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Concussion in Sport – Return to Sports following Concussion

Abstract

The diagnosis and management of concussion during sports activity is since years one of the most challenging endeavours for all sports physician working on the field. In the last years, more than 20 management guidelines regarding return to play issues have been published. Current research has prompted a reevaluation and revision of prior guidelines with the aim to create an «unité de doctrine» in concussion management strategies.

Two International Symposia on Concussion in Sport, in Vienna 2001 and in Prague 2004, were organised by the International Ice Hockey Federation (IIHF), the Fédération Internationale de Football Association Medical Assessment and Research Centre (FIFA, F-MARC), and the International Olympic Committee Medical Commission (IOC).

The experts group of these two Concussion Symposia pointed out some important recommendations of return of sports following concussion which are discussed in this Current Concept paper. Definition of concussion has changed, on-field examination has been shown to be difficult but crucial, and serial follow-up controls are mandatory to precisely evaluate the severity of the lesion. Based upon a scale of postconcussion symptoms, precise return to play recommendations have been defined and should be known by all physicians involved in speed and contact sports.

Zusammenfassung

Die Diagnose und Behandlung einer Commotio cerebri im Sport ist seit Jahren eine richtige Herausforderung für den an der Front arbeitenden Sportmediziner. In den letzten Jahren wurden mindestens 20 verschiedene Behandlungsrichtlinien publiziert. Neuere Studien sollen diese Richtlinien revidieren, um eine «unité de doctrine» in der Behandlungsstrategie der Commotio cerebri im Sport erstellen zu können.

Kürzlich fanden zwei internationale Symposien über dieses Thema statt, 2001 in Wien und 2004 in Prag. Organisiert wurden sie vom Internationalen Eishockeyverband IIHF, vom Internationalen Fussballverband FIFA und seinem medizinischen Untersuchungszentrum F-MARC sowie von der medizinischen Kommission des Internationalen Olympischen Komitees IOC. Eine Expertengruppe erhielt den Auftrag, ein Consensuspapier mit den aktuellsten Richtlinien in der Behandlung der Commotio cerebri im Sport – vor allem, was die Wiedererlangung der Sportfähigkeit betrifft – zu erstellen.

Die Diagnosestellung hat sich geändert, die Commotio cerebri wird neu und einfacher eingeteilt, und es wird ein neues Commotio-Protokoll erstellt, das sowohl dem an der Front arbeitenden Sportmediziner wie auch dem in einem Spezialistenzentrum tätigen Arzt die Diagnose sowie die Behandlung vereinfacht. Genaue Untersuchungen sind für die Bestimmung des Schweregrades der Hirnschädigung unentbehrlich und bestimmen die therapeutischen Schritte. Dieser klar definierte schrittweise Rehabilitationsprozess muss allen Personen – nicht nur dem Arzt –, die im Umfeld des Athleten Verantwortung für die schnelle Wiedererlangung der Sportfähigkeit tragen, bekannt sein.

Schweizerische Zeitschrift für «Sportmedizin und Sporttraumatologie» 53 (1), 11–16, 2005

Introduction

The diagnosis and management of concussion during sports activity is since years one of the most challenging endeavours for all sports physician working on the field. First of all, the team physician is called to make the diagnosis and he has to take the decision for a return to play based on limited observation of the athlete and after a brief sideline evaluation. This often happens in adverse conditions and under pressure from coaches, other players and fans, and in a very limited period of time. In the last years, more than 20 management guidelines regarding return to play issues have been published. Current research has prompted a reevaluation and revision of prior guidelines with the aim to create an «unité de doctrine» in concussion management strategies.

In November 2001, the first International Symposium on Concussion in Sport was held in Vienna, Austria. This symposium was organised by the International Ice Hockey Federation (IIHF), the

Fédération Internationale de Football Association Medical Assessment and Research Centre (FIFA, F-MARC), and the International Olympic Committee Medical Commission (IOC).

The aim of this first symposium was to provide recommendations for the improvement of safety and health of athletes who suffer concussive injuries in ice hockey, football (soccer), and in other sports. To this end a range of experts were invited to address specific issues of epidemiology, basic and clinical science, grading systems, cognitive assessment, new research methods, protective equipment, management, prevention, long term outcome, and to discuss a unitary model for understanding concussive injury. At the conclusion of the conference, a small group of experts were given a mandate by the conference delegates and organising bodies to draft a document describing the agreement position reached by those in attendance at that meeting (The Concussion in Sports CIS Group) [1].

The Second International Symposium on Concussion in Sport, organised by the same organisations, was held November 2004

in Prague, Czech Republic. The aim of this 2nd symposium was to consider the latest research on head injuries with an emphasis first on rehabilitation, recovery and return to play, and secondly to review and update the Vienna Concussion Consensus Paper, and establish a new effective concussion management programme [2].

Definition of concussion

Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.

Concussion may be caused by a direct blow to head, face, neck, or elsewhere on the body with an «impulsive» force transmitted to the head.

Concussion typically results in the rapid onset of short lived impairment of neurological function that resolves spontaneously.

Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a *functional disturbance rather than structural injury*.

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.

Concussion is typically associated with grossly normal structural neuroimaging studies.

Injury grading scales

The Vienna recommendation was that the injury grading scales be abandoned in favor of combined measures of recovery, in order to determine injury severity and prognosis, and in the same way individually guide return to play decisions was underlined [3]. It was also noted that concussion severity could only be determined in retrospect after all concussion symptoms have cleared, the neurological examination is normal and cognitive function has returned to baseline [4].

Loss of consciousness (LOC)

The traditional approach to diagnosis of concussion utilizing loss of consciousness (LOC) as a primary and important symptom has well known limitations in assessing the severity of sporting concussive injury. Finding in this field describes loss of consciousness (LOC) association with specific early deficits but does not necessarily predicate the severity of the injury [5].

Anterograde and retrograde amnesia

There is renewed interest in the role of amnesia (anterograde/retrograde) and its manifestation of injury severity. Published evidence suggests that the nature, burden, and duration of the clinical post-concussive symptoms may be more important than the presence or duration of amnesia alone [5, 6, 7]. Retrograde amnesia varies with the time of measurement post-injury and is in fact a poor parameter of injury severity [8].

Epidemiology

In the USA as many as 300 000 concussions are identified each year in athletic activity (number certainly underestimated) [9, 10]. A comparative review of USA Consumer Product Safety Board reports dates for soccer, ice hockey and American football from 1990 to 1999. These data were reviewed and summarised as follows: there were an estimated 86 697 head injuries in soccer, 17 008 in ice hockey, and 204 802 in American football that presented to USA emergency departments from 1990 to 1999. The injuries were examined in relation to participation rates per year, in 1999 the

following numbers were estimated for head injuries per participant per year; soccer 0.10%, hockey 0.11%, and American football 0.13%. Cumulative skull and brain injuries (concussions, fractures, and internal injuries) presenting to emergency departments from 1990 to 1999 were 50 035 in soccer, 9883 in ice hockey, and 128 968 in football. Comparing years 1990 to 1999, head injuries have increased 150% in soccer, 134% in ice hockey, and 62% in American football. Concussion as an injury group has increased 250% in soccer, 269% in ice hockey, and 77% in football from 1990 to 1999 [11, 12].

In countries where skiing is an important sport, 16% of all injuries are skiing injuries. The majority of the injuries seen by skiers are injuries to the limbs, followed by head injuries in alpine skiers and snowboarders, and injuries in the back and chest in cross-country skiers. The percentage of head injuries in alpine skiing is 9%, jumping 5%, cross country 4%, and snowboarding 7%. Most of the head injuries are contusions and wounds; about 15% are inner head injuries like concussion. Severe head injuries count for a minority of cases and are seen in competitive alpine skiers and occasionally in jumpers. Most of the severe head injuries are seen among leisure skiers during off-piste skiing [13].

Concussions in soccer, which soccer players may refer to as «dings», «having your bell rung», and «seeing stars» have received increasing attention due to concerns about longer-term effects. Most concussions cause a temporary disruption in mental functioning and most concussion symptoms seen in amateur and professional soccer players fade within a week or two [14].

In the Swedish Elite League (12 teams) 705 injuries were registered during 17 seasons (1984/85–2000/01), and of these 54 were concussions (8%).

During the final 5 years of the registration a total of 32 concussions were found.

Most of these concussions were minor but concussions with prolonged loss of consciousness are rare. On the other hand, more and more players with several concussions were registered [15].

The *IIHF Injury Reporting System 1998–2004* reports 664 injuries during 1471 games in 70 championships and an alarming increase of head and face injuries is noted (See *Table 1*; with kind permission of M. Aubry).

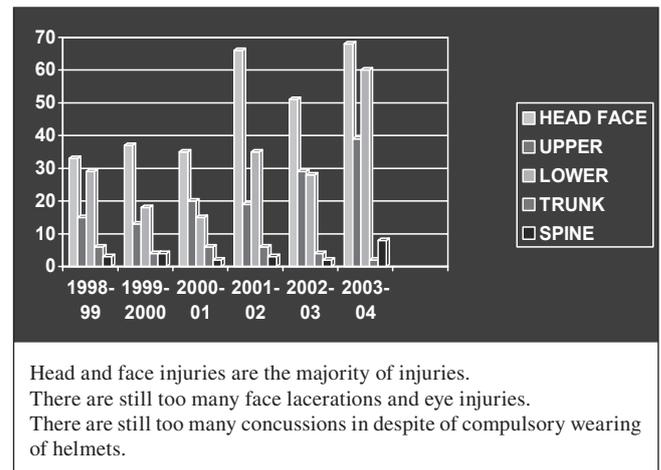


Table 1: Five season summaries of the IIHF Injury Reporting System 1998–2004; Body part injured.

A «new» classification of concussion in sport

In the past, as reported above, concussions have been classified with a number of different grading systems. After the Vienna Symposium this approach was abandoned. The Prague update Symposium evidenced for better understanding that concussion may be categorized for management purposes as either simple or complex.

Simple concussion

A simple concussion is defined as an injury, whose symptoms resolve progressively without complications over 7–10 days. In such cases, apart for limiting playing or training whilst symptomatic, no further treatment is required during the period of recovery and the athlete typically resumes sport without further problems. Mental status screening (see below) would be one of the most important assessment steps of these injured athletes. The more expensive and time intensive neuropsychological screenings are not necessary.

Simple concussion represents the most common form of injury and can be appropriately managed by primary care physicians or by an experienced team medical staff under medical supervision. The most important step of treatment is rest until all symptoms resolve and then a graded program of exertion before return to sport.

Complex concussion

Complex concussion is defined as an injury where athletes suffer persistent symptoms, including recurrence with exertion, specific sequelae, as e.g. convulsive convulsion or prolonged cognitive impairment following the injury. In this group, one may include all athletes who had history of multiple concussions.

Formal neuropsychological testing as cornerstone of an appropriate investigation should be considered in complex concussion. These athletes would be managed by an interdisciplinary team of physicians such as sport medicine doctor, neurologist, rehabilitator, and neurosurgeon if necessary.

A «new» Concussion Protocol

Clinical history

The importance of a detailed concussion history is reported by several authors [12, 16, 17]. Not only a correct on-field diagnosis (see below) is important but also the knowledge about suffered concussion in the past must be reported. Often athletes will not recognise all the concussions they had [26]. The Prague 2nd Concussion in Sport Symposium emphasised the importance of a serious preparticipation evaluation including the concussion history, a baseline cognitive assessment and symptom score of each athlete, in particular it is recommended in organized high risk sports (e.g. professional football, ice hockey, boxing) regardless of age or level of performance.

The finding that there is increased risk of subsequent concussive injuries after a first concussion is documented, although the reasons for this remain controversial. The clinical history should also include information about all previous head, face, or neck injuries as these may have clinical relevance to the present injury. At least, an accurate analysis of the protective equipment used at the time of injury is an important part of the clinical history.

Sideline evaluation

Sideline evaluation including neurological assessment and mental status testing is an essential component in the protocol [18]. The on-field diagnosis of concussion can be very difficult not only for the young inexperienced sports medicine practitioner but also for a long years experienced team physician. There may be no direct trauma to the head and frequently the injured patient is not unconscious. The athlete may be unaware that he has been injured immediately after the injury and may not show any obvious signs of concussion. To complicate the situation, athletes of all levels of competition, but first of all in professional sport, tend to minimize or hide symptoms in an attempt to prevent their removal from the game, thus creating the potential for exacerbation of the injury.

There are a lot of common on-field signs and symptoms of concussion reported by the medical staff on the one side and by the injured athlete on the other side. Both observations are very important.

Signs and symptoms of acute concussion

Cognitive features (observed by staff)

- Unaware of period, opposition, score of game
- Confusion
- Amnesia
- Loss of consciousness
- Unaware of date, time, place

Physical signs (observed by medical staff)

- Loss of consciousness / impaired conscious state
- Poor coordination or balance
- Convulsive convulsion / impact seizure
- Gait unsteadiness / loss of balance
- Slow to answer questions or follow directions
- Easily distracted, poor concentration
- Displaying unusual or inappropriate emotions (laughing, crying)
- Nausea/vomiting
- Vacant stare / glassy eyed
- Slurred speech
- Personality changes
- Inappropriate playing behavior

Typical symptoms (reported by the injured athlete)

- Headache
- Dizziness
- Nausea
- Unsteadiness / loss of balance, Feeling «dinged» or «stunned» or «dazed»
- «Having my bell rung»
- Seeing stars or flashing lights
- Ringing in the ears
- Double vision

Other symptoms such as sleepiness, sleep disturbance and subject feeling of slowness and fatigue in the setting of an impact may indicate that concussion has occurred or has not resolved.

When a player shows *ANY symptoms or signs of a concussion*:

- (1) The player should not be allowed to return to play in the current game or practice.
- (2) The player should not be left alone; and regular monitoring for deterioration is essential.
- (3) The player should be medically evaluated after the injury.
- (4) Return to play must follow a medically supervised stepwise process.

A player should never return to play while symptomatic. «When in doubt, sit them out!»

On-field cognitive testing (The Maddock’s questions) [19] (These evaluations are ideally developed in the language of the athlete)

Orientation
 Ask the athlete the following questions:
Where are we? City? Name of the Arena?
What day is it?
Who is the opposing team?

Anterograde (Posttraumatic) Amnesia
 Ask the athlete to repeat some simple words (e.g., dog, flower, sun).

Retrograde Amnesia
 Ask the athlete the following questions:
 What was the score of the game prior to the hit?
 In which period of the game are we?
 Do you remember the hit (mechanism of injury)?

Concentration
 Count backward from 100 to 1.
 Repeat the months of the year backward.

Word List Memory
 Ask the athlete to repeat the words mentioned earlier (e.g., dog, flower, sun).

Neuropsychological tests

The consensus of the updated Vienna CIS-Group (CISG) was that neuropsychological testing is one of the cornerstones of concussion evaluation in complex concussion. It is not currently regarded as important in the evaluation of simple concussion. It contributes significantly to both understanding of the injury and management of the individual but is not considered the only basis of management of return to play decisions. It must rather be seen as an aid to the clinical decision making.

Over the past decade, neuropsychological testing has evolved into a valuable tool in the diagnosis and treatment of cerebral concussion [20, 21]. Common to all neuropsychological test batteries is the need for and benefit of baseline pre-injury testing and serial follow-up.

In the United States, neuropsychological testing is now routinely utilised by the majority of National Football League (NFL) teams and has been mandated for all athletes within the National Hockey League (NHL). The utilisation of neuropsychological testing in amateur athletes has been limited by a number of practical issues including a limited number of neuropsychologists with specific training in sports medicine and the time demands of traditional «paper and pencil» neuropsychological test instruments [22, 23].

The use of computerized neuropsychological test batteries holds great promise in the evaluation of the concussed athletes.

Rehabilitation

The consensus of the Vienna CIS-Group (CISG) was that a structured and supervised concussion rehabilitation protocol is of great value for optimal injury recovery, and safe and successful return to play.

The rehabilitation principles were common to all identified programmes and are outlined below.

Important principles state that the athlete be completely asymptomatic and have normal neurological and cognitive evaluations before the start of the rehabilitation programme. Therefore the more prolonged the symptom duration, the longer the athlete will have sat out.

The athlete will then proceed stepwise with gradual incremental increases in exercise duration and intensity, and pause or back-track with any recurrence of concussive symptoms (PCS Scale see below).

It is appreciated that, although each step may take a minimum of one day, depending on the duration of symptoms, proceeding through each step may take longer in individual circumstances.

Return to play Recommendations

(The Vienna CIS-Group Consensus)

The majority of injuries will be simple concussions and such injuries recover spontaneously over several days following the below protocol [10].

It is important to emphasise to the athlete that *no activity / complete rest* means *physical and cognitive rest*.

For monitoring postconcussion symptoms the below *Postconcussion Symptoms Scale* (PCS Scale) is of great value.

The return to play following a concussion follows a stepwise process:

1. No activity, complete rest. Once asymptomatic, proceed to level 2
2. Light aerobic exercise such as walking or stationary cycling, no resistance training
3. Sports-specific training (e.g. skating in hockey, running in soccer)
4. Non-contact training drills
5. Full contact training after medical clearance
6. Game play

With this stepwise progression, the athlete should continue to proceed to the next level if asymptomatic at the current level. If any symptoms occur after concussion, the patient should drop back to

the previous asymptomatic level and try to progress again after 24 hours.

Obviously, the athlete must be symptom-free without any medications that may affect or modify the symptoms of concussion.

Scale of postconcussion symptoms: PCS Scale 0/120

	Rating					
	None		Moderate		Severe	
Headache	0	1	2	3	4	5 6
Nausea	0	1	2	3	4	5 6
Vomiting	0	1	2	3	4	5 6
Drowsiness	0	1	2	3	4	5 6
Numbness or tingling	0	1	2	3	4	5 6
Dizziness	0	1	2	3	4	5 6
Balance problems	0	1	2	3	4	5 6
Sleeping more than usual	0	1	2	3	4	5 6
Sensitivity to light	0	1	2	3	4	5 6
Sensitivity to noise	0	1	2	3	4	5 6
Feeling slowed down	0	1	2	3	4	5 6
Feeling like «in a fog»	0	1	2	3	4	5 6
Difficulty concentrating	0	1	2	3	4	5 6
Difficulty remembering	0	1	2	3	4	5 6
Trouble falling asleep	0	1	2	3	4	5 6
More emotional than usual	0	1	2	3	4	5 6
Irritability	0	1	2	3	4	5 6
Sadness	0	1	2	3	4	5 6
Nervousness	0	1	2	3	4	5 6
Other	0	1	2	3	4	5 6

Adapted from Lowell and Collins [27]

This *Postconcussion Symptoms Scale* was developed to help monitoring the injured athlete by himself or by not medical personal such as physiotherapist, coaches or parents. Practically this 20-item scale requires the athlete to subjectively rank symptoms such as headache, dizziness, photosensitivity, and so on. Each symptom is rated on a scale of 0 (no symptoms) to 6 (severe symptoms) and a rate of 0–20 is considered as normal and allows to proceed to step 2 in the stepwise return to play process. This is an adjunct to neurocognitive scores provided by the clinical report established by an experienced physician. It is very helpful for comparison of postconcussion symptoms to pre-injury symptoms. It reports and promotes a more comprehensive understanding of the recovery process for all persons included in the treatment, and interested in a quick recovery. It is important to note that subjective symptoms and neurocognitive test results do not always correlate, and the evaluation of both aspects of recovery is essential.

The Future

New diagnostics tools

Some researchers are developing and evaluating the use of new diagnostic techniques in concussive injury in sport. In particular K. Johnston et al. [24] have reported studies involving the use of Event-Related Potentials (ERP) and functional magnetic resonance imaging (fMRI).

ERP assess cerebral activity following mild traumatic brain injuries in college athletes practicing contact sports. Concussion victims showed a striking decrease in P300 amplitude, an effect presumed to reflect alterations in attentional-cognitive processes. Moreover, the degree of impairment was strongly related to the severity of post-concussion symptoms and recovery was seen with resolution of symptoms. The data suggest that concussions cause objectively measurable changes in the electrophysiological markers of brain activity and hence in the functions of the structures from which they originate. ERP may thus constitute a reliable method to accurately monitor the clinical course and recovery of head injuries in athletes.

Using functional MRI (fMRI), the researchers compared the activation patterns and the performance of athletes who had suffered one or more concussions to a group of healthy control subjects on both verbal and visual working memory tasks. The concussed athletes showed significantly poorer performances compared to the control group. The concussed subjects displayed different activation patterns than the control group. In the patient group, the activations observed are generally weaker and of different anatomical location, suggesting a change in functional anatomy after concussion.

Case study

fMRI Protocol (with kind permission of K. Johnston)

Present history: M.G., 30y old hockey player playing in the Swiss A League with 7 concussions in his professional career. *Figure 1* shows his fMRI at the follow-up control 5 months after the last injury (e.g. verbal working memory).

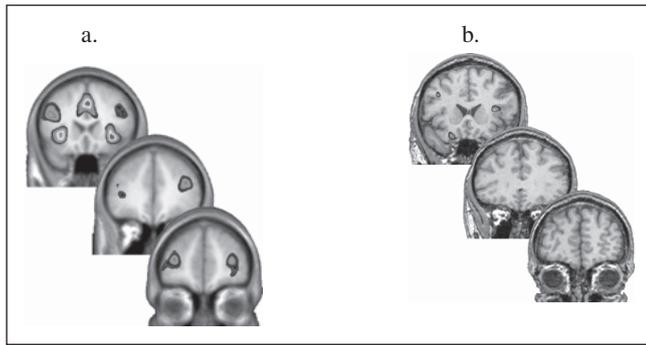


Figure 1: Verbal working memory fMRI results: a) activation patterns of 28 normal college athletes in the frontal regions of interest; b) M.G. showed a lack of activation in the same regions.

Biomedical Serum Markers

Biochemical serum markers of brain injury (including S-100b, NSE, MBP) were proposed as means of detecting cellular damage if present [28]. However, there is currently not sufficient evidence to justify the use of these markers clinically.

Conclusions

The clinical management of concussion is evolving rapidly and will continue to evolve in the next 10 years. Some trends have become particularly clear over the last two years:

- Concussion management is an individual treatment.
- We have still much to learn about both the short- and long-term consequences of injury.
- We need more research studies to investigate the biomechanics, pathophysiology and clinical course of sports related concussion.
- There is still a lot to do in prevention and education.

Prevention

An important step in prevention to reduce the head injury is certainly to improve rules avoiding actions where a clear-cut mechanism is implicated in a particular sport rate, such as no head checking in ice hockey. Similarly, rule enforcement is a critical aspect of such approaches and referees play an important role.

Rule changes and rule enforcement play a key role in reducing and preventing concussion.

The analysis of the protective equipment used at the time of injury is an important part of the clinical history, for both recent and remote injuries, as mentioned above. The benefit of this approach allows modification and optimisation of protective behaviour and an opportunity for education.

Education

The promotion of fair-play and respect for opponents are ethical values that should be encouraged in all sports and sporting associations. All persons involved in sports activity, so athletes, coaches, managers, sports physicians, referees and equipment manufacturers, play an important part in ensuring these values. If all work together to ameliorate not only performance but also safety of athletes, we will further enjoy our favorite sports activity.

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