



Summary

The 6th concussion meeting took place from October 27th to 30th October 2022 in Amsterdam gathering a working group of more than 100 concussion specialists from the International Olympic Committee (IOC), several sports federations (such as the Fédération Internationale de l'Automobile (FIA), Fédération Equestre Internationale (FEI), Fédération Internationale de Football Association (FIFA), International Ice Hockey Federation (IIHF) et World Rugby) and 600 invited participants. The objective was to update the recommendations from the 5th concussion meeting in Berlin from 2016, by publishing a total of ten systematic reviews, an update of the consensus statement and several tools in the British Journal of Sports Medicine.

Keywords

Consensus statement – Concussion – Update – Sports – Traumatic brain injury

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Was gibt's Neues aus Amsterdam? Das sechste Konsensus-Meeting der sportassoziierten Concussion

Zusammenfassung

Das sechste Konsensus-Treffen der sportassoziierten Concussion fand vom 27. bis 30. Oktober 2022 in Amsterdam statt. Die Arbeitsgruppe bestand aus über 100 Concussion-Spezialisten, zusammengesetzt aus dem Internationalen Olympische Komitee (IOC), mehreren Sportverbänden (wie die Fédération Internationale de l'Automobile (FIA), Fédération Equestre Internationale (FEI), Fédération Internationale de Football Association (FIFA), International Ice Hockey Federation (IIHF) et World Rugby) und 600 eingeladenen Teilnehmern. Ziel war es, die letzten

REVIEW / SPECIAL ISSUE

The 6th concussion meeting – What has Amsterdam told us, and what is new?

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Eingegangen/submitted: 31.8.2024; überarbeitet/revised 16.10.2024; akzeptiert/accepted: 17.10.2024
Online verfügbar seit/Available online: 23 November 2024

Historical background

The first two concussion meetings took place in Vienna and Prague in 2001 [1] and 2004 [10] and were organized by the participating sports ruling bodies (FIFA (football), IIHF (ice hockey)), which mandated a small group of experts to publish a consensus on sports-related concussion (SRC), resulting also in the Sports Concussion Assessment Tool (SCAT). Its primary goal was to act as a side-line tool for health-professional to evaluate the possibility of a SRC and assist upon the decision on return to play using multiple neurocognitive and neuromotor tasks. For the first time, SRC grading scales were abandoned and newly distinguished in a simple or complex form referring to the time of return to sport.

Subtypes of SRC were postulated, the role of amnesia questioned, and differences in the pediatric population outlined.

The next two conferences were organized in Zurich in 2008 [13] and 2012 [11] using a formal consensus approach, inviting not only physicians and therapists but also certified athletic trainers, coaches, and other people involved in the care of injured athletes. The classification in simple and complex was abandoned. Five categories of suspected diagnoses were defined: somatic symptoms (head-ache, cognitive or emotional symptoms), 2) physical signs (amnesia or loss of consciousness), 3) behavioral changes, 4) cognitive impairment and 5) sleep disturbances. If one of

Empfehlungen von 2016 in den heutigen wissenschaftlichen Kontext zu setzen. Zehn systematische Übersichten, ein Update der Konsenserklärung und mehrere Arbeitswerkzeuge wurden im *British Journal of Sports Medicine* publiziert.

Schlüsselwörter

Konsensus – Sportassoziierte – Gehirnerschütterung – Sport – Traumatische Hirnverletzung

these components was present, SRC should be suspected. The complexity of this injury was pointed out, especially due to his evolving nature. The SCAT was further developed, a 'Child-SCAT' added, and a 'pocket SCAT'/'concussion recognition tool (CRT)' introduced as a side-line aid for quicker recognition. Modifiers of SRC were introduced, such as type and duration of symptoms, number of previous concussion, threshold in repeated concussion, age, co- and pre-morbidities, gender and medication.

The 5th concussion consensus meeting took place in Berlin, in 2016 [12]. The SCAT-5 [4], Child-SCAT-5 and the CRT-5 [2] were further developed and up-dated. With the new knowledge, the SCAT was still seen as an important help in side-line evaluation by health-professionals, and losing in its utility at 4-5 days post injury, except for the list of symptoms that may serve to monitor and track the athlete's recovery. It was furthermore recommended to have a baseline testing for comparison in the case of a concussive state. In addition to the CRT, sideline video review has been mentioned to improve early SRC recognition. It was suggested that the sports-ruling body facilitate medical evaluation during the game by providing time to the medical staff. The diagnosis, and the decision for return to play remains a medical decision and purely based on clinical judgment. The term 'persistent symptoms' was introduced, describing the persistence of symptoms of more than 14 days in adults and 4 weeks in children. Early severe symptoms seem to be a predictor for slow

recovery, as much as little symptoms at day one for quick return to sport. Pure rest in the early phase is debated and the lack of high-quality research is highlighted. Although a lack of evidence for EEG, advanced neuro-imaging, they were recommended to be used in the research setting.

The 6th concussion meeting in Amsterdam

The 6th concussion meeting was postponed by two years due to the COVID-19 pandemic. Finally in 2022, over 100 experts, including members from the aforementioned sport ruling bodies, the International Olympic Committee and the Concussion in Sports group (CISG), were chosen by the organizers to form working groups. These experts worked together to summarize their work in a consensus using the Delphi protocol integrating the critical comments of the 600 invited participants.

More than 78'000 abstracts were screened and 1459 full-text reviews were included in their final work. The consensus statement was published in the *British Journal of Sports Medicine* [15] with a total of 10 systematic reviews on the topics previously specified [3,5,7–9,16–20]. Updated versions of the SCAT, Child-SCAT, CRT and a new tool, the Sport Concussion Office Assessment Tool (SCOAT), were introduced.

The main objective of the concussion meeting were to summarize the best current knowledge of preventing, recognizing and treating SRC for health-care professionals in sports, and laypersons. The main

objectives can be summarized as: reduce, recognize and remove, re-evaluate, rest, refer, rehabilitate, recuperation, return to sport, retire, refine.

Most tools from the 5th or the 6th concussion consensus statement have been translated and validated by concussion experts in Danish, French and German, and some also in Arabic, Chinese, Czech, Finnish, Greek, Hebrew, Portuguese, Russian, and Spanish and published online (www.concussioninsportgroup.com).

What has been updated?

The definition of a SRC has only marginally been adapted in the 6th concussion statement, which is being caused by a direct blow to the head, neck or body, resulting in an impulse force transmitted to the brain. Instead of describing SRC as a short-lived impairment of neurological function without structural injury resolving spontaneously, a possible axonal injury, blood flow change and inflammation affecting the brain initiated by a neurotransmitter and metabolic cascade was added.

SCAT6/Child-SCAT6

The SCAT6 represents the 5th version of the SCAT, while the Child-SCAT6 is the 2nd published revision of the Child-SCAT document. These two tools are best used within the first 72 hours, the SCAT6 for 13 years and older, and the Child-SCAT6 for children between 8-12 years of age. A minimum of 10-15 minutes is required to apply these tools correctly. The objective remains the same: being a tool for healthcare professionals only. The key points have been taken over, and advising against the use of

aspirin or other anti-inflammatory drugs been added.

As the SCAT-5, the SCAT-6 is divided in an on- and off-field section. The on-field section includes observation of the injury mechanism and immediate symptoms, movements or behavior of the athlete, followed by the Glasgow Coma Scale (GCS), a cervical spine assessment (previously mentioned in middle of the SCAT-5 assessment), a roughly cursory neurological oculo-motor and coordination screen, and a memory test. The objective is to recognize early symptoms of SRC or even structural brain injuries. Despite all this, the SCAT-6 is still “just” a screening tool for SRC and does not allow to make the diagnosis on its own.

The off-field assessment has undergone only minor changes, still including cognitive screening (orientation, immediate and delayed recall memory with introduction of time pressure, and concentration), coordination and balance tasks, whereas the tandem gait was added with a single and dual task, to the already previously tested modified BESS test. Although having the highest discriminatory value, the vestibular ocular motor screening (VOMS) has not been added to the SCAT6 but only in the SCOAT6, due to its duration of submission.

It has been noted that socio-cultural differences might be clinically relevant for the SCAT6, making normative data mandatory for different subpopulations, or even better, individual pre-competition assessment.

CRT-6

The Concussion Recognition Tool (CRT) aims to provide a quick and easily understandable overview of

concussion for laypersons. It summarizes the most important clinical patterns of injury mechanism, early behaviours exhibited by athletes who have suffered an SRC, and associated symptoms. It also highlights red flags that necessitate calling an ambulance. It is stressed that in any case of suspicion, the athlete must be withdrawn from the game, and be evaluated by a health-care professional. Improvements in the CRT-6 include better visibility and summarization of visible clues of suspected concussion, and of the symptom cluster including physical symptoms, change in emotions and in thinking.

Long-term symptoms

Persisting post-concussion symptoms (PPCS) are defined by symptoms lasting for more than 4 weeks in adults, adolescents or children, and can be assessed by the SCOAT6 or Child SCOAT6. A multimodal clinical assessment is mandatory in these cases. Delayed access to health care professionals specialized in SRC is associated with longer recovery. It can be challenging to make the difference between pre-existing or only concussion-related symptoms, which might be exacerbated by several intrinsic or extrinsic biopsychosocial factors. It is therefore crucial to investigate on previous mental health issues, learning or attention difficulties, central neurological problems (visual, oculomotor and vestibular disorders), cervical spine, headache/migraine, sleep disorders and many other conditions.

Delayed recognition and continued play, along with sleep disturbances during the first 10 days, are both

associated with persisting symptoms and therefore a prolonged RTP.

Rehabilitation/return to activity

Early SRC management has been adapted, and based on recent evidence showing that after an initial time of 24–48 hours of rest, earlier return to activity and cognitive exertion (return to learn) might be beneficial. An increase of symptoms by 2 points during the exercise can be tolerated, if the symptoms improve within 1 hour after exercise. Especially for returning to learning, the following adjustments have been recommended: environmental (i.e. frequent breaks, limited screen time), physical (no activities at risk of injury and head contact), curriculum (extra time to finish assignments), and testing (delaying exams). Dizziness, neck pain, or persisting headache of more than 10 days with adequate early treatment, should benefit from cervicovestibular rehabilitation. In general, the average time of return to sport has been found at 20 days and for return to studying at 8 days.

Prevention strategies

The systematic review on prevention of concussion upon 200 articles and 6 meta-analyses was oriented on rule changes, wearing protective gear, adapting training regimen, and how to manage the situation of an athlete with suspected concussion. They concluded in following statements and recommendations: 1) Wearing mouthguards across all age groups in ice hockey, was able to reduce the incidence by 28%. 2) Disallowing body-checking in child or adolescent ice hockey reduced the rate of SRC by 58%. It was clearly

shown, that it was a misconception believing that being exposed to body checking in youth, will teach protective measures and decrease SRC. 3) Neuromotor warming-up exercises performed three-times a week, showed significant reduction among all age group. 4) Further recommendations were to limit contacts in American football, and especially 5) to support optimal concussion management strategies by implementing laws and protocols.

What has been added?

SCOAT6 and Child SCOAT6

The newly developed Sport Concussion Office Assessment Tool (SCOAT6) and its counterpart for children (Child SCOAT6) provide a standardized framework to assist the SRC trained healthcare worker evaluate the clinical complexity of a SCR and identify areas that might need referral to a specialist. These can be used from the 3rd to the 30th day after a SCR, focusing on the assessment of balance and coordination, eye movements, cervical spine, cognition, psychological and neurological status.

The tools also include the athlete's personal history of previous head injuries or neurological, psychological/psychiatric or learning disorders, including also family history of anxiety, depression, migraine and others, the use of medication. A multitude of tests has been included, such as the list of symptoms, immediate and late memory test, orthostatic vital signs, an in depth clinical cervical spine and neurologic assessment, the modified BESS test (Balance Error Scoring System), the timed tandem gait (forward and backwards, with each

the eyes opened and closed) with or without a dual cognitive task, the VOMS test (modified vestibular/ocular-motor screening), the graded aerobic exercise test (Buffalo concussion treadmill test) and questionnaires screening on sleep, depression and anxiety.

Additionally, it is recommended to screen the athlete by using the sport mental health assessment tool (SMHAT-1) [6], and a computer based neuropsychological testing battery.

When should an athlete retire?

The panel could not find enough evidence to recommend a clear definition for when an athlete should retire from its sporting activity, the decision being complex and multifaceted. The factors suggesting retirement are long-lasting, persistent neuropsychological symptoms, with or without pathological finding on neurological examination despite adequate treatment. An increase in the severity of symptoms with an increasing number of SRC, or a decreased threshold for suffering an SRC, were mentioned as significant considerations. Similar to other injuries, the athlete needs to be informed about the health risk and benefits of continuing his/her activity, with decision depending on individual risk tolerance and psychological readiness.

Future perspectives

Biomarkers, genetic testing or advanced neuro-imaging are currently useful for research but cannot yet be recommended for clinical practice. Neuro-imaging, electrophysiological and autonomic dysfunction measurements show

promising results, especially for follow-up.

There is still a lack of evidence regarding the long-term health risks of SRC due to many confounding factors in the limited number of published articles. However, the panel concluded that there was no increased incidence of depression or suicide among amateur athletes compared to the general population. Former professional American football and soccer players did not show an increased risk of suicide or mortality due to psychiatric diseases, contrarily to an increased mortality to neurological diseases such as ALS and dementia.

It has been highlighted as a major limitation, that the vast evidence for this consensus is based on a overrepresentation of North-American and European studies, mainly on male athletes, with a small proportion of female, adolescent, child and para-athletes. Most studies lack a control group, and are retrospective. Furthermore, sports-specific guidelines should be developed to be applicable in the different sport situations [14].

Conclusion

The 6th concussion consensus statement from Amsterdam has summarized the best current evidence on SRC. It has updated several tools for healthcare professional, applicable to pediatric and adult athletes that can be used during play (SCAT6, Child SCAT6) but also in office settings (SCOAT6, Child SCOAT6). It has introduced new concepts of etiopathology, rehabilitation, return to sport and learning, and highlighted specific

limitations for certain group of athletes. A major emphasis has been set on knowledge transmission, ensuring that even laypersons can quickly recognize and appropriately proceed in the early management of a SRC. Research around SRC is a rapidly evolving field, with many aspects still poorly understood, indicating that another update in the upcoming years will likely be necessary.

Conflict of interest

There is no conflict of interest.

CRedit authorship contribution statement

Philippe M. Tscholl: Conceptualization, Validation, Writing – original draft. **Géraldine Martens:** Conceptualization, Validation, Writing – review & editing. **Caroline Tooth:** Validation, Writing – review & editing. **Marc-Antoine Démaret:** Validation, Writing – review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.orthtr.2024.10.001>.

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