Special Issue Article **"Concussion"**   Review Article

Concussion Office Based Rehabilitation Assessment: A Novel Clinical Tool for Concussion Assessment and Management

Matthew Katz*, **Stephane Lenoski, Haitham Ali and Neil Craton**

Department of Family Medicine, Sport And Exercise Medicine, University of Manitoba, Canada

Corresponding author:
Matthew Katz,
Department of Family Medicine, Sport And Exercise Medicine, University of Manitoba, Canada
Email: matthewkatz@shaw.ca

ABSTRACT

The Concussion Office Based Rehabilitation Assessment (COBRA) is a novel tool constructed to ensure a comprehensive assessment of patients who may have sustained a concussion. The SCAT-5 has long been the gold standard for concussion assessment, however, it was designed as a sideline tool and its utility can be seen to decrease after a few days post-concussion. It also does not prompt evaluation of all the phenotypes of concussion. As such, the COBRA was created to assess all the potential manifestations of concussion in the office setting a day or two after an injury has been sustained. The COBRA utilizes the eight phenotypes of concussion as a guide to assess each of the potential biopsychosocial features that can be associated with these injuries and can be used to guide evidence-based treatments. Through early identification of concussion phenotypes, the clinician may start optimal treatment and hopefully prevent prolonged recovery and persisting symptoms.

INTRODUCTION

Concussion is a hot-topic in today's society and an important condition in the domain of Sport and Exercise Medicine. Sport Related Concussion (SRC) is common, involving approximately 3.8 million athletes per year in the United States. It is noted that most patients have symptom resolution in the first 7-10 days after injury[1], although this have come into question with several recent publications [2]. SRC is defined by the Berlin Consensus Statement as immediate and transient symptoms of traumatic brain injury induced by biomechanical forces". It is characterized by a rapid onset of short-lived neurologic impairments that will resolve spontaneously. These symptoms are largely functional, however, there may result in neuropathological impairments.SRC may nor may not involve a loss of consciousness. In most cases, sequential improvement is the natural history [3]. The American Society of Sport Medicine defines concussion similarly as a "traumatically induced transient disturbance of brain function that involves a complex pathophysiologic process" [4]. Similar definitions are seen with the Veterans' Affairs as well as American College of Rehabilitation Medicine definitions [5,6]. There are more concussive injuries outside of the domain of athletics, and little is known about this group of patients. Concussion is a clinical syndrome involving multiple symptoms. Leslie et al proposed that this syndrome does not require brain involvement, as symptoms may be the result of non-neurologic pathology such as whiplash or inner ear pathology. This influences the clinical assessment and treatment of patients with potential concussive injury.

Concussion Office Based Rehabilitation Assessment: A Novel Clinical Tool for Concussion Assessment and Management. Physical Medicine & Rehabilitation Journal. 2022; 4(1):123.

SCIENTIFIC LITERATURE

Craton et al attempted to classify concussion based on the seven distinguishing phenotypes [7]. Similar efforts to subdivide the clinical manifestations of concussion have been proposed by other researchers [8,9]. From the work done by these groups, it can be purported that concussion manifests in at least seven different ways: Cognitive dysfunction, oculomotor symptoms, affective disturbances, cervical dysfunction, headache, cardiovascular manifestations and vestibular manifestations (COACH CV). Furthermore, recent research has shown the consistent relationship between somatic symptom disorder and prolonged concussive symptoms [10]. "a clinical" tool to accurately assess SRC in the health care providers office and determine the appropriate phenotype would be an asset for all clinicians, especially those not treating patients with these injuries on a regular basis.

The current gold standard for concussion evaluation is the Sideline Concussion Assessment Tool 5 (SCAT-5). This is a standardized tool designed for assessment of potential SRC in the milieu of the sporting event by those covering the sporting event. It is designed for the immediate or on-field assessment after an athlete sustains an injury. The SCAT-5 prompts reviewing red flags, observable signs, memory, Glasgow coma scale as well as assessment of the cervical spine [11]. The purpose of the SCAT-5 is that of a screening tool to merit a more detailed clinical assessment. It is not meant as a diagnostic assessment, nor is it appropriate outside the realm of sport. The utility of the SCAT-5 assessment is seen to decrease as soon as three days after injury [12]. At this time, there is no comprehensive, validated tool that can be used in the health care provider's office to guide the clinical assessment a day or two after a patient has sustained a potential concussion. Given the multiple potential biomedical and psychosocial issues that can be involved in the evolution after head and neck injury, a focused clinical tool to evaluate these areas is warranted. The goal of this paper is to introduce a novel clinical inventory that purports to evaluate the specific potential phenotypes of concussion. The Concussion Office Based Rehabilitation Assessment (COBRA) will help the clinician to identify potential impairments and treatment opportunities that have presented themselves in the first few days after injury (Figure 1).

The COBRA is designed to serve as a roadmap for the clinician to assess, document and treat each specific phenotype of concussion. It uses the acronym COACHCV, from Craton et al, with the addition of further classification for somatic symptoms, using the Somatic Symptom Scale [13]. It provides a comprehensive method of assessing the patient in the office, not in the milieu of sport. Of note, the COBRA is not a substitute for a comprehensive neurologic examination. It is designed as a tool to allow for further assessment of concussion phenotypes. The COBRA itemizes information that is important in the assessment of injured individuals when concussion is suspected. The clinical time required to consider each of these potential trajectories is justified by the current literature.

The COBRA is divided into sections in order to characterize each phenotype of concussion based on symptoms and clinical signs of that area. The first section is a symptom inventory designed to evaluate the burden of potential concussion symptoms using the familiar likert scale. The maximum symptom score is 132. A higher symptoms score is associated with a worse prognosis, so documenting this information is important for the clinician [3]. Within this section, four questions overlap with somatic symptom disorder as tested with Somatic Symptom Scale-8 and they have been denoted separately. Similar assessment has been done with the Rivermead test; however, the benefit of the COBRA is in the further subcategorization of concussion phenotypes. Rivermead would be a suitable screening test for cognitive concussive symptoms.

Cognitive impairment in the form of memory concerns, decreased attention and concentration are some of the most common symptoms of concussion. This is seen to be especially prominent in the acute period [3]. This is associated with decreased mental processing speed as well as impaired executive function. The SCAT5 can be utilized to assess cognitive function in the acute period. However, as previously explained, the utility decreases after the first 3-5 days.Other tests that have attempted to measure cognitive performance include ImPACT and Cogsport testing [13]. These tests are not available in most clinical scenarios. As a result, there is a need for a clinical assessment tool to help the clinician accurately diagnose concussion. The COBRA allows the clinician to test cognitive function through orientation, memory, recall and attention. Deficits in the cognitive assessment can trigger the clinician to focus on cognitive rehabilitation. This may involve the use of neuropsychological interventions if symptoms persist.

Concussion: Office Based Rehabilitation Assessment (COBRA)

Name   Age   Gender   Date

With this injury, was there:
Loss of consciousness?   Yes/No
Confusion/disorientation/Amnesia?   Yes /No
Number or prior concussions?
Past history of learning disability/ADHD/migraine   Yes/No
Medications?

Symptoms that could represent concussion:
(Circle how you feel now)

^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 like "in a fog"	0 1 2 3 4 5 6	
"Don't feel right"	0 1 2 3 4 5 6	
Difficulty remembering	0 1 2 3 4 5 6	
Confusion	0 1 2 3 4 5 6	
Drowsiness	0 1 2 3 4 5 6	
*Feeling slowed down	0 1 2 3 4 5 6	
*Difficulty concentrating	0 1 2 3 4 5 6	
*^Fatigue or low energy	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 Symptom score   /132
Symptoms worse with light activity? Yes/No   Intense activity? Yes/No

Cognitive screen:
Orientation
What is the current date and time? (1 point *for each correct answer [month, date, day of the week, year, time]*)
Orientation score of 5
Immediate Memory

				Alternate List
Elbow	0 1	0 1	0 1	candle
apple	0 1	0 1	0 1	paper
carpet	0 1	0 1	0 1	sugar
saddle	0 1	0 1	0 1	sandwich
bubble	0 1	0 1	0 1	wagon

Immediate Memory score total   of 5

Concentration: Digits Backward

List	Trial 1
4-9-3	0 1
3-8-1-4	0 1
6-2-9-7-1	0 1
7-1-8-4-6-2	0 1

Total of 4
**Month in Reverse Order (1 pt. for entire sequence correct; can do serial 7s as alternate))
Concentration score   of 5

Delayed recall score   of 5

GCS:
Cranial nerve anomaly?   Yes/No
Cerebellar signs   Yes/No
General Neurological examination summary:

Is this patient fit to drive?   Yes/No

Oculo-motor examination:
Near point convergence   _____ (cm)
Saccadic eye movement   Normal/Abnormal
Visual pursuit/EOM   Normal/Abnormal

Affective disturbances   (Score 1 for yes, 0 for no)
Responses from symptom scale in
traditional concussion list*   Depression score ____ of 48
Has patient had a prior history of depression?   Yes / No
Any previous other psychiatric diagnosis?   Yes / No
Has patient lost interest in things?   Yes / No
Does patient feel they are letting people down?   Yes / No
Any thoughts of harming themselves?   Yes / No
**Symptoms of PTSD   Yes / No
Total depression score out of 54

Cervical assessment:
Canadian C spine rules:
Any high-risk factor that mandates radiography? (Age ≥65 yr or dangerous
mechanism or paresthesiae in extremities)   Yes/No
Any low-risk factor that allows safe assessment of range of motion? Simple rear-end motor vehicle
collision or sitting position in the emergency department or ambulatory at any time or delayed onset
of neck pain or
absence of midline cervical-spine tenderness.   Yes/No
Able to rotate neck actively 45° left and right?   Yes/No

Cervical range of motion   Full/Painless/Restricted/Painful
Does it provoke headache or dizziness?   Yes/No
Spurling maneuver painful/provoke headache?   Yes/No
Cervical zygapophyseal joint palpation painful?   Yes/No
Does it provoke headache or dizziness?   Yes/No

Headache assessment:
Suffer from headaches prior to the concussion?   Yes/No
Does palpation of craniofacial muscles
reproduce the patient's headache?   Yes/No
Does palpation of cervical structures
reproduce the patient's headache?   Yes/No
Are the patient's headaches migrainous?   Yes/No

Cardiovascular assessment:

Exercise intolerance/Fatigue   Yes/No
Orthostatic symptoms   Yes/No
Orthostatic vital signs:
HR and rhythm supine _____   HR standing _____
BP supine _____   BP standing _____

Vestibular assessment

Rhomberg sign: Positive /Negative
Tandem gait: Gait for 3 meter/turn _____ sec
Dix Hall-Pike: Positive /Negative
Vestibulo-ocular reflex   Positive /Negative
Nystagmus   None/Vertical/horizontal
BESS testing   Error score _____
Visual motion sensitivity   normal/abnormal

Somatization
^ denotes Somatization Symptoms that are also those of concussion combined with those listed
below (scored from 0-48 with a higher score showing increased potential somatization)

^Stomach or bowel problems	0 1 2 3 4 5 6
^Back Pain	0 1 2 3 4 5 6
^Pain in your arms, legs or joints	0 1 2 3 4 5 6
^Chest pain or Shortness of breath	0 1 2 3 4 5 6

COBRA18 2.0   Manitoba Adult Concussion Network

Figure 1: Concussion Office Based Rehabilitation Assessment (COBRA).

Oculomotor manifestations have frequently been associated with concussion [11,6]. Dysfunction in near point convergence, saccadic eye movements and visual pursuit have all been described. In some studies, over 60 per cent of patients with concussion reported symptom provocation with oculomotor screening [6,11,14]. Furthermore, when oculomotor dysfunction has been recognized, it has been shown to be a prognostic indicator associated with prolonged recovery [6,15]. The COBRA prompts the testing of near point convergence, saccadic eye movements, visual pursuit and extra-ocular movements. Deficits in these domains can focus the clinician on ocular rehabilitation.The purpose of this test is simply to establish if there are normal or abnormal extraocular movements.

Affective disturbances are a risk factor for persisting concussion symptoms. They can also be a potential consequence of concussion and ten of the traditional concussion symptoms are also symptoms of depression (Feeling slowed down, difficulty concentrating, fatigue or low energy, trouble falling asleep, more emotional, irritability, sadness, nervousness or anxiety) [7]. As such, the COBRA suggests emphasis of this trajectory of concussion. Using answers from the symptom scoring index as well as specific questions addressing psychiatric symptoms, the clinician is able to establish if an affective trajectory of concussion is present. Once this is seen, careful patient follow-

03

Concussion Office Based Rehabilitation Assessment: A Novel Clinical Tool for Concussion Assessment and Management.
Physical Medicine & Rehabilitation Journal. 2022; 4(1):123.

SCIENTIFIC LITERATURE

up is indicated. Depression and anxiety are commonly seen as co-morbidities in the concussed individual and can be consequences after concussion. Early treatment is essential.

There is significant overlap between the clinical presentation of concussion and that of whiplash [16]. It is important to recognize that concussion patients may present with a cervicogenic source to many of their symptoms. The prevalence of cervical pathology in concussion is unknown, however, cervical spine dysfunction has been documented as one of the most prominent phenotypes of concussion. Matuszak, concluded that the examination of the cervical spine, neck range of motion, Spurling test and palpation of the muscular and bony anatomy was important in assessing concussion patients [17]. The COBRA utilizes these tests as well as incorporating the Canadian C-Spine rules in order to assess for more worrisome cervical spine injuries. With focused rehabilitation of the cervical spine and its musculature, the patient can be treated effectively and restored to normal function earlier [18].

Headache is perhaps the most common symptom associated with concussion. Most types of headaches can be seen in the concussion patient. Red flags must always be reviewed with concussion for significant intra-cranial pathology, however, once this has been ruled out, treatment of headache can be based on the specific type of headache documented. The most common headaches associated with concussion have been migraine, tension, post-traumatic and cervicogenic [19,20]. Pre-existing migraines have been associated with poorer outcomes post-concussion. Some headaches may benefit from pharmacologic management, as such, early recognition is important in treatment. Physiotherapy for cervicogenic headache has been shown to expedite recovery [18].

One of the lesser known trajectories of concussion is cardiovascular dysfunction. There are several known associated cardiovascular manifestations of concussion. These include exercise intolerance, altered heart rate variability, Postural Orthostatic Tachycardia Syndrome (POTS), autonomic nervous system anomalies, elevated heart rate and others [21-23]. Therefore, it is important to assess the patient for these signs. The COBRA suggests questions for exercise intolerance and the documentation of orthostatic symptoms related to heart rate and blood pressure which could be reflective of autonomic dysfunction. By establishing this trajectory early, rehabilitation

can be focused on improving cardiovascular function. This may be done with the use of submaximal heart rate training as well as gradual aerobic exercise training [9].

Vestibular dysfunction is a common manifestation of concussion. Up to 81% of patients shows vestibular dysfunction on initial presentation with concussion [24]. The vestibular system receives multiple inputs from multiple systems including the oculomotor, brainstem, spinal cord, cervical spine, cerebral cortex, cerebellar and peripheral sensory systems. Patients with concussion may present with vertigo, dizziness, balance and gait difficulties as well as associated visual symptoms. Through testing with Rhomberg, tandem gait, Dix-Hallpike, BESS testing, visual motion sensitivity and the presence of nystagmus, the clinician is able to assess possible vestibular dysfunction. When established, this patient may be suited for vestibular rehabilitation [8,9,16].

The final potential phenotype observed with concussion is somatization. Assessing patients in the acute setting for Somatic Symptom Disorder (SSD) seems less intuitive, but pre-injury somatic symptom score has been shown to be a strong predictor of symptom duration in concussed patients [25]. The concussion Likert scale shares several of the same symptoms with SSD and it may be difficult to distinguish between the two, especially in protracted cases. While of less value in the first few weeks after injury, SSD can be associated with delayed recovery. Symptoms related to this disorder can be attributed to brain injury and some studies have shown up to 55% of patients with delayed recovery are somatising [30]. Patients with Somatic Symptom Disorder often require specific psychological intervention. The COBRA utilizes the Somatic Symptom scale-8.Four symptoms of potential somatization are found in the general concussion symptom inventory, and the other four symptoms are included in its own section. The total score of symptoms is added to be out of 48, with a higher score indicated increased somatization behavior.

DISCUSSION

While the SCAT-5 is designed for the sideline assessment of concussion, the majority of concussion patients are diagnosed in the clinical setting. Given that the SCAT-5 sensitivity decreases 2-3 days after the incident, and the majority of clinic visits do not occur in this period, there is a need for a different method of assessment for this milieu. The COBRA encompasses a

04

Concussion Office Based Rehabilitation Assessment: A Novel Clinical Tool for Concussion Assessment and Management.
Physical Medicine & Rehabilitation Journal. 2022; 4(1):123.

SCIENTIFIC LITERATURE

detailed roadmap for assessing concussion and its various phenotypes.

The COBRA was tested by a group of physicians within Manitoba with experience in treating concussions. The feedback was largely positive. The value of the COBRA was seen to be in the thoroughness and ability to test specific phenotypes. While, some physicians said that they may not use the entire survey, they appreciated that if they suspected a specific phenotype of concussion, they would then be able to utilize that part of the COBRA. Furthermore, the feedback regarding practical use by the family physician has been positive. Treatments now exist for all phenotypes of concussion so identifying specific clinical impairments can help patients move past the "rest until symptoms abate" treatment nihilism of previous guidelines [7,16,27].

Further research on the validity and reliability of the COBRA for diagnosis of concussion and management is required. It has not been tested by multiple physicians or other health care providers who treat patients with concussion. While, it has been evaluated by a small group of physicians and athletic therapists and the value seen, further study will be needed to determine if this tool is a useful instrument [28-30].

CONCLUSIONS

The COBRA introduces a novel inventory for the clinical assessment of concussion. Its value is in determining if concussion has occurred and the specific phenotype involved. With early diagnosis, the patient can be treated specifically with the goal of early return to function. Further work is required to demonstrate the sensitivity, specificity and diagnostic utility of the COBRA.

REFERENCES

1. Ochiai Hidenobu, Tomohiro Abe. (2019). "Clinical features and early detection of sport-related concussion". Acute Medicine and Surgery. 6: 49-53.

2. Thompson JM. (2008). Persistent Symptoms Following Mild Traumatic Brain Injury (mTBI) – A Resource for Clinicians and Staff. Veterans Affairs Canada Research Directorate Technical Report. 26: 1-26.

3. McCrory P, Meeuwisse W, Dvorak J, Aubry M, Bailes J, et al. (2016). Consensus statement on concussion in sport-the 5th international conference on concussion in sport held in Berlin, October 2016. Br. J Sports Med. 51: 838-847.

4. Harmon Kimberly G, James R. (2019). Clugston. "American Medical Society for Sports Medicine Position Statement on Concussion in Sport." Clinical Journal of Sport Medicine. 29: 87-100.

5. (1993). Mild Traumatic Brain Injury Committee, Head Injury Interdisciplinary Special Interest Group, American Congress of Rehabilitation Medicine. Definition of mild traumatic brain injury. Journal of Head Trauma Rehabilitation. 8: 86-87.

6. Ventura RE, Balcer LJ, Galetta SL, Rucker JC. (2016). Ocular motor assessment in concussion: Current status and future directions. J Neurol Sci. 361: 79-86.

7. Craton Neil, Ali H, Lenoski S. (2017). "COACH CV: The Seven Clinical Phenotypes of Concussion." Brain Sciences. 7: 119.

8. Ellis Michael, Leddy John, Willer Barry. (2014). Physiological, vestibulo-ocular and cervicogenic post-concussion disorders: An evidence-based classification system with directions for treatment. Brain Injury. 29: 238-248.

9. Leddy J, Baker JG, Haider MN, Hinds A, Willer B. (2017). A Physiological Approach to Prolonged Recovery From Sport-Related Concussion. J Athl Train. 52: 299-308.

10. Sullivan Karen A, Kaye Sherrie-Anne, Blaine H, Edmed SL, Meares Set, et al. (2019). "Psychological approaches for the management of persistent postconcussion symptoms after mild traumatic brain injury: a systematic review", Disability and Rehabilitation.

11. Mucha A, Collins MW, Elbin R, Furman JM, Troutman-Enseki C, et al. (2014). A brief vestibular/ocular motor screening (VOMS) assessment to evaluate concussions preliminary findings. Am. J Sports Med. 42: 2479-2486.

12. Sufrinko Alicia, McAllister-Deitrick J, Womble M, Kontos A. (2017). "Do Sideline Concussion Assessments Predict Subsequent Neurocognitive Impairment After Sport-Related Concussion?" Journal of Athletic Training. 52: 676-681.

13. Goldberg M, Madathil R. (2015). Evaluation of Cognitive Symptoms Following Concussion. Curr. Pain Headache Rep. 19: 45.

14. Pearce KL, Sufrinko A, Lau BC, Henry L, Collins MW, Kontos AP. (2015). Near Point of Convergence After a

05

Concussion Office Based Rehabilitation Assessment: A Novel Clinical Tool for Concussion Assessment and Management.
Physical Medicine & Rehabilitation Journal. 2022; 4(1):123.

SCIENTIFIC LITERATURE

Sport-Related Concussion: Measurement Reliability and Relationship to Neurocognitive Impairment and Symptoms. Am J Sports Med. 43: 3055-3061.

15. Halstead ME, McAvoy K, Devore CD, Carl R, Lee M, et al. (2013). Returning to learning following a concussion. Pediatrics. 132: 948-957.

16. Leslie O, Craton N. (2013). Concussion: Purely a brain injury? Clin. J Sport Med. 23: 331-332.

17. Matuszak JM, McVige J, McPherson J, Willer B, Leddy J. (2016). A Practical Concussion Physical Examination Toolbox: Evidence-Based Physical Examination for Concussion. Sports Health. 8: 260-269.

18. Schneider KJ, Meeuwisse WH, Nettel-Aguirre A, Barlow K, Boyd L, et al. (2014). Cervicovestibular rehabilitation in sport-related concussion: a randomised controlled trial. British Journal of Sports Medicine. 48: 1294-1298.

19. Eckner JT, Seifert T, Pescovitz A, Zeiger M, Kutcher JS. (2017). Is Migraine Headache Associated with Concussion in Athletes? A Case-Control Study. Clin J Sport Med. 27: 266-270.

20. Seifert T. (2016). Post-Traumatic Headache Therapy in the Athlete. Curr. Pain Headache Rep. 20: 41.

21. Anzalone Anthony, Blueitt Damond, Case Tami, McGuffin Tiffany, Creed Kalyssa, et al. (2016). A Positive Vestibular/Ocular Motor Screening (VOMS) Is Associated With Increased Recovery Time After Sports-Related Concussion in Youth and Adolescent Athletes. The American Journal of Sports Medicine.

22. Gall B, Parkhouse W, Goodman D. (2004). Heart rate variability of recently concussed athletes at rest and exercise. Med Sci Sports Exerc. 36: 1269-1274.

23. Heyer GL, Fischer A, Wilson J, MacDonald J, Cribbs S, et al. (2016). Orthostatic Intolerance and Autonomic Dysfunction in Youth with Persistent Postconcussion Symptoms: A Head-Upright Tilt Table Study. Clin J Sport Med. 26: 40-45.

24. Corwin DJ, Wiebe DJ, Zonfrillo MR, Grady MF, Robinson RL, et al. (2015). Vestibular Deficits Following Youth Concussion. J Pediar. 166: 1221-1225.

25. Nelson L, Tarima S, LaRoche AA, Hammeke TA, Barr WB, et al. (2016). Preinjury somatization symptoms contribute to clinical recovery after sport-related concussion. Neurology. 86: 1856-1863.

26. Perrine K, Gibaldi JC. (2016). Somatization in Post-Concussion Syndrome: A Retrospective Study. Cureus. 8: e743

27. Paul McCrory, Willem H Meeuwisse, Mark Aubry, Robert C Cantu, Jiři Dvořák Ruben J. (2013). Consensus Statement on Concussion in Sport: The 4th International Conference on Concussion in Sport, Zurich, November 2012. Journal of Athletic Training. 48: 554-575.

28. Davis GA. (2017). Sport concussion assessment tool - 5th edition. Br J Sports Med. 51: 851-858.

29. Maruta J, Lumba-Brown A, Ghajar J. (2018). Concussion Subtype Identification With the Rivermead Post-concussion Symptoms Questionnaire. Front. Neurol. 9: 1034.

30. Thomas Donald, Coxe Kathryn, Li Hongmei, Pommering Thomas, Young Julie, et al. (2017). Length of Recovery From Sports-Related Concussions in Pediatric Patients Treated at Concussion Clinics. Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine. 11: 1-19.