

Concussion in sport

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Introduction

There are many published definitions of concussion in the literature. In addition there are several grading scales that have been used to help make decisions on when to return an athlete to sport after a head injury. The result is a lot of confusion and misinformation, not only amongst athletes but also amongst the medical teams making return to play decisions.

In order to try and alleviate some of this confusion and give some clear guidelines on management of head injuries in athletes, the 1st International Symposium on Concussion in Sport was held in Vienna in 2001. Attending this meeting were team physicians, neurologists, neuropsychologists and researchers from around the world representing American and Australian Rules Football, Rugby Union and League, Soccer, Ice Hockey and Boxing amongst other contact sports. At the end of the conference a working group, the Concussion in Sport Group (CIS) produced a position statement.¹ This position statement is well worth reading if you see athletes with concussion.

The 2nd International Symposium on head injury in sport was held in Prague in November 2004. This was used to reflect on the guidelines issued in 2001, look at the state of current research and plan for the future. A working group was convened again at the conclusion of the conference, but a position statement has yet to be released. There is unlikely to be any significant changes to the Vienna statement, but there will be added

some specific guidelines for children with concussion.

Definition of concussion

The definition of concussion that the CIS group came up with was long and complex (see Box 1). This made some very important points:

- Concussion is caused by a mechanical force to the brain and that mechanical force may be from a blow to another region of the body other than the head. In other words you can be concussed by a blow to the trunk, for example, if this leads to acceleration, deceleration or rotational forces to the head.
- You can be concussed without having had a period of loss of consciousness.
- Neurological impairment from concussion resolves spontaneously and follows a sequential course. If there is not complete resolution of neurological function then the injury cannot be defined as concussion.
- Concussion results in changes in brain function but no structural changes and so conventional imaging, such as CT, MRI and x-rays will be normal and are of no use in grading the severity of concussion. Imaging does, however, have an important place in the detection of structural lesions, such as bleeding, in more severe head injuries.

Grading of concussion

The CIS group deliberately did not endorse any particular grading system. This is because they believed

that each case of concussion should be managed individually and that it was impossible to predict the clinical course of a particular head injury from a group of signs and symptoms.

It is now accepted that the presence or absence of loss of consciousness following a head injury is no use in predicting time to full recovery. Amnesia, however, in particular loss of memory for events prior to the injury (retrograde amnesia), if present, is associated with a longer recovery time.

Diagnosis

In the vast majority of cases the diagnosis is made on the basis of a history and clinical examination. There is no one symptom that can be used to determine if someone has been concussed. Symptoms that may indicate that an athlete has been concussed include*:

- Headache
- Nausea
- Vomiting
- Drowsiness
- Numbness or Tingling
- Dizziness
- Balance problems
- Sleep disturbance
- Sensitivity to light or noise
- Feeling slowed down or 'in a fog'
- Difficulty concentrating or remembering
- Emotional lability
- Irritable
- Not feeling right

* Adapted from Lovell & Collins, Journal of head trauma and rehabilitation 1998; 13:9-26.

Physical signs that might indicate an athlete has been concussed are: (CIS group 2002)

- Loss of/impaired consciousness
- Poor co-ordination or balance
- Convulsive movements/seizure
- Gait unsteadiness/loss of balance
- Slow to answer questions or follow directions
- Easily distracted or poor concentration
- Inappropriate emotions (laughing, crying, aggressive)
- Nausea/vomiting
- Vacant stare/glassy-eyed
- Slurred speech
- Personality changes
- Inappropriate playing behaviour (running the wrong way)
- Significantly decreased playing ability.

Often the signs are subtle. There are occasions when someone who knows the athlete personally can recognise that the athlete is just not right, whereas to someone who has not met them before the athlete may seem fine.

Unfortunately many concussions in sport go unrecognised. There are several reasons for this. Athletes often do not recognise that they have been concussed as there is a common misconception that you have to have had a period of unconsciousness to be concussed. Secondly, most athletes do not have easy access to medical staff and, as symptoms often settle within 24 hours, they do not have ongoing symptoms that prompt a medical consultation. Thirdly, athletes are used to seeing professional players return to play after being knocked out and simply do not understand the risks associated with returning to play too soon. Finally, there is a – probably large – group of athletes who know that they have been concussed but hide their injury from medical staff because they do not wish to be stood down from playing the following week.

At the Prague Conference, Rob Cantu estimated that at the NCAA (college) level of American Football, where the players are reasonably well-educated about concussion and have good access to medical staff, there was an

under-reporting of head injuries by a factor of four to seven times. I suspect that under-reporting is higher than this in recreational sport in New Zealand.

Pitch side assessment of head injury

It is impractical to go through the above list of symptoms and signs on the pitch side as athletes simply will not know the answer to these questions. The above checklist of symptoms was designed to be used in the office setting in the days following a head injury.

The traditional questions for assessing orientation (e.g. time, place and person) are not reliable in athletes with a head injury.² The Sideline Assessment of Concussion (SAC)³ was recommended by the CIS group as being a convenient and effective tool to use on the sideline and includes tests of orientation, immediate memory, concentration and delayed recall combined with a neurological examination and exercise stress test.

ACC Sportsmart has produced 'sideline concussion check' – a credit card sized booklet. This has been endorsed by Sports Medicine NZ and the NZ Rugby Union. This provides a handy reminder of the symptoms and signs of concussion and a modified SAC tool as well as a take home leaflet to give to the concussed player with advice for the next few days. Copies can be obtained by phoning 0800 844 657 or via www.acc.co.nz/sportsmart. As with all these assessment tools, a pre-injury baseline is very useful.

Neuropsychological testing postconcussion

There are now several software tools available for assessing an athlete post head injury (e.g. Cog Sport and ImPACT). These test a variety of brain functions that are most likely to be affected by concussion and include reaction time, verbal and visual memory and speed of information processing. Although there are normative tables giving average data for the population, there can still be a wide variation in baseline scores be-

Box 1. CIS Group definition of concussion

Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features the incorporate clinical, pathological and biomechanical injury constructs that may be used in defining the nature of a concussive head injury include:

1. Concussion may be caused by either a direct blow to the head, face, neck or elsewhere on the body with an 'impulsive' force to the head.
2. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.
3. Concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.
4. Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course.
5. Concussion is typically associated with a grossly normal structural neuroimaging studies.

tween athletes in the same team and a baseline test score will enable the clinician to determine more accurately if an athlete has returned to normal.

Other means of assessing an athlete's neuropsychological status are simple pen and paper tests that can be administered by the team medical staff (often untrained in the use of these tests) or formal assessment by a trained neuropsychologist (taking on average 40–60 minutes).

The CIS consensus was that neuropsychological testing was one of the cornerstones of concussion evaluation and contributes significantly to the management of the individual. At the Prague Conference there was general agreement that computer-based testing was superior to the traditional pen

and paper tests as computer-based assessment is quicker, requires less training, is easier to interpret, offers more accurate assessment of reaction time, is easier to administer and is preferred by athletes.

Acute management of a head injury

As usual, with a head injury there is always the potential for a concomitant neck injury, so always manage the player as though they have a neck injury until you are satisfied that they do not.

When a player shows any signs or symptoms of concussion they should be removed immediately from the field. They should be assessed by a doctor and should not be left alone. Whether a player should return to play on the same day as a concussion is a matter for some debate. In a study from the NFL (American Football) it was reported at the Prague Conference that over 50% of players returned to play the same game and over 25% of those who had loss of consciousness also returned to play on the same day. This is not to say that this is appropriate management, this is just what is happening.

There are two schools of thought on management after a head injury; one is that as long as a player's symptoms and signs resolve completely within a defined period (usually less than 10 minutes) and the SAC test (or other mental status assessment tool) is normal and the player remains symptom free after an exercise test (usually sprints up and down the sideline), then it is unlikely that the athlete has been concussed and it is safe to return to the field of play as long as you monitor them and remove them from play if there is a recurrence of symptoms.

The other is that a player should never return to play the same contest after a head injury. This is because it has been shown that even if a player's symptoms resolve quickly (within five to 10 minutes), they can still develop symptoms and have sig-

nificant neuropsychological testing deficits the following day.

Management of return to play

The CIS group recommended a step-wise return to sport. Whilst an athlete is still symptomatic they should rest from all physical exercise (including activities such as golf or going on a shopping trip) as exercise can exacerbate symptoms and prolong recovery. Even mental exercise can exacerbate symptoms and students may need to be signed off studies or an athlete off work for a few days to aid recovery.

Once the athlete is symptom free (and has normal neuropsychological testing if available) they can proceed with gradual increases in exercise duration and intensity. Each step should be at least one day after the previous (CIS group):

1. No activity – complete rest until asymptomatic
2. Light aerobic exercise such as walking or stationary bike
3. Sport specific training (running/ skating)
4. Non contact training drills (higher intensity)
5. Full contact training (AFTER medical clearance)
6. Game play.

It is important to note that an athlete should not resume any contact activities until cleared by a doctor. If symptoms occur at any level then the athlete should rest for 24 hours and go back at least one level.

The majority of concussions have recovered within one week. In a poster presentation at Prague, Collie et al. presented a series of 99 consecutive concussions in Australian Rules Footballers. They were all managed in accordance with the Vienna Guidelines with a stepwise return to activity once asymptomatic and normal neuropsychological tests. Over 90% returned to play within a week. There was no increase in incidence of concussion or other injury and there was no decrease in performance when these were compared with a

control group of non-concussed Australian Rules Footballers.

Management of concussion in NZ

At present in New Zealand, despite the large number of concussions that actually do present to doctors, there is no neuropsychological testing readily available. *Sports Medicine NZ* has published guidelines that recommend a minimum three week stand down period after a concussion. This is not based on any hard scientific facts but was recommended on the basis that the vast majority of concussions have recovered by three weeks.

Not all concussions have recovered by three weeks – that is why it is important to always get medical clearance prior to resuming contact activities. At a minimum the athlete should be specifically asked about the presence of any symptoms from the above list (usually on a scale from 0–5) and also asked on a scale of 0–100 how they feel. This is a much better way of unmasking subtle symptoms rather than just asking an athlete 'how do you feel' to which the response is likely to be 'fine Doc!'

If deviating from these guidelines, the following points are worth considering:

- An athlete should never return to play until asymptomatic and then return to play should follow a step-wise increase in activity as suggested by the CIS group.
- You should never use a grading scale to determine when an athlete should return to play – return to play should always be based on resolution of symptoms and signs and normal neuropsychological function (if available)
- Determining when an athlete has recovered is not straightforward; athletes will not always tell the truth and will deny symptoms if they think that they might be stopped from playing.
- Every concussion is different and not all concussions recover within a week – even though the majority will recover within one week.

- Some athletes may be symptom free but still have abnormal neuropsychological tests.
- Unless you know the athlete well (and therefore can pick up subtle clues that may indicate that they have not recovered) and have neuropsychological testing available, then you should not be allowing an athlete to return to play inside three weeks.

Head injuries in children

Children deserve a special mention. Structurally the brain and skull of children is different to athletes. In addition there is the risk of Second Impact Syndrome. In this rare syndrome, if a second concussive injury is sustained prior to recovery from the first one, then massive brain oedema occurs caused by disturbance of autoregulation of brain blood flow. The second impact may be only a trivial injury. There is a high incidence of mortality and 100% morbidity associated with this syndrome. Most clinicians are particularly conservative with return to play decisions in children after a concussion.

Retirement from sport or management of recurrent concussions

As long as an athlete recovers completely between injuries (symptomatically and neuropsychologically) there is not a fixed number of concussions in a season that means an athlete should sit the rest of the season out, or a number in a career that means that an athlete should retire.

Of particular concern is an athlete who finds that it is taking progressively longer to recover from subsequent head injuries or is getting concussed with progressively less trauma. If you have a patient who you are concerned about, then they should be assessed by a clinician who is experienced in dealing with head injuries in athletes and neuropsychological testing would be an important part of the assessment of the clinical picture.

Summary

The management of concussion in theory is very simple. It is safe to return to sport once the athlete has fully recovered and as long as a step wise return to sport is tolerated symptom free. Unfortunately it can be difficult to tell if an athlete has been concussed in the first place and determining when full recovery has occurred is even more tricky. As neuropsychological testing with computer-based programmes becomes more available these decisions will get easier.

References

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