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Sideline Assessment of Concussion

Caitlin A. Nicholson,* Kathleen M. Weber,† and Elizabeth M. Pieroth‡

A concussion is a transient disturbance in neurologic function due to a force absorbed by the head or body which is transmitted to the brain. An athlete who sustains a concussion can experience abnormal cognition, difficulty with balance, vision changes, memory deficits, and a variety of symptoms including headache, irritability, feeling "in a fog," or just "not feeling right." Evaluation of a suspected concussion begins with ruling out catastrophic injuries to the head, neck, and brain which would require transport to an emergency department. Once life- and limb-threatening injuries have been excluded, the athlete should undergo a thorough sideline evaluation of their symptoms, cognitive function, neurologic status, balance, and visual system. This is best accomplished using the Sport Concussion Assessment Tool, 5th edition (SCAT5) as well as 1 or 2 additional scales to test the visual system. While these tools provide information about an athlete with suspected concussion, the final diagnosis relies on the health care provider's medical judgment. This chapter will outline the sideline evaluation and early management of sport-related concussion (SRC).
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Introduction and Epidemiology

Concussion is one of the most significant issues in sports medicine today. It results from a force applied to the head or body that is transmitted to the brain, causing a transient disturbance in neurologic function.[1-3] Concussion is a prevalent injury with 1.6-3.8 million sport-related concussions (SRCs) reported annually in the United States.[4-6] Children and adolescents are thought to make up 1.0-1.8 million of these diagnoses.[3] The estimated number of SRCs has increased in certain sports, although this change is attributed to better reporting, and increased participation in athletics rather than a true increase in the incidence of SRC.[7,8] Concussion can cause significant morbidity through acute cognitive and neurologic symptoms which can have downstream effects on school and work attendance as well as healthcare burden and quality of life.[9] All of these factors make sport-related concussion a major concern for sports medicine physicians and sideline health care providers.

Nearly two thirds of SRCs occur during competitions or games so sideline diagnosis and management of concussion is a crucial skill for sideline medical providers.[4,10] There is no one test or biomarker that is diagnostic of concussion so accurate diagnosis relies on a detailed history and physical examination as well as a combination of validated assessment tools [Sport Concussion Assessment Tool, 5th edition (SCAT5); the Balance Error Scoring System (BESS) and modified BESS; King-Devick (K-D) test; and vestibular and/or ocular motor screen (VOMS)] which can be performed on the sideline or in the locker room.[1,11,12] This chapter will discuss the assessment and early management of an athlete with suspected SRC on the sideline of a game or competition.

Concussion Pathophysiology and Risk Factors

A concussion is a brief, reversible disturbance of brain function due to trauma.[3] When a force delivered to the body is transmitted to the brain, neuronal cells and axons stretch

*Division of Primary Care Sports Medicine, Fellow in Primary Care Sports Medicine, Rush University Medical Center, Chicago, IL.
†Division of Primary Care Sports Medicine, Director of the Section of Primary Care Sports Medicine and Primary Care Sports Medicine Fellowship Program, Rush University Medical Center, Chicago, IL.
‡Director of the Concussion Program, Rush Medical College, Chicago, IL.
Address reprint requests to Caitlin A. Nicholson, MD, Midwest Orthopaedics at Rush, 1611 West Harrison Street, Suite 300, Chicago, IL 60612 E-mail: Caitlin.nicholson@gmail.com

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and this provokes a multitude of ionic and metabolic events. The intracellular concentrations of calcium and potassium change and neurotransmitters are indiscriminately released.[3] Mitochondria are less able to generate energy so there is more reliance on glucose as an energy source.[3,13] Cerebral blood flow also decreases, exacerbating this energy deficiency.[14,15] Finally, autonomic regulation is disrupted while the body corrects these metabolic abnormalities.[15] These pathophysiologic changes underlie the transient, reversible neurologic symptoms of concussion.[14] Studies suggest that the brain is vulnerable while the body corrects these abnormalities and an additional concussive injury can worsen the cellular and metabolic changes.[3]

There are many risk factors for concussion. SRC occurs more often in games than in practices and is slightly more common in the second half of games.[4,16] In the practice setting, two-thirds of concussive events occur after the first hour of practice, suggesting that athlete fatigue may play a role in some SRCs.[4] Player-to-player contact is the most common mechanism of injury, underlying 62.3%-76.2% of SRCs.[4,7,16] SRC can also occur due to contact with the playing surface or equipment and these mechanisms cause a higher proportion of SRCs in female athletes than males in sex-comparable sports such as soccer, basketball, and baseball and/or softball which have similar rules for girls' and boys' teams.[4]

The sports with the highest risk for SRC are rugby, wrestling, men's and women's ice hockey, and football.[7,17] Position type can also affect concussion risk. In professional football, offensive skill players such as the quarterback, tight end, running backs, and wide receivers have a higher risk of SRC than linemen and defensive skill players.[18] Additionally, illegal gameplay, and contact can contribute to SRC risk. One study of high school soccer players reported that 25.3% of SRCs were associated with illegal gameplay.[14] A separate study of youth hockey players reported that 43% of diagnosed SRCs were associated with contact that resulted in a penalty.[19]

Sex also affects SRC risk. In sex-comparable sports, the concussion rate is 1.4-1.9 times higher for female athletes compared to male athletes.[4,20] There are multiple reasons why female athletes sustain SRC at a higher rate than their male counterparts. Women and girls have decreased head-neck mass, neck girth, and neck strength, causing them to experience greater forces on the brain after they receive a concussive-type impact.[6,21] Within the brain, female axons are of smaller diameter and are more prone to stretching.[22] Additionally, females have more cerebral blood flow and a higher rate of glucose metabolism at baseline which may exacerbate the post-concussive metabolic changes and explain the more severe and prolonged symptoms seen in female athletes with SRC.[6,22,23] There is also some evidence that estrogen and progesterone levels may affect the severity of concussion symptoms. One study showed that female athletes taking oral contraceptive pills experience less severe symptoms than their counterparts not taking birth control pills.[24] Finally, studies report that female athletes are more likely to disclose SRCs than male athletes.[6] These many factors explain the higher rate of SRCs seen in female athletes.

History of a concussion is a known risk factor for SRC. Only 8.3%-11.6% of SRCs are recurrent concussive injuries however athletes with a history of concussion have 3.6-4.4 times the risk of a subsequent concussion when compared to athletes without a history of SRC.[4,7,25-27] Athletes with a prior concussion are also at increased risk of musculoskeletal and extremity injuries during sport, making diagnosis and management of concussion key to overall injury prevention.[26,28]

Initial On-Field Evaluation

Having an emergency action plan (EAP) is the first step in preparing to manage any sideline injury, including SRCs.[1,14] An EAP is a written document detailing the procedures for medical emergencies at an athletic site including the location of the AED(s), how Emergency Medical Services (EMS) would transport an athlete from the field, and other essential logistics. The athletic trainer, team physician, and other sideline medical personnel should be familiar with the EAP and should practice using it in sideline preparedness drills at least annually.

The initial assessment of an athlete with suspected SRC begins by evaluating for head and cervical spinal injuries.[1] If an athlete has collapsed on the field or if there is suspicion for a head, neck, or spinal injury, the medical provider should first assess the athlete's airway, breathing, and circulation (ABCs).[1] If these are normal, the next step is to evaluate the cervical spine and neurologic function by palpating the cervical spinous processes and assessing movement and sensation in the extremities.[1] The examiner should also ask the athlete if they are experiencing numbness, tingling, or neck pain. If the athlete has neurologic abnormalities, neck pain, or cervical spinous tenderness, the examiner should treat for a cervical spinal injury, and stabilize the cervical spine with a cervical collar or neck brace. If any of the ABCs are abnormal or if there is concern for spinal injury, the athlete should be placed on a spine board so they can be transported by EMS to a nearby hospital for further evaluation.[1]

There are additional signs and symptoms of neurologic compromise which should prompt consideration for emergent referral to a hospital. These "Red Flags" (Fig. 1) are loss of or changes in consciousness, increased agitation or combativeness, seizure or convulsive movements, double vision, vomiting, severe headache, neck tenderness, and weakness or burning in the arms or legs.[29] Some of these symptoms can be seen in individuals with concussion so the sideline medical provider should use their judgment to discern if the symptoms are due to SRC or from a more serious condition. If the sideline provider cannot rule out a more serious injury, it is best to refer the athlete to an emergency room for a more thorough evaluation.

In addition to "Red Flags" concerning for neurologic compromise, there are also "Observable Signs" (Fig. 2) which are concerning for a possible concussion. These include lying motionless on the field of play, difficulties with balance or gait, disorientation or confusion, a vacant look, or presence of a facial injury.[29] If a player has any of these observable

Red Flags for Head, Neck, or Cervical Spinal Injury from the SCAT5
Neck pain
Diplopia
Weakness, tingling, or burning in the arms or legs
Severe or worsening headache
Seizure or convulsions
Loss of consciousness
Worsening mental status
Vomiting
Increasing restlessness, agitation, or combative behavior

Figure 1 "Red Flags" for head, neck, or cervical spinal injury from the SCAT5. If these symptoms occur in an athlete who recently sustained an injury to the head, the sideline medical provider should consider referring the athlete to a nearby hospital for emergent evaluation (Color version of the figure is available online.)

signs, they should be removed from play for further evaluation.[29]

Many providers begin their concussion evaluation by sequestering a necessary piece of equipment such as the athlete's helmet to avoid a medically unadvised return to play.[14] The medical evaluation should start with Maddocks questions (Fig. 3) which assess orientation and immediate recall.[29] Following these, it is prudent to evaluate the athlete's neurologic function including strength and sensation in the limbs and to examine the cervical spine for tenderness and range of motion if these were not assessed on the field.[29]

The Glasgow Coma Scale (GCS, Fig. 4) can be used to stratify the severity of global neurologic symptoms. It is a standardized assessment for patients with a suspected traumatic brain injury and evaluates a patient's eye opening as well as their verbal and motor responses to stimuli. The maximum score is 15 and a score of 15 indicates a neurologically intact, awake patient. Lower scores reflect more severe neurologic dysfunction. Concussion is a mild traumatic brain injury and GCS scores in persons with concussion are between 13 and 15.[1] The GCS should be performed as part of the initial evaluation of a player with suspected SRC or more serious neurologic injury and can repeated serially. In an athlete with concussion, the GCS score should improve over time or remain stable at 15. A score under 13 or GCS scores that decrease over time suggest that the athlete may have sustained a more serious injury and should prompt consideration for referral to an emergency room.

Once life- and limb-threatening injuries have been ruled out, the sideline medical provider can begin evaluating for SRC. Depending on the sport, this assessment may occur on the field (eg, soccer, baseball) in a time-limited setting or on the sideline (eg, football, rugby, ice hockey, basketball) where the physician has more time to evaluate the player.[1]

Off-Field Evaluation of Concussion: The SCAT5

There are many different tools available to evaluate an athlete with suspected SRC. The SCAT5 is the most well-established, rigorously developed assessment and should be the mainstay of any concussion evaluation.[2,30] It was published in 2017 and is freely available online.[2] The SCAT5 is not protected by copyright as long as it is used in its complete form.[2] It includes the red flags, observable signs, GCS, and Maddocks questions mentioned previously as well as a 22-item symptom questionnaire; the Standardized Assessment of Concussion (SAC) which tests memory and cognition; the modified BESS which assesses balance and coordination; and a focused neurologic exam.[1,9,29] The current recommendation for concussion screening is to use a multimodal assessment as this improves the sensitivity and specificity of diagnosis so it is common practice to include one other measure with the SCAT5.[3,12] The SCAT5 does not test the visual or vestibular system so the K-D test and VOMS are commonly included in this multimodal evaluation.[9]

General Pearls

It is recommended to assess an athlete with suspected SRC in a quiet location with few distractions such as a locker room.[1]

Observable Signs of Suspected Concussion from the SCAT5
Lying motionless on field of play
Uncoordinated gait or difficulty with balance
Disorientation or confusion
Blank stare or vacant look
Facial injury

Figure 2 "Observable Signs" of a suspected concussion from the SCAT5. If a physician notices any of these signs in an athlete who recently sustained a blow to the head, the athlete should be removed from play immediately, and evaluated for a concussion.

Maddocks Questions to Assess Memory from the SCAT5
What venue are we playing at today?
Which half are we in?
Who scored most recently?
What team did you play last week or in the last game?
Did your team win the last game?

Figure 3 Maddocks questions from the SCAT5. Maddocks questions are used to assess orientation and immediate recall after a possible concussive event.

However, some sports require an on-field evaluation during games, and an athlete can only be removed from play if they will not return to the competition. If this is the case, the evaluator should assess the athlete's cognition, balance, and coordination on the field before making a recommendation about return-to-play.[30] Abnormalities in any of these tests are suggestive of a possible concussion and should trigger removing the player from the game for a more detailed assessment. If the on-field evaluation is normal, this does not exclude the diagnosis of SRC, and the player should be periodically re-assessed throughout the rest of the competition.[11]

Once an athlete is removed from play, they should be monitored continuously, and should be accompanied by a responsible adult if leaving the sideline.[30] Even athletes who had normal ABCs and cervical spine exams can experience rapid deterioration of neurologic function and need emergent transport to a hospital. Additionally, the symptoms of a concussion can evolve and change so serial evaluations are a staple of management.[14]

Symptom Evaluation

The athlete should complete a detailed symptom checklist to document the presence and severity of their symptoms. Symptoms of a concussion are notoriously vague and often vary between athletes, so it is important for sideline medical providers to have a high index of suspicion if an athlete reports "not feeling right."[30] The post-concussion symptom score on the SCAT5 evaluates 22 different symptoms which an athlete rates on a scale of 0 (no symptoms) to 6 (severe symptoms) (Fig. 5).[29] It is important to note that many athletes experience some of these symptoms at baseline and others can experience symptoms from conditions separate from concussion such as dehydration or medical illness.[11,14] Additionally, pre-existing diagnoses such as migraines, motion sickness, learning disabilities, attention-deficit disorder, and mood disorders can cause concussive-type symptoms.[11,14] As such, it can be difficult to differentiate new symptoms from pre-existing ones if the athlete has an underlying condition. A baseline symptom score which is recorded in the pre-season with the athlete in their usual state of health can be a useful comparison to the acute sideline score and can help the provider better interpret the post-injury symptom scale. Additionally, an athletic trainer who is familiar with the athlete can be invaluable as they may be able to provide information about acute changes in behavior or personality not reflected by the symptom score.

Cognitive Testing

Cognitive testing after a suspected concussion should evaluate orientation, concentration, immediate memory, and delayed recall.[1] The SAC tests each of these domains and scores for each portion are summed for a total score out of 5. The SAC score has good sensitivity in diagnosing an acute concussion, but scores typically normalize within 48 hours, so they are not as useful to trend over time.[1]

Glasgow Coma Scale (GCS)		
Best eye response	**Best verbal response**	**Best motor response**
No eye opening (1)	No verbal response (1)	No motor response (1)
Eye opening in response to pain (2)	Incomprehensible sounds (2)	Extension to pain (2)
Eye opening to speech (3)	Inappropriate words (3)	Abnormal flexion to pain (3)
Eyes opening spontaneously (4)	Confused (4)	Flexion or withdrawal from pain (4)
	Oriented (5)	Localizes to pain (5)
		Obeys commands (6)
Maximum score: 4	**Maximum score: 5**	**Maximum score: 6**

Figure 4 Glasgow Coma Scale (GCS). The GCS assesses global neurologic function through eye, verbal, and motor responses to stimuli. The scores in individual domains are added for a maximum overall score of 15, indicating a neurologically intact, and awake patient. A concussion is a mild traumatic brain injury and would have a GCS score of 13-15, indicating few or no global neurologic deficits.

	Symptom Severity						
	None	Mild		Moderate		Severe	
Symptoms	0	1	2	3	4	5	6
Headache							
"Pressure in head"							
Neck pain							
Nausea or vomiting							
Dizziness							
Blurry vision							
Balance problems							
Sensitivity to light							
Sensitivity to noise							
Feeling slowed down							
Feeling "in a fog"							
"Don't feel right"							
Difficulty concentrating							
Difficulty remembering							
Fatigue or low energy							
Confusion							
Drowsiness							
More emotional							
Irritability							
Sadness							
Nervous or anxious							
Trouble falling asleep							

Figure 5 Post-concussive symptom score from the SCAT5. This scale assesses 22 symptoms which may occur after a concussion and evaluates their severity.

The orientation questions on the SAC test orientation to time, specifically the month, date, day of the week, year, and time of day.[29] The immediate memory portion tests an athlete's ability to learn a list of 5- or 10- words. They have 3 trials to learn the full list of words and all 3 trials must be completed even if the athlete successfully repeats all the words on the first or second trial.[29] The 10-word list is a change to the SCAT5 as previous versions have only included a 5-word list.[3] Using the 10-word list lessens the ceiling effect seen when using the 5-word list to test immediate and delayed recall.[5] Normative data for the 5-word list showed that 52% of athletes had a perfect immediate recall score (15 of 15 words) at baseline and athletes with SRC averaged a score of 13 of 15 on immediate recall.[31,32] With the 10-word list, athletes averaged 20 of 30 words on immediate recall at baseline, so it is recommended that health care providers use the 10-word list for cognitive testing.[5] After neurologic and balance testing, the athlete is asked to remember the 5- or 10-word list they learned without prompting, testing their delayed recall.[29]

The concentration assessment involves 2 tasks. First, the athlete listens to a string of numbers, and repeats them backwards with the string growing progressively longer (up to 6 digits) in each successive trial.[29] If the athlete makes an error in repeating the digits, there is a second string of numbers of the same length that the examiner reads next.[29] Errors in repeating both sets of digits of the same length will stop this portion of the test.[29] The second test of concentration asks the athlete to recite the months of the year backwards.[29]

Neurologic Testing

The brief neurologic exam on the SCAT5 evaluates extra-ocular movements and cerebellar function. When testing extra-ocular movements, the examiner should observe for smooth pursuits, and ask the athlete if this testing provokes or worsens any visual symptoms such as double vision.[29] The cerebellum oversees motor coordination and the SCAT5 assesses this with the finger-to-nose and tandem gait tests. Finger-to-nose testing is performed as 5 successive repetitions of bringing either the right or left index finger from an extended position out to the side of the body to the nose.[29] Difficulty performing this motion is considered a failed test. In the tandem gait test, the athlete walks with a heel-to-toe gait for approximately 3 meters along a strip of athletic tape.[29] They must turn around at the end of the strip and walk back in the same fashion to complete the test. If the athlete steps off the line, allows space between the heel and toe, or grabs the examiner or an object to prevent themselves from falling, they have failed this test.[29]

Although not formally included in the SCAT5, some experts recommend a brief neurologic examination of the extremities during this part of the evaluation.[1] This includes strength and sensation testing in the limbs and if there are any abnormalities, assessing reflexes as well.[1] Additionally, if the neck was not examined earlier, the examiner should

palpate the cervical spinous processes for tenderness, and check passive range of motion.[1]

Balance Testing

Either the BESS or the modified BESS can be used to test balance in an athlete with suspected SRC.[11] Both measures require the athlete to maintain their balance for 20 seconds in 3 different positions: a narrow double-leg stance, single-leg stance on the non−dominant foot, and tandem stance with the non−dominant foot in back. The athlete performs each stance with their eyes closed and their hands on their hips. Each time the athlete steps out of position, sways, or opens their eyes is an error and assigned a point.[14] An athlete can accrue a maximum of 10 points from errors in each stance for a total score out of 30 points. It is not uncommon for athletes with concussion to have difficulty with their balance. In a study of football players diagnosed with concussion, their BESS scores on the day of the concussive event increased an average of 5.7 points when compared to their baseline testing.[14]

The BESS and modified BESS differ in the surfaces used during balance testing. The BESS is completed on both a firm and soft foam surface whereas the modified BESS is completed only on a firm surface.[11] The SCAT5 includes the modified BESS.[29] Both scales were designed to be completed with the athlete wearing sneakers however this is often not the case on the sideline, where an athlete may be in cleats or have their ankles taped.[14] Additional factors that can affect the tests are fatigue from exercise, lower-extremity musculoskeletal injuries such as an ankle sprain, and active gameplay during testing.[9,33] These factors are worth noting in how they may affect the results of the tests but should not preclude an athlete from undergoing balance testing as part of a concussion evaluation.

SCAT5 Limitations and Conclusions

The SCAT5 is a lengthy assessment, requiring at least ten minutes to complete.[2] This is one of the limitations of this test but should not discourage a provider from performing it as it is the gold standard in concussion assessment.

Upon completion of the SCAT5, the physician has information about an athlete's symptoms, cognition, neurologic function, and balance. The SCAT5 itself is not diagnostic of a concussion; the physician must use the results as well as the mechanism of injury to either diagnose a concussion or another condition if present. If a player is diagnosed with a concussion, they should not return to practice or competition that day.[22] If the athlete is not diagnosed with a concussion, they may be able to return to the competition that day depending on their diagnosis.[15]

Visual Testing: An Aid to the SCAT5

Although the SCAT5 is considered the most established and rigorously developed concussion assessment, it does not test the visual system which is often affected in athletes with SRC. It is recommended to use at least 1 scale in addition to the SCAT5 to improve the sensitivity and specificity of concussion diagnosis and evaluators typically include either the K-D test or the VOMS as both measures test the visual system.[1,3,9,12,13]

The K-D test is a proprietary rapid number naming test which evaluates an athlete's oculomotor function and information processing system.[13,34] The athlete reads numbers from left to right off pre-made cards or an app accessed using a tablet.[34] The athlete performs 1 practice trial then reads off 3 numerical sequences with increasing complexity.[34] The total time required to complete this task is their score on the test and a lower time is a better score.[34] At baseline, athletes typically complete the test in less than 2 minutes, and with no errors. In general, athletes with a concussion complete the K-D test an average of 4.8-5.1 seconds slower than their baseline times.[13,34,35] However, a study of Canadian professional American Football players noted that 38% of players later diagnosed with a concussion had scores faster than their baseline test with an average improvement of 3.4 seconds, indicating that the K-D test when used alone does not have adequate sensitivity for concussion screening.[35]

The K-D test adds a valuable piece of information to a concussion assessment. In a subgroup analysis of 69 athletes diagnosed with SRC who underwent serial K-D, tandem gait tests, and the SAC, all 69 athletes had an abnormal score on at least 1 of these measures, suggesting that some athletes with SRC may have predominantly visual symptoms which could result in falsely normal scores on the SCAT5 if used alone.[13]

One limitation of the K-D test is the equipment required to perform it.[30] The physician must have the flipbook of cards or a tablet with the app on the sidelines to perform the test and K-D test is copyrighted which may be a financial barrier to its implementation.[30] An additional consideration when using the K-D test is that the app and the cards are not interchangeable. Baseline testing times using the app are 2.8 seconds slower on average than baseline times using the flipbook.[36] This difference in baseline times could mask an abnormal result or give a false elevation in time so sideline health care providers should test an athlete using the same method as their baseline testing.

The VOMS is an alternative to the K-D test and assesses the visual and vestibular systems.[9] During the VOMS, an athlete performs 5 different vestibulo-ocular tasks (ocular convergence, horizontal and vertical saccades, smooth pursuits, horizontal and vertical vestibulo-ocular reflex, and visual motion sensitivity) and rates how each of these maneuvers provoke or worsen their symptoms of mental fogginess, dizziness, headache, and nausea. [9] Symptoms are rated from 0 (no symptoms) to 10 (severe symptoms) and an increase of 2 points after testing suggests vestibulo-ocular dysfunction.[9,30] The VOMS has been studied in the outpatient setting days after a concussion but has not been validated on the sidelines.[1,9] Even so, it is seen as a useful adjunct to the SCAT5 as it adds unique information about the vestibulo-ocular system to a concussion assessment, and many

providers choose to perform the VOMS on the sidelines as part of their evaluation.[1,9] The VOMS relies on self-reported symptoms so one concern when using this test is that athletes may deny changes in their symptoms during testing so sideline health care providers should use their medical judgment when interpreting the results of this test.

Special Populations and Considerations

While the SCAT5 is considered the gold-standard concussion assessment in adolescent and adult athletes, portions of this test would be difficult for youth athletes to complete at their baseline. For children 5-12 years old, the Child SCAT5 is the preferred concussion screening tool.[1,30] It contains most elements of the SCAT5 with a few notable exceptions. The symptom checklist uses pediatric-appropriate wording and symptom severity is scored from 0 to 3.[37] Additionally, there is a second symptom scale for one of the child's parents to complete.[37] The SAC still tests immediate and delayed recall with 5- or 10-word lists as well as the ability to name a string of digits backwards. However, the child is asked to name the days of the week backwards instead of the months of the year.[37] Finally, there is a picture that the child is asked to describe as part of the neurologic testing in lieu of reading written text if the child cannot read.[37] Similar to the SCAT5 in adults, the Child SCAT5 provides information about a suspected concussion that a physician may use in their clinical diagnosis of concussion.

One other population of interest is the athlete with a plausible mechanism of injury for concussion who has a normal concussion evaluation on the sideline. The sideline medical provider may consider putting the athlete through an exertional challenge in which they perform sprints, push-ups, and/or sit-ups then repeat some of the concussion tests.[1] Instructing an athlete to perform a series of activities (eg "Do 2, 20-yard sprints followed by 15 push-ups and 10 sit-ups") allows the examiner to test the athlete's memory and observe their coordination during the exercises.[1] Concussion symptoms should worsen with exercise so normal testing after an exertional challenge would be inconsistent with a concussion. This challenge, in addition to repeating parts of the SCAT5, may provide valuable information, and can aid in return-to-play decisions.[1] The sideline medical provider should use caution when interpreting the results of repeat concussion testing as an athlete's improved performance could reflect practice effects rather than being at their baseline cognitive function.

Early Management of the Athlete Diagnosed With a Concussion

An athlete diagnosed with a concussion should not return to the game or practice that day.[14] They should remain on the sideline for subsequent evaluations then go home with a responsible adult who is aware of their diagnosis.[14] The sideline medical provider should review signs or symptoms that would require emergent evaluation with the athlete and the adults in their household. These include worsening headache, repeated vomiting, seizures, weakness or numbness in the limbs, problems with balance or coordination, confusion, slurred speech, and change in consciousness.[29] The athlete should avoid any activities that risk re-injury or worsen their symptoms for the next 24-48 hours.[2] It is no longer recommended to wake an athlete up from sleep after a concussion so they should be allowed to sleep as desired. If the athlete requests pain medication for a headache, acetaminophen is preferred over ibuprofen, and aspirin as non−steroidal anti−inflammatories carry a risk of bleeding.[14] After the initial 24-to-48 hours of rest, the athlete may begin symptom-limited physical activity, even if they are still symptomatic. Once asymptomatic, they may start their team's return to play protocol.

The athlete should follow up with a sports medicine physician or other doctor with expertise in concussion within 1 week to repeat portions of the concussion testing and to discuss return-to-play or if needed, referral to a specialist.[2,14]

Conclusion

A concussion can cause a constellation of transient neurologic symptoms. Evaluation of suspected SRC begins with ruling out catastrophic injuries to the head, neck, and brain. Once life- and limb-threatening injuries have been excluded, the athlete should undergo a thorough sideline evaluation of their symptoms, cognitive function, neurologic status, balance, and visual system typically by using the SCAT5 plus 1 or 2 additional tests assessing the visual system. There is no "gold standard" test to diagnose a concussion so the final diagnosis relies on the trained health care provider's medical judgment.

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