussion-modifying factors

Recovery times following concussion vary between athletes; the average time for clinical symptom resolution might be influenced by athlete sex, age, and the presence of pre-injury medical or psychological diagnoses.<sup>1,4</sup> Concussion modifiers are factors that might affect SRC recovery and influence a clinician's management, and include:<sup>1-3,6,18,21,22</sup>

- a high number of concussive symptoms reported
- reported severe acute and subacute symptoms
- prolonged loss of consciousness (greater than one minute) at the time of the injury
- a post-concussive seizure, following the injury
- experiencing vestibular–ocular symptoms, such as dizziness and blurred vision
- experiencing sleep disturbance in the 10 days after SRC
- having a previous history of concussion
- the age of the athlete (a more conservative approach is indicated in children)
- female gender
- a history of depression, anxiety, migraine, learning disability, attention deficit hyperactivity disorder or sleep disturbance
- the use of medications, especially psychoactive or anticoagulant medications.

If the clinician suspects that an athlete is at a heightened risk of a prolonged recovery, it is worthwhile to consider early intervention, including early specialist referral.<sup>20</sup>

### Persistent symptoms

Most concussion cases follow a relatively uncomplicated rehabilitation and return to life and sport with minimal intervention required. However, 20–30% of athletes experience persistent symptoms, explained as symptoms

persisting for greater than four weeks, regardless of whether they are an adult, child or adolescent.<sup>1</sup> Persisting symptoms might be related to the concussion itself, due to pre-existing conditions, or both.<sup>1,6</sup> Common factors to be considered in the setting of persisting symptoms include: learning or attention difficulties, mental health issues, cervical and vestibular or VOMS disturbance, headache/migraine disorders, sleep disturbance, pain, and dysautonomia. Patients with symptoms extending beyond four weeks require serial multimodal reassessment; these patients often benefit from the involvement of the multidisciplinary team.<sup>6</sup>

### Involving the multidisciplinary team

Patients experiencing multiple or more severe symptoms will benefit from the early involvement of a multidisciplinary team. Targeted treatment interventions and rehabilitation should be based on the nature of persisting SRC symptoms, as identified by the clinician, and are often indicated by the results of repeated SCOAT6 tests.<sup>1</sup> Team members that can provide specific input to patients experiencing prolonged symptoms include:

- Sport and Exercise Medicine Physician (experienced at managing complex concussions)
- Physiotherapist (cervicovestibular rehabilitation) for patients with vestibular, oculomotor and cervical spine symptoms (eg dizziness, vertigo, neck pain)
- Migraine/Headache Specialist (eg neurologist)
- Optometrist, for patients with persisting ocular symptoms (eg diplopia)
- Clinical Psychologist, for patients with additional or pre-existing mental health concerns, cognitive impairments or sleep difficulties following concussion
- Sports or Performance Psychologist can benefit elite athletes or typically high-functioning professionals to manage stressors associated with SRC injury, recovery timeframes, and modifications/removal from usually training/working environments due to concussive injury
- Exercise Physiologists can help with tailored return to training progressions, or detailed specific exercise plans, should they be required. Exercise Physiologists are also very useful for patients experiencing prolonged dysautonomia

(including postural hypotension), in order to progress physical activity in small increments

- Sports Dietitians – there is emerging evidence to support nutritional interventions in the immediate post-concussion period<sup>23</sup> and many Sports Dietitians are working closely in this space
- Occupational Therapists can be used to assist patients with difficulties at work (eg headaches while working on screens all day).

## Key points

SRC is a growing health concern in Australia and a not uncommon presentation to general practitioners in the community (See Box 1 for resources). Key points to remember for the diagnosis and appropriate management of SRC are:

- concussion can occur in the absence of loss of consciousness
- concussion is a clinical diagnosis made by the treating practitioner, based on a combination of incident history, examination features, and multimodal testing using tools such as the SCAT
- medical imaging does not diagnose a concussion in a patient with a history suggestive of SRC
- the key principles of management include a brief period (24–48 hours) of relative rest, followed by a supervised and graduated return to cognitive and physical activity
- no athlete should return to contact or collision sport until medically cleared to do so
- most individuals will recover uneventfully after SRC within four weeks from injury; however, complication can occur, particularly with premature return to sport
- for patients with persisting concussion symptoms, involvement of a multidisciplinary team can address and improve specific symptoms.

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