Chiropractic and concussion in sport: a narrative review of the literature

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Abstract

Objective: Concussion is a common sporting injury that may be seen by doctors of chiropractic and should be managed following current practice guidelines. The purpose of this abstract is to present a literature review on chiropractic management of concussion in sport and to discuss current guidelines.

Methods: A review of the literature was performed using the PubMed search engine. MeSH terms included *chiropractic* and *concussion*. Search dates were the beginning of the record through July 30, 2013. All languages and article types were included in the search. Articles found were retrieved and evaluated for the relevance of chiropractic management of concussion in sport.

Results: Five articles were found (1 prospective study, 1 survey, 3 literature reviews) ranging in publication years from 1993 to 2012. No articles reported a position statement, and none provided a review of current concussion management practices related to chiropractic practice. No articles reported adverse outcomes of chiropractic management of an athlete with concussion.

Conclusion: Research related to the chiropractic management of concussion in sport is a nascent area of investigation. Although there are few published articles, the articles in this review showed that doctors of chiropractic encounter concussed athletes at events and in

The views expressed in this article are those of the authors and do not reflect the official policy or position of the United States Olympic Committee.

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clinical practice. It is essential for doctors of chiropractic to understand the importance of using standardized concussion assessment tools and current concussion guidelines.

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Introduction

In the United States (US), of 1.7 million people with traumatic brain injury (TBI), 52,000 die and 275,000 are hospitalized annually.¹ Approximately 75% of TBIs are concussions or mild TBI. Sport-related concussion accounts for approximately 300,000 head injuries per year in the US, but this number may be underreported.² A survey of US emergency departments showed a range of injuries based upon specific sports, which included head injuries (ice hockey [17,008], soccer [86,697], American football [204,802]) and concussion (ice hockey [4820], soccer [21,715], American football [68,861]).³

Concussion in sport is common and may result in long-term disability or death. Management of concussion is becoming more evidence based as more literature is published and consensus groups work to address best practices and support clinical decision making.^{4,5} It is essential for health care providers who manage athletes to be educated and competent in the most up-to-date standards for the management of head injuries.

Doctors of chiropractic (DCs) often will manage patients with concussion in clinical practice or when providing care to athletes at sporting events.⁶ Because athletes are often eager to return to play and potential serious injury may result if they return too early, it is important that concussion be managed following current practice guidelines to ensure best practices are followed.⁶

Concussion as defined by the recent Zurich conference

“Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include: 1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an ‘impulsive’ force transmitted to the head. 2. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours. 3. Concussion may result in neuropathological changes, but the acute clinical

symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.⁴ Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that in some cases symptoms may be prolonged.”⁴

Concussion is a common injury that must be properly managed. At present, there is no published article that reviews the literature on chiropractic and concussion. Therefore, the purpose of this article is to summarize published articles that address chiropractic management of concussion and to discuss concussion guidelines.

Methods

A review of the literature was performed using the PubMed database. Search terms included *chiropractic* and *concussion*. We did not narrow the search to sports or athletes to capture as many articles as possible. [Appendix 1](#) shows the full electronic search strategy for PubMed, which includes a variety of relevant search strings. PubMed was searched from the beginning of the record through July 30, 2013. All languages and article types were included in the search. Articles found were retrieved and evaluated for their relevance to the chiropractic management of concussion. There were no exclusion criteria. Studies were selected if they related in any way to chiropractic management of concussion. Because so few studies were found, we did not extract data or assess for risk of bias.

Results

The search resulted in 5 articles that specifically addressed the chiropractic management of concussion (1 prospective study, 1 survey, 3 literature reviews).⁷⁻¹¹ The articles ([Table 1](#)) ranged in publication dates from 1993 to 2012. No articles reported a position statement regarding chiropractic assessment or care

Table 1 Articles reviewed

Year	Type	Publication
1993	Review	Dalby BJ. Chiropractic diagnosis and treatment of closed head trauma. <i>J Manipulative Physiol Ther.</i> 1993 Jul-Aug;16(6):392-400.
2004	Chart review	Kazemi M, Pieter W. Injuries at the Canadian National Tae Kwon Do Championships: a prospective study. <i>BMC Musculoskelet Disord.</i> 2004 Jul 27;5:22.
2006	Review	Pelletier JC. Sports related concussion and spinal injuries: the need for changing spearing rules at the National Capital Amateur Football Association (NCAFA). <i>J Can Chiropr Assoc.</i> 2006 Sep;50(3): 195-208.
2009	Survey	Coghlin CJ, Myles BD, Howitt SD. The ability of parents to accurately report concussion occurrence in their bantam-aged minor hockey league children. <i>J Can Chiropr Assoc.</i> 2009 Dec;53(4): 233-50.
2012	Review	Marshall CM. Sports-related concussion: a narrative review of the literature. <i>J Can Chiropr Assoc.</i> 2012 Dec;56(4):299-310.

for concussion, and none provided a review of current concussion management practices related to chiropractic practice.

Discussion

Doctors of chiropractic manage patients who have experienced head trauma. Regardless of the source of the injury—sporting event, fall, or car accident—it is prudent for the practicing chiropractic physician to be familiar with the literature and current guidelines that relate to concussion. The following is a summary of the results of our literature search and information related to chiropractic training and concussion management.

Literature review

In 1993, Dalby⁷ presented a narrative review of chiropractic management of head trauma, such as that occurring from car accidents, sports, or other injuries. Noting that chiropractic physicians will often be the first provider to see patients who have experienced head injury, the argument is made that chiropractors are

managing injuries from head trauma, such as concussion, on a regular basis. The article also argues that neuromusculoskeletal conditions that patients experience after head injury are those that chiropractors manage, such as headache, vertigo, neck pain, and back pain. Included in the review is a summary of the standard procedures that a DC would perform on a patient with closed head trauma. The article describes questions to be included in the health history, such as mechanism of injury, loss of consciousness, and other signs and symptoms. The article also presents clinical examination procedures that should be performed after head injury, including the mini-mental examination, vital signs, cranial nerves, orthopedic, and other neurological examinations. Diagnostic tests are described and suggested to be ordered based upon salient history and examination findings. In 1993, the classifications for concussion were graded on a more general scale, relying upon loss of consciousness for grading; and this article is a reflection of that period. Management of concussion is described as including proper triage, referral to a hospital if signs and symptoms indicate. General chiropractic clinical management is described as including the proper evaluative assessment, reassurance and educating the patient about sequelae, ensuring no underlying conditions that would contraindicate conservative chiropractic treatment, and proper follow-up. The article also has a brief summary regarding prevention, noting that part of chiropractic practice is the prevention of disease. Thus, chiropractic advice to patients should include prevention measures such as “encouraging patients to wear automobile seat belts and motorcycle/bicycle helmets...” For the year 1993, this article provides insight into the breadth and scope of how DCs manage patients with concussion.

In 2004, Kazemi and Pieter⁸ performed a chart review of injuries observed during a martial arts competition. The study reports the region of the body that was injured, including neck, upper and lower back, face, and upper and lower extremity injuries. They also report diagnoses including sprain, contusion, laceration, and concussion. Thus, head trauma was not the primary focus of this study. Their discussion mentions concern for the high occurrence of concussions for this particular sporting event and urges preventive measures and more research in this area especially as it might relate to equipment, mechanism of injury, and prevention. For this study, the Colorado concussion classification system was used; but there was no discussion of management or treatment of the athletes, as that was not the purpose of the study.

A 2006 narrative review by Pelletier⁹ focuses on Canadian concussion and spinal injuries in American football and chiropractic management and prevention of these injuries. The article emphasizes that chiropractic physicians have patients in their practices who might engage in sports that cause spinal injuries and concussion resulting from activities such as football “spearing” injuries. The article provides a search of PubMed with a particular focus on spearing injuries. Of 697 references and 63 reviewed, he only found 1 that related to Canadian amateur football injuries. The article describes the regulations with spearing injuries and provides a timeline outlining the elimination of spearing in American amateur football from 1976 to 2005. He presents the mechanism of injury to the cervical spine and reviews concussion as one of the results of this type of injury. The article discusses how concussion can present in many ways and that loss of consciousness is not required to have a concussion and then describes various classification systems for grading concussion. A table is provided that compares Cantu’s grading system with the 2nd International Conference on Concussion and Sport, Prague, 2004. The author points out that the concussion grading systems have a subjective component and suggests that, although there is a challenge with these systems, the most recent guidelines should be followed. The recommendation is made that any athlete having a concussion should be removed from play and not returned to the game, and that proper examination should follow. The article recognizes that DCs may be the first practitioners to interact with an injured athlete, often because the patients are seeking care for symptoms of posttraumatic concussion syndrome. The article briefly discusses chiropractic management including the importance for chiropractors to use up-to-date guidelines and return-to-play protocols. This review concludes with a brief description of prevention measures and advice that DCs should offer their patients. He reminds the reader that “The chiropractic profession is a strong advocate of prevention whether it be relating to spinal degenerative conditions or sport related injuries.” Thus, a strong component of what chiropractic physicians can contribute includes prevention of concussion.

In 2009, Coghlin et al¹⁰ published a study that investigated the accuracy of how parents and guardians report concussion symptoms in their children who are playing in a minor hockey league. The underlying purpose of the article was to bring to the attention of the reader that education and awareness of concussion symptoms are important in educating people about concussion injuries. As it is often parents who notice

behavior changes in their child, communicate with health care providers, and are responsible for their children’s health, it is essential that they are accurate with noting concussion symptoms. The authors state that early detection and documentation are important in successful management of an athlete with concussion. Because many concussion symptoms are subjective (eg, feel “dinged,” dizziness, nausea) or difficult to measure (eg, moodiness, irritability, poor concentration, photophobia), recognizing them is crucial. This summary discusses the Sport Concussion Assessment Tool (SCAT) and how this tool should be used to monitor a patient with concussion. The survey used the SCAT as a template to evaluate if the parents could accurately identify concussion symptoms. Of 114 surveys collected, they found that “correct responses to signs and symptoms of concussion was 21.25/25 for the mothers and 20.41/25 for the fathers.” For those surveyed, the concussion symptoms most often missed included difficulty falling asleep, inability to describe time and place, and increased emotion/irritability. The authors recommended that more education should focus on concussion symptoms. As DCs are often providing care to these patients, they may assist with education and bringing greater awareness of concussion to parents.

In 2012, Marshall¹¹ published a narrative review of the literature on concussion due to sports injury with a focus on biomechanics, pathophysiology, diagnosis, and management. As this article was published in 2012, it referred to the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. The summary also mentions the use of SCAT2, which is the revised version of the earlier SCAT. This article does a fine job going into great detail regarding essential information that a DC would need to know in regard to the literature on concussion.

Guidelines

Although we found no articles reporting adverse outcomes of chiropractic management of an athlete with concussion, we believe it is prudent that chiropractic physicians should follow current guidelines for concussion management and practice to the fullest extent of their education, yet within their professional scope of practice. There are several concussion guidelines available from various professional bodies of health care experts. The American Academy of Neurology recently updated its 1997 guideline with the publication “Summary of evidence-based guideline update: evaluation and management of concussion in sports: report of the Guideline Development Subcommittee of the

American Academy of Neurology”.⁵ An international guideline that has also been updated was published as “Consensus statement on concussion in sport—the 4th International Conference on Concussion in Sport held in Zurich, November 2012”.¹² Both have made similar updates based upon the literature and provide guidance to health care practitioners who manage patients with concussion. These documents may be accessed at no cost from the following links: Zurich 2012 <http://bjssportmed.com/content/47/5/250.full.pdf+html> and American Academy of Neurology <http://www.neurology.org/content/80/24/2250.full.pdf+html>.

Measuring tools

There are several measuring tools that have been validated. For example, Immediate Post-Concussion Assessment and Cognitive Testing and SCAT are outcome measures that have been evaluated for validity.¹³ The SCAT has been updated to its third and newest version, SCAT3.¹⁴ The SCAT3 is a standardized tool for evaluating concussion in patients 13 years and older. The SCAT3 can be used after concussion; however, it is recommended for all athletes who play sport in which head injury may occur to compare pretest scores with scores after an injury. For a copy of SCAT3, see [Appendix 2](#).

Education and scope of practice

Chiropractic physicians receive didactic and clinical training to competently and safely perform physical examination, diagnosis, and treatment of common neuromusculoskeletal conditions. Doctor of chiropractic degree programs in the US and elsewhere provide formal training in ambulatory care patient evaluation, which includes skills for physical examination, orthopedic and neurological examination, differential diagnosis, diagnostic imaging, triage, referral, and comanagement. In addition to demonstrating competency in musculoskeletal conditions, to become licensed in the US, DCs must pass standardized written and practical examinations. In the US, the National Board of Chiropractic Examiners (<https://www.nbce.org>) provides standardized testing that leads to licensure. Subjects include case history, vital signs, head and neck examination, diagnosis, neurological examination, orthopedic examination, and many other competency areas.

Chiropractic educational programs have been compared with medical programs, with noted similarities and differences.¹⁵ Studies have shown that chiropractic training results in competency, which may be comparable

or superior to medical training in musculoskeletal medicine.¹⁶⁻¹⁹ Licensed chiropractors may choose to receive additional postgraduate training, such as through a sports medicine program. This additional training provides extra skills and knowledge specific to sports injuries related to concussion and return-to-play assessment.

Scope of chiropractic practice varies depending upon the country or region; however, there are some basic standards that have been provided. The World Health Organization (WHO)²⁰ has outlined the expectations of a practicing chiropractor to include:

- “● competently perform a differential diagnosis of the complaints presented by patients;
- achieve particular expertise in diagnostic imaging, orthopaedics, pain management and rehabilitation of the neuromusculoskeletal system and/or diagnosis and management of vertebral subluxation;
- achieve competence in interpreting clinical laboratory findings;
- acquire the ability to appraise scientific and clinical knowledge critically;
- understand and apply fundamental scientific/medical information, and be capable of consulting with and/or referring to other health care providers;
- generally possesses the necessary knowledge and skill to serve and communicate with members of the public in an effective and safe manner.”

The WHO states that chiropractic clinical skills are to include:

- “history-taking skills, general physical examination, laboratory diagnosis, differential diagnosis, radiology, neurology, rheumatology, eyes, ears, nose and throat, orthopaedics, basic paediatrics, basic geriatrics, basic gynaecology and obstetrics, and basic dermatology.”

And WHO states that chiropractic patient management includes:

- “● manual procedures, particularly spinal adjustment, spinal manipulation, other joint manipulation, joint mobilization, soft-tissue and reflex techniques;
- exercise, rehabilitative programmes and other forms of active care;
- psychosocial aspects of patient management;
- patient education on spinal health, posture, nutrition and other lifestyle modifications;
- emergency treatment and acute pain management procedures as indicated;
- other supportive measures, which may include the use of back supports and orthotics;
- recognition of contraindications and risk management procedures, the limitations of chiropractic

care, and of the need for protocols relating to referral to other health professionals.”

Health care team at sporting events

Chiropractic physicians, especially those who have had additional sports training and certification such as through the American Chiropractic Board of Sports Physicians, often will participate in health care teams for amateur and elite sporting events. The management of athletes with head injuries requires accurate clinical decision making, adherence to established protocols, and coordination with others on the health care team. For sideline care, emergency skills training and drills for injuries are necessary to allow health care team members to function as a unit during sporting events. All health care team members should be trained in basic life support, cardiopulmonary resuscitation, and advanced first aid and trauma management, including removal of equipment and transportation of the athlete. Members of the team should have preassigned duties for which they have been trained. The team should establish in advance which standard protocols will be used for head and cervical spine injury and concussion.^{4,5} All materials (eg, evacuation equipment, spine board, oxygen) and procedures (eg, emergency evacuation plan, ambulance access, location of hospital/trauma center) should be secured in advance and be understood by everyone on the health care team. Immediately after an athlete has experienced head trauma on the field of play, the physician should follow appropriate emergency procedures, which include standard emergency response protocols. Following emergency assessment, additional clinical evaluations are necessary to determine the severity of injury and the potential for the athlete to return to sport activity.

Tissues damaged during injury may take time to show symptoms and signs; therefore, the athlete is evaluated periodically for at least 20 minutes following the injury. Typically, specific evaluation procedures are performed at 5-minute intervals to ascertain the progress. During this time, changes in the examination findings are noted to identify if there are any signs of intracranial hemorrhage, brain damage, shock, or other negative events. Providers may need to make an urgent referral to an emergency department depending on the findings. It is the responsibility of the health care team leader to have the urgent referral protocol agreed upon and communicated to all team members before the event. Athletes should not be allowed to return to play in

the current event or practice if there are any signs or symptoms of head injury.^{4,5}

Clinical evaluation of head injury

Oftentimes, the chiropractic practitioner will not be present when the injury occurs. The patient may report to the chiropractic clinic days later with common symptoms such as neck pain or headaches. Thus, it is important that patients are queried if there has been head trauma, especially if the initiating event was in an environment where one may sustain a head injury (eg, sporting event, car accident, fall injury). It is wise to assume that a patient who has received enough force to cause cervical spine injury would likely have brain injury; and therefore, complete musculoskeletal and neurologic examinations are warranted.⁶

Subtle findings of head injury may be missed in emergency settings because of time constraints or because symptoms and signs have a late onset of presentation. This is true of low-grade brain injury and hematomas, which may have serious complications later. Symptoms of brain injury can be delayed. Therefore, because an emergency department or other medical provider “cleared” a patient, it does not mean that brain injury is not present. It may be that the symptoms were not present at the time of initial examination. Thus, it is prudent to do a thorough history and examination for any patient with a recent history of head trauma.⁶

Standard and thorough history and physical examination protocols should be followed.⁶ However, if at any time during the patient encounter more serious injury is suspected, the patient should be transported by the emergency medical system to the nearest emergency department for further workup. A thorough history includes, but is not limited to, mechanism of injury, symptoms, chief concern, and cognitive examination. Using standardized outcome measures, such as SCAT3, may help with monitoring the patient over time. Ideally, the patient would have had a baseline SCAT3 on record so that the health care provider may compare findings; but this is not always available. A head-to-toe physical examination should be conducted to rule out other potential pathology sustained during the injury. The neurologic evaluation includes tests for cognition, brain stem, cranial nerve, cerebellar, and spinal nerve function.

The athlete’s mood should be observed throughout the examination process. Sometimes, subtle changes in an athlete’s mood can only be detected by family and friends; so it may be prudent to interview them to identify if the athlete has had any mood or affect changes after the head injury. The clinical examination

must be thorough and include regional evaluations of the head and neck and the entire nervous system. Head injuries are complex and require high levels of clinical decision making. Accordingly, sufficient time is needed for such an evaluation. Return to play should not be allowed if an athlete demonstrates any symptoms or signs of a concussion. Additional evaluation by other health care providers may be warranted depending upon the findings of the examination.⁶

Prevention and education

As health care providers, chiropractic physicians are responsible for not only good diagnosis, triage, and patient management, but also prevention of injuries and education. Chiropractic physicians may assist with prevention through offering educational programs for injury prevention, through a thorough explanation of the sport and possibility of injury to players and their parents before an athlete begins to play a sport, or through community programs and advocacy to prevent sporting injuries. As well, DCs can offer preparticipation physical examinations to screen athletes and assist with prevention and education.⁶

Some individuals are at higher risk for injury when competing in certain sports; thus, a preparticipation examination can help identify these issues before an event occurs. The responsibility of the physician is to guide parents and patients toward appropriate activities. A comprehensive examination also provides a baseline for future comparisons if an injury should occur. The sports examination is an excellent opportunity to educate the athlete and the parents if the athlete is a minor.⁶ The preparticipation examination is also an excellent time to record SCAT3 information so that should there be a concussion in the future, comparison scores may be reviewed.

Depending upon the sport, protective equipment may assist with preventing injuries. The physician should encourage that the proper protective equipment be properly fitted and worn during practice and play. Another area for prevention is in the rules of play in various sports. Health care providers have the responsibility to advocate for safer rules in sports for which their patients participate.⁶

Prevention may also be accomplished through conditioning and training of the athlete. Body strength, agility, balance, and coordination, as well as proper coaching in technique related to the sport, may help the patient avoid injuries. The best way to treat concussion is to prevent one from happening. Thus, clinicians

should work with athletes not only to reduce any pain, but to assist with developing conditioning programs for the athlete to prevent injuries.⁶

Education is an important injury prevention strategy. Education may include informing an athlete of the risks for death and disability by returning to play too soon. It is also important to educate parents, coaches, trainers, athletes, and officials about improper and dangerous sporting techniques and having athletes return to play before they are free of signs and symptoms and have been cleared by a health care provider. Good sportsmanship should also be encouraged at all times. The ethics of sport dictate that respect for rules and concern for other players should be promoted by athletes, but also coaches, parents, and health care providers.⁶

There are many educational resources available to help educate patients, coaches, and health care providers about concussion. [Fig 1](#) shows examples of concussion materials that may be accessed on the Internet.

Limitations

There are limitations to this review. Other indexing systems, such as the Cumulative Index to Nursing and Allied Health Literature and the Index to Chiropractic Literature, could have been searched for additional publications regarding chiropractic and concussion. Broadening the search to include the terms *injury* and *traumatic* would have yielded more articles through which to screen; but it is unlikely that this would have produced more pertinent articles for review, as we searched the title, abstract, and key words, which likely would include the term *concussion*. It should also be considered that, in addition to jurisdictional differences, there are some variations in training for chiropractors. Doctors of chiropractic with advanced training in managing sports injuries have more exposure to the clinical and event-site evaluation of concussion, return-to-play guidelines, and management of the patient with concussion. Thus, the education recommendations of the WHO, although relevant to the core DC training curriculum, are likely less than those of chiropractic postgraduate specialists in sports care.

Chiropractic collaboration and future research

Chiropractors can contribute to early recognition and prevention of concussion. Especially for those who are

Resources for concussion

Centers for Disease Control and Prevention – this website offers information about concussion and mild traumatic brain injury and includes educational information, training and fact sheets, for patients, parents, athletes, and healthcare providers.
<http://www.cdc.gov/concussion/sports/resources.html>

United States Olympic Committee – information about concussion.
<http://www.teamusa.org/search?i=home&q=concussion>

National Athletic Trainers' Association – this website offers information including position statements and news releases.
<http://www.nata.org/health-issues/concussion>

National Collegiate Athletic Association – information and training courses on concussion.
<http://www.ncaa.org/concussions>

National Federation of State High School Associations – information and training courses for coaches on concussion.
<http://www.nfhslearn.com/electiveDetail.aspx?courseID=38000>

Sport Concussion Assessment Tool – educational resources and handouts, includes SCAT3 for adults and children.
<http://www.cattonline.com/scat>

Other resources: Search the Internet for your state's resources and regulations. Many states have concussion resources aimed at specific sports and/or age groups such as youth sports.

Concussion tracking systems for purchase

Immediate Post-Concussion Assessment and Cognitive Testing – offers a computerized concussion evaluation system for purchase.
<http://www.impacttest.com/>

Axon Sports – offers a computerized concussion evaluation system for purchase.
<https://www.axonsports.com/index.cfm>

Note: Inclusion of information in this figure is not an endorsement of any product or entity.

Fig 1. Concussion resources for DCs. *SCAT 3*, Sport Concussion Assessment Tool.

trained in sports and participate directly with athletic teams, the opportunity to work collaboratively to prevent and manage concussion is high. Current evidence-based guidelines for the assessment and management of concussion in athletes should be followed by chiropractors providing care to such patients. It may be of benefit to chiropractic patients and chiropractic providers that a position statement and consensus document be developed from currently available literature from all health science disciplines for the evidence-based chiropractic management of concussion in athletes. There are few readily available publications pertaining to the chiropractic management of concussion in sport; therefore, efforts should be taken to do more research in this area.

Conclusion

Although there are few published articles, the articles in this review showed that DCs encounter concussed athletes at events and in clinical practice. It is important

for DCs to understand the importance of using standardized concussion assessment tools, such as the SCAT3, and current concussion guidelines.

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Appendix 1. Search strategy used for PubMed search.

(chiropr[All Fields] OR chiropractors[All Fields] OR chiropractic[All Fields] OR chiropractic/alternative[All Fields] OR chiropractic/bournemouth[All Fields] OR chiropractic/chiropractors[All Fields] OR chiropractic/classification[All Fields] OR chiropractic/complications[All Fields] OR chiropractic/consortium[All Fields] OR chiropractic/contraindications[All Fields] OR chiropractic/dental[All Fields] OR chiropractic/economics[All Fields] OR chiropractic/education[All Fields] OR chiropractic/ethics[All Fields] OR chiropractic/history[All Fields] OR chiropractic/instrumentation[All Fields] OR chiropractic/jurisprudence[All Fields] OR chiropractic/legislation[All Fields] OR chiropractic/manipulation[All Fields] OR chiropractic/manipulative[All Fields] OR chiropractic/manpower[All Fields] OR chiropractic/massage[All Fields] OR chiropractic/methods[All Fields] OR chiropractic/nursing[All Fields] OR chiropractic/osteopathic[All Fields] OR chiropractic/osteopathy[All Fields] OR chiropractic/psychology[All Fields] OR chiropractic/rehabilitative[All Fields] OR chiropractic/standards[All Fields] OR chiropractic/trends[All Fields] OR chiropractic/university[All Fields] OR chiropractic/utilization[All Fields] OR chiropractic/veterinary[All Fields] OR chiropractic/west[All Fields] OR chiropractic'[All Fields] OR chiropractic's[All Fields] OR chiropracti-

cal[All Fields] OR chiropractically[All Fields] OR chiropractice[All Fields] OR chiropracticness[All Fields] OR chiropractics[All Fields] OR chiropractie[All Fields] OR chiropractique[All Fields] OR chiropractitioner[All Fields] OR chiropractitioners[All Fields] OR chiropractor[All Fields] OR chiropractor/medical[All Fields] OR chiropractor/osteopath[All Fields] OR chiropractor/population[All Fields] OR chiropractor'[All Fields] OR chiropractor's[All Fields] OR chiropractors[All Fields] OR chiropractors/osteopaths[All Fields] OR chiropractors'[All Fields] OR chiropractors'association[All Fields] OR chiropracty[All Fields] OR chiropraktickou[All Fields] OR chiropraktik[All Fields] OR chiropraktiker[All Fields] OR chiropraktique[All Fields] OR chiropraktisch[All Fields] OR chiropraktische[All Fields] OR chiropraktischen[All Fields] OR chiropraktischer[All Fields] OR chiropraktishen[All Fields] OR chiroprassi[All Fields] OR chiropratic[All Fields] OR chiropratica[All Fields] OR chiropratique[All Fields] OR chiropraxie[All Fields] OR chiropraxiebehandeling[All Fields] OR chiropraxis[All Fields] OR chiropraxy[All Fields] OR chiroprax[All Fields]) AND ("brain concussion"[MeSH Terms] OR ("brain"[All Fields] AND "concussion"[All Fields]) OR "brain concussion"[All Fields] OR "concussion"[All Fields]).

Appendix 2

SCAT3™

Sport Concussion Assessment Tool – 3rd Edition

For use by medical professionals only

Name

Date/Time of Injury:
Date of Assessment:

Examiner:

What is the SCAT3?¹

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged from 13 years and older. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively². For younger persons, ages 12 and under, please use the Child SCAT3. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool¹. Preseason baseline testing with the SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.

NOTE: The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgement. An athlete may have a concussion even if their SCAT3 is "normal".

What is a concussion?

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific signs and/or symptoms (some examples listed below) and most often does not involve loss of consciousness. Concussion should be suspected in the presence of **any one or more** of the following:

- Symptoms (e.g., headache), or
- Physical signs (e.g., unsteadiness), or
- Impaired brain function (e.g., confusion) or
- Abnormal behaviour (e.g., change in personality).

SIDELINE ASSESSMENT

Indications for Emergency Management

NOTE: A hit to the head can sometimes be associated with a more serious brain injury. Any of the following warrants consideration of activating emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
- Deteriorating mental status
- Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs

Potential signs of concussion?

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and **should not be permitted to return to sport the same day** if a concussion is suspected.

Any loss of consciousness? ☐ Y ☐ N

"If so, how long?" _____

Balance or motor incoordination (stumbles, slow/laboured movements, etc.)? ☐ Y ☐ NDisorientation or confusion (inability to respond appropriately to questions)? ☐ Y ☐ NLoss of memory: ☐ Y ☐ N

"If so, how long?" _____

"Before or after the injury?" _____

Blank or vacant look: ☐ Y ☐ NVisible facial injury in combination with any of the above: ☐ Y ☐ N

1 Glasgow coma scale (GCS)

Best eye response (E)

No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4

Best verbal response (V)

No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5

Best motor response (M)

No motor response	1
Extension to pain	2
Abnormal flexion to pain	3
Flexion/Withdrawal to pain	4
Localizes to pain	5
Obeys commands	6

Glasgow Coma score (E + V + M) of 15

GCS should be recorded for all athletes in case of subsequent deterioration.

2 Maddocks Score³*"I am going to ask you a few questions, please listen carefully and give your best effort."*

Modified Maddocks questions (1 point for each correct answer)

What venue are we at today?	0	1
Which half is it now?	0	1
Who scored last in this match?	0	1
What team did you play last week/game?	0	1
Did your team win the last game?	0	1
Maddocks score	of 5	

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.

Notes: Mechanism of Injury ("tell me what happened?"):

Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of Injury.

BACKGROUND

Name: _____ Date: _____

Examiner: _____

Sport/team/school: _____ Date/time of injury: _____

Age: _____ Gender: ☐ M ☐ F

Years of education completed: _____

Dominant hand: ☐ right ☐ left ☐ neither

How many concussions do you think you have had in the past? _____

When was the most recent concussion? _____

How long was your recovery from the most recent concussion? _____

Have you ever been hospitalized or had medical imaging done for a head injury? ☐ Y ☐ N

Have you ever been diagnosed with headaches or migraines? ☐ Y ☐ N

Do you have a learning disability, dyslexia, ADD/ADHD? ☐ Y ☐ N

Have you ever been diagnosed with depression, anxiety or other psychiatric disorder? ☐ Y ☐ N

Has anyone in your family ever been diagnosed with any of these problems? ☐ Y ☐ N

Are you on any medications? If yes, please list: ☐ Y ☐ N

SCAT3 to be done in resting state. Best done 10 or more minutes post exercise.

SYMPTOM EVALUATION

3 How do you feel?

"You should score yourself on the following symptoms, based on how you feel now".

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
“Pressure in head”	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	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
“Don’t feel right”	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
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22) _____

Symptom severity score (Maximum possible 132) _____

Do the symptoms get worse with physical activity? ☐ Y ☐ N

Do the symptoms get worse with mental activity? ☐ Y ☐ N

☐ self rated ☐ self rated and clinician monitored
☐ clinician interview ☐ self rated with parent input

Overall rating: If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

☐ no different ☐ very different ☐ unsure ☐ N/A

Scoring on the SCAT3 should not be used as a stand-alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

COGNITIVE & PHYSICAL EVALUATION

4 Cognitive assessment

Standardized Assessment of Concussion (SAC)⁴

Orientation (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1

Orientation score _____ of 5

Immediate memory

List	Trial 1		Trial 2		Trial 3		Alternative word list		
elbow	0	1	0	1	0	1	candle	baby	finger
apple	0	1	0	1	0	1	paper	monkey	penny
carpet	0	1	0	1	0	1	sugar	perfume	blanket
saddle	0	1	0	1	0	1	sandwich	sunset	lemon
bubble	0	1	0	1	0	1	wagon	iron	insect
Total									

Immediate memory score total _____ of 15

Concentration: Digits Backward

List	Trial 1	Alternative digit list			
4-9-3	0 1	6-2-9	5-2-6	4-1-5	
3-8-1-4	0 1	3-2-7-9	1-7-9-5	4-9-6-8	
6-2-9-7-1	0 1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3	
7-1-8-4-6-2	0 1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6	
Total of 4					

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan ☐ 0 ☐ 1

Concentration score _____ of 5

5 Neck Examination:

Range of motion _____ Tenderness _____ Upper and lower limb sensation & strength _____

Findings: _____

6 Balance examination

Do one or both of the following tests.

Footwear (shoes, barefoot, braces, tape, etc.) _____

Modified Balance Error Scoring System (BESS) testing⁵

Which foot was tested (i.e. which is the **non-dominant** foot) ☐ Left ☐ Right

Testing surface (hard floor, field, etc.) _____

Condition

Double leg stance: _____ Errors

Single leg stance (non-dominant foot): _____ Errors

Tandem stance (non-dominant foot at back): _____ Errors

And / Or

Tandem gait^{6,7}

Time (best of 4 trials): _____ seconds

7 Coordination examination

Upper limb coordination

Which arm was tested: ☐ Left ☐ Right

Coordination score _____ of 1

8 SAC Delayed Recall⁴

Delayed recall score _____ of 5

INSTRUCTIONS

Words in *Italics* throughout the SCAT3 are the instructions given to the athlete by the tester.

Symptom Scale

"You should score yourself on the following symptoms, based on how you feel now".

To be completed by the athlete. In situations where the symptom scale is being completed after exercise, it should still be done in a resting state, at least 10 minutes post exercise.

For total number of symptoms, maximum possible is 22.

For Symptom severity score, add all scores in table, maximum possible is $22 \times 6 = 132$.

SAC⁴

Immediate Memory

"I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order."

Trials 2 & 3:

"I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before."

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. **Score 1 pt. for each correct response.** Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

Concentration

Digits backward

"I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."

If correct, go to next string length. If incorrect, read trial 2. **One point possible for each string length.** Stop after incorrect on both trials. The digits should be read at the rate of one per second.

Months in reverse order

"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November ... Go ahead"

1 pt. for entire sequence correct

Delayed Recall

The delayed recall should be performed after completion of the Balance and Coordination Examination.

"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."

Score 1 pt. for each correct response

Balance Examination

Modified Balance Error Scoring System (BESS) testing⁵

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)⁶. A stopwatch or watch with a second hand is required for this testing.

"I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."

(a) Double leg stance:

"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."

(b) Single leg stance:

"If you were to kick a ball, which foot would you use? [This will be the dominant foot] Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

(c) Tandem stance:

"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."

Balance testing – types of errors

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. **The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10.** If a athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of **five seconds** at the start are assigned the highest possible score, ten, for that testing condition.

OPTION: For further assessment, the same 3 stances can be performed on a surface of medium density foam (e.g., approximately 50 cm x 40 cm x 6 cm).

Tandem Gait^{6,7}

Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. A total of 4 trials are done and the best time is retained. Athletes should complete the test in 14 seconds. Athletes fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object. In this case, the time is not recorded and the trial repeated, if appropriate.

Coordination Examination

Upper limb coordination

Finger-to-nose (FTN) task:

"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended), pointing in front of you. When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose, and then return to the starting position, as quickly and as accurately as possible."

Scoring: 5 correct repetitions in < 4 seconds = 1

Note for testers: Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. **Failure should be scored as 0.**

References & Footnotes

1. This tool has been developed by a group of international experts at the 4th International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2012. The full details of the conference outcomes and the authors of the tool are published in The BJSM Injury Prevention and Health Protection, 2013, Volume 47, Issue 5. The outcome paper will also be simultaneously co-published in other leading biomedical journals with the copyright held by the Concussion in Sport Group, to allow unrestricted distribution, providing no alterations are made.
2. McCrory P et al., Consensus Statement on Concussion in Sport – the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. British Journal of Sports Medicine 2009; 43: i76-89.
3. Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine. 1995; 5(1): 32–3.
4. McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sport Medicine. 2001; 11: 176–181.
5. Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24–30.
6. Schneiders, A.G., Sullivan, S.J., Gray, A., Hammond-Tooke, G. & McCrory, P. Normative values for 16-37 year old subjects for three clinical measures of motor performance used in the assessment of sports concussions. Journal of Science and Medicine in Sport. 2010; 13(2): 196–201.
7. Schneiders, A.G., Sullivan, S.J., Kvarnstrom, J.K., Olsson, M., Yden, T. & Marshall, S.W. The effect of footwear and sports-surface on dynamic neurological screening in sport-related concussion. Journal of Science and Medicine in Sport. 2010; 13(4): 382–386

Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

Problems could arise over the first 24–48 hours. The athlete should not be left alone and must go to a hospital at once if they:

- Remember, it is better to be safe.**
Consult your doctor after a suspected concussion.

For example:

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
No activity	Physical and cognitive rest	Recovery
Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity, 70 % maximum predicted heart rate. No resistance training	Increase heart rate
Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
Non-contact training drills	Progression to more complex training drills, eg passing drills in football and ice hockey. May start progressive resistance training	Exercise, coordination, and cognitive load
Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
Return to play	Normal game play	

If the athlete is symptomatic for more than 10 days, then consultation by a medical practitioner who is expert in the management of concussion, is recommended.

Medical clearance should be given before return to play.

(To be given to the **person monitoring** the concussed athlete)

If you notice any change in behaviour, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please contact your doctor or the nearest hospital emergency department immediately.

- Rest (physically and mentally), including training or playing sports until symptoms resolve and you are medically cleared
- No alcohol
- No prescription or non-prescription drugs without medical supervision. Specifically:
 - No sleeping tablets
 - Do not use aspirin, anti-inflammatory medication or sedating pain killers
- Do not drive until medically cleared
- Do not train or play sport until medically cleared

Test Domain	Score		
	Date: ____	Date: ____	Date: ____
Number of Symptoms of 22			
Symptom Severity Score of 132			
Orientation of 5			
Immediate Memory of 15			
Concentration of 5			
Delayed Recall of 5			
SAC Total			
BESS (total errors)			
Tandem Gait (seconds)			
Coordination of 1			

Patient's name _____

Date/time of injury _____

Date/time of medical review _____

Treating physician _____

Contact details or stamp