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CONCUSSION MANAGEMENT FOR THE ORTHOPAEDIC SURGEON

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Abstract

» Orthopaedic surgeons functioning as team physicians are in a unique position to recognize subtle changes in an athlete's behavior and may be the first responders to concussions at sporting events.

» The rate of sports-related concussions has increased over the past few decades, necessitating that orthopaedic team physicians gain a greater understanding of the diagnosis and management of this condition.

» During the sideline evaluation, life-threatening injuries must be ruled out before concussion evaluation may take place.

» In most cases, patients experience a resolution of symptoms within a week; however, a smaller subset of patients experience persistent symptoms.

» Physicians covering sporting events must remain current regarding recommendations for treating sports-related concussions and must document their management plan to minimize potential harm to an athlete.

The incidence of sports-related concussions in the United States has increased over the past few decades, and concussion-related research, media coverage, and policy are projected to evolve accordingly¹⁻³. A number of guidelines and consensus articles in sports-related concussions have recently been developed, including the 2016 Berlin Concussion in Sport Group Consensus Statement⁴ and the American Medical Society for Sports Medicine position statement⁵.

Orthopaedic surgeons often are on the sidelines during competition and are the first responders to athletic injuries⁵. Team physicians are in a unique position to recognize subtle changes in an athlete's behavior or personality, as they are familiar with the athlete at baseline⁶. Although it would be ideal for the dedicated team physician to be present at every competitive

event, sometimes this is not feasible and, thus, many orthopaedic surgeons and residents may spend time filling in or covering sporting events, even if they are unfamiliar with individual athletes. During their time on the sideline, they remain responsible for the acute care of sports-related concussions during play. Thus, it is important to be familiar with all aspects of concussion, including diagnosis, management, current assessment tests, and legal implications^{5,6}. The aim of this article was to serve as an informative guide to aid orthopaedic surgeons in providing sideline medical care during sports events and in ongoing management of concussed athletes.

Diagnosis of Concussion

Concussion was formally defined by the Concussion in Sport Group (CISG) as "traumatic brain injury induced by biomechanical forces."⁴ Because of its subtle

presentation and the nonspecific symptoms that often overlap with those of other conditions, concussion can be a challenging diagnosis for a physician to make⁶. To aid in the diagnosis of concussion, in 2017, the CISG identified common features of a concussive head injury⁴. First, a sports-related concussion is often the result of a direct or indirect force to the head⁴. Sports-related concussions typically result in rapid-onset, transient symptoms of neurological impairment, although delayed-onset symptoms are possible⁵. These symptoms should not be explained by other causes such as drug or medication use, alcohol use, comorbidities, or other injuries^{4,5}. In most cases, symptoms resolve within a week; however, persistent symptoms may be seen in a smaller number of patients⁴. Lastly, these symptoms are due to a functional disruption to neural pathways rather than a result of a structural injury⁴. Thus, a concussion injury cannot be visualized on standard structural neuroimaging tests⁴.

Epidemiology

Sports-related concussion affects athletes at all levels of play^{1,7}. The U.S. Centers for Disease Control and Prevention estimated that a total of 1.6 to 3.8 million individuals each year sustain a sports-related traumatic brain injury in the United States⁸, and concussion may account for as much as 15% of all sports-related injuries in high school athletes⁹. These numbers may be even larger, as many athletes fail to report concussion-related symptoms^{10,11}. Potential barriers that prevent athletes from reporting concussion-related symptoms have been found to include not wanting to be removed from play, being unsure of the cause of their symptoms, and not experiencing any pain or disability from symptoms¹². Nonetheless, the reported rate of concussion has increased over the past few years, which may be explained by improved identification of concussion and an actual increase in the number of sports-related concussions due to the growing power and strength of athletes¹.

Clinical Evaluation

Before the Injury

Before practice or competition begins, a physician should assess each athlete's readiness to participate in sport through a thorough pre-participation examination^{10,11}. Pre-participation assessments should evaluate cognition, brain injury history, concussion-related symptoms, and balance¹³. In the case of a history of multiple prior concussions or persistent symptoms from a previous concussion, orthopaedic surgeons should refer the athlete to a neurologist¹⁴. Pre-participation examination may be a multidisciplinary effort to ensure that athletes are prepared both medically and physically for competition.

It is becoming increasingly common for computerized neurocognitive tests to be used as additional baseline assessments¹³. These tests should not replace the patient history or physical examination¹⁵. Overall, if there is any doubt by the physician with regard to the athlete's health or safety, the athlete should not be allowed to participate in sport¹⁴.

Concussion education should also be offered to all athletes prior to participation in sport¹³. Athletes should be advised on the importance of reporting symptoms to their team physician in a timely manner¹⁴. Lastly, as concussion prevention methods continue to be investigated and developed, orthopaedic surgeons are encouraged to utilize their expertise in medicine to help to identify areas of improvement in competition and practice such as protective equipment, training strategies, and concussion education that may offer further protection to athletes¹⁶.

On-Field and Sideline Evaluations

Orthopaedic surgeons are often responsible for sideline recognition of concussion symptoms, which is the first and most critical step taken to mitigate the risk of further injury⁶. Thus, orthopaedic surgeons must be able to recognize warning signs of concussion and must be aware that

initial actions that must take place on the field in the case of suspected concussion evaluate for the signs of a more serious injury, prior to sideline evaluation¹⁵.

In the case of a traumatic event, an on-field evaluation of the athlete should begin with an assessment of airway, breathing, and circulation¹⁵. If there is a problem with any of these, the basic principles of first aid should be followed¹⁷. Next, the physician's priority must be to rule out more serious injuries that require emergency care including cervical spine injury, skull fracture, and intracranial hemorrhage¹⁸. The first step in evaluating for a more serious injury is to determine the athlete's level of consciousness¹⁸. If an athlete demonstrates a prolonged loss of consciousness, the athlete should be cared for as if he or she has sustained a substantial intracranial or cervical spine injury¹⁸. Manual in-line stabilization of the cervical spine or immobilization using a spine board should take place before the athlete is transferred to a nearby emergency department (ED)¹⁸⁻²⁰. Physicians should also look for signs of skull fracture, such as mastoid or periorbital ecchymosis, eyelid hematoma, and bloody otorrhea. A neurological examination should be completed to assess for signs of intracranial injury, including uneven pupils, disconjugate eye movements, and asymmetric motor function²⁰. A Glasgow Coma Scale (GCS) score may also be calculated and may be used as an indicator of moderate to severe brain trauma¹⁸. An athlete demonstrating signs of skull fracture, focal neurological deficit, or a GCS score of <15 should be transferred to a nearby ED for emergency neuroimaging²⁰. Other symptoms that require emergency medical services include declining mental status, posttraumatic seizure, repeated emesis, extremity numbness, difficulty walking, and severe or worsening headache^{4,15} (Table I).

Once serious injuries that require immediate transfer to the ED have been excluded, assessment for concussion may begin⁵. Concussion injury disrupts

TABLE 1 On-Field Assessment of Injuries Necessitating Emergency Care

	Assessment	Immediate Care
Step 1: check ABCs		
Airway	Voice Breath sounds	Head tilt and chin lift Transfer to ED
Breathing	Respiratory rate Chest wall movements or percussion	Seat comfortably Rescue breaths Transfer to ED
Circulation	Palpate pulse Capillary refill time	Control bleeding Elevate legs Transfer to ED
Step 2: eliminate more serious injury*		
Cervical spine injury	Cervical spine assessment	Immobilization of spine Transfer to ED
Intracranial bleeding	Neurological examination	Transfer to ED
Skull fracture	Physical examination of head	Transfer to ED
Step 3: Evaluate for concussion injury		
*Other symptoms that require emergency medical services include declining mental status, posttraumatic seizure, repeated emesis, extremity numbness, difficulty walking, severe or worsening headache, and a GCS score of <15.		

neural pathways, resulting in variable and nonspecific signs and symptoms including headache, loss of consciousness, amnesia, gait unsteadiness, behavioral changes, cognitive impairment, and sleep or wake disturbances⁴. It should be noted that headache is the symptom most commonly reported by concussed athletes and that a loss of consciousness is uncommon, seen in <10% of concussed athletes^{4,21}. An athlete displaying any signs of concussion should immediately be removed from play for sideline evaluation^{4,5}. As alluded to earlier, the distinction between the on-field and sideline evaluations is heavily predicated on determining the severity and need for imminent intervention. If suspicion for concussion remains high, even after a benign on-field evaluation, the athlete should be brought to the sidelines for a more thorough evaluation.

A sideline evaluation for concussion should begin with questions that assess the athlete's orientation and memory¹⁸. For example, the physician may ask about the venue name, the current date, or events related to the game prior to or after the injury¹⁸. The

physician should then evaluate the athlete using specific sideline concussion assessment tools. Serial assessment tests in the initial few hours after the injury should be administered to monitor for delayed-onset or worsening symptoms^{4,5}. Physicians should also note any history of previous concussion or comorbid conditions, such as attention-deficit/hyperactivity disorder (ADHD), learning disorders, depression, and migraines¹⁵. All of these conditions have been associated with a greater risk of concussion or a prolongation of concussion symptoms^{15,22}.

Return to play should be determined by a licensed medical professional and is contingent on the results of a concussion evaluation²³. Ideally, return to play is guided by a team physician or primary care physician who is familiar with the patient, rather than a covering physician. Under no circumstances may the athlete return to play on the same day if there is any suspicion for concussion, regardless of symptom resolution²³. The physician should document the events of the evaluation, whether or not the athlete was cleared, and ongoing observation of the athlete²³.

Athletes who sustain a concussion and do not demonstrate signs of a more serious injury should be provided with in-home care information and should be asked to follow up with a physician within 3 days^{19,20}. Follow-up should be conducted by a physician familiar with the patient, whether that physician is an orthopaedic surgeon acting as the team physician or a primary care physician familiar with concussion care. At home, athletes may eat and sleep and do not need to be awakened for evaluation every hour^{19,20}. To treat headache symptoms, athletes may be counseled to use ice or acetaminophen; aspirin or nonsteroidal anti-inflammatory drugs should not be used until 24 to 48 hours after the injury, especially if there is a possibility of intracranial bleeding^{19,20}. Alcohol should be avoided, and athletes should be warned not to drive, as a concussion injury may prolong reaction time^{19,20}.

Assessment Tests

Types of Neurocognitive Testing

A number of neurocognitive tests have been increasingly used to determine an athlete's baseline performance before training or competition begins¹³. These

tests may also be used to identify or monitor signs and symptoms of concussion⁴. It should be noted that each athlete has a unique baseline before the injury to compare with testing after the injury, which may be more accurate than normative standardized values¹⁵. The role of baseline assessments and sports-related concussion management in children and adolescents is not well established and may differ from older teenagers and adults²⁴. Currently, the Sport Concussion Assessment Tool, Fifth Edition (SCAT5), is the most widely used and readily available assessment tool and has versions for both older and younger athletes⁴.

The SCAT5

The SCAT5 is a validated neurocognitive tool for sideline assessment of sports-related concussions in individuals who are ≥ 13 years of age^{4,6,25}. The SCAT5 should be performed in a distraction-free environment while the athlete's heart rate is in its resting state¹³.

The SCAT5 assesses the patient function via multiple domains including a symptom checklist, the GCS, memory assessment Maddocks score, the Standardized Assessment of Concussion, the Balance Error Scoring System, a coordination examination, a neck examination, and the Standardized Assessment of Concussion delayed recall^{17,26-28}. If baseline test scores are used for reference, a physician should attempt to replicate baseline testing conditions⁴. The Child SCAT5 should be used to evaluate concussion in 5 to 12-year-old children, as it is accommodated to the developmental stages and language barriers of children of that age range and also considers symptoms reported by parents^{29,30}.

Computerized Neurocognitive Testing The Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)

The ImPACT (ImPACT Applications) is the most commonly used computer-based neurocognitive test in North America³¹. The ImPACT consists of the following tasks: Word Memory, Immediate; Design Memory, Immedi-

ate; X's and O's; Symbol Match; Color Match; Four Letters recall; Word Memory, Delayed; and Design Memory, Delayed³². The results of these tasks are used to compute output scores in verbal memory, visual memory, reaction time, oculomotor processing speed, and impulse control³². The ImPACT also collects demographic information and includes a 22-item post-concussion symptom scale³³.

Concussion Vital Signs

The Concussion Vital Signs (CNS Vital Signs) is another online assessment tool composed of 7 tests¹¹. These 7 tests include the Verbal Memory Test, the Visual Memory Test, the Finger Tapping Test, the Symbol Digit Coding Test, the Stroop Test, the Shifting Attention Test, and the Continuous Performance Test^{33,34}. The results of these tests are used to measure reaction time, processing speed, attention, and memory³².

Concussion Resolution Index

The Concussion Resolution Index (HeadMinder) is an online neurocognitive assessment³¹. The Concussion Resolution Index consists of 6 subtests that are used to calculate 3 composite scores: simple reaction time, complex reaction time, and processing speed³¹.

Automated Neuropsychological Assessment Metrics (ANAM)

The ANAM (Vista Life Sciences) is an online neurocognitive assessment tool³³. The following tests are found on the ANAM4: Simple Reaction Time, Procedural Reaction Time, Code Substitution Learning, Code Substitution Delayed, Mathematical Processing, Matching to Sample, and a second administration of the Simple Reaction Time³². These tests are used to measure a variety of neurocognitive functions, including reaction time, processing speed, attention, and memory³².

Vision-Based Measures

Recent research has focused on the use of oculomotor evaluations to aid in the identification of concussion. A majority of individuals diagnosed with traumatic

brain injury experience some type of oculomotor dysfunction, and identifying the oculomotor pathways disrupted may provide physicians with insight into the areas of the brain impacted by concussion³¹. Oculomotor functions that are commonly disrupted by concussion injury include convergence, saccades, and pursuits³⁵.

The King-Devick (K-D) Test

The K-D test (King-Devick Technologies) is a 2-minute sideline assessment tool that has been increasingly used to assess horizontal, saccadic eye movements and attention^{31,36}. To complete the K-D test, individuals are required to read single-digit numbers from left to right and top to bottom from a set of 3 paper cards or an electronic tablet^{31,36}. Each card is unique, and the difficulty level increases with each successive card³¹. The quickest time (in seconds) that it takes an athlete to complete each of the 3 cards without error is added up for a measure of total time³¹. Worse scores have been demonstrated in individuals who sustained a concussion injury³⁷.

Ongoing Management of Concussions

The strategies for the ongoing management of concussion continue to evolve. Currently, considering the heterogeneity in concussion presentation, treatment plans are often individualized. However, treatment plans for all patients tend to follow a similar sequential order, beginning with physical and cognitive rest (Table II)^{11,15}. Although the majority of athletes who have sports-related concussions have a resolution of symptoms within 7 days, about 10% of athletes may have prolonged post-concussive symptoms³⁸.

Rest involves minimizing physical and cognitive stimuli and is the most widely used intervention for individuals diagnosed with concussion⁴. The aim of this intervention is to prevent the aggravation of symptoms and subsequent injury by reducing energy demands placed on the brain^{4,15}. To further ensure adherence to rest, physicians should inform patients, family members, coaches, and educators about

TABLE II Phases of Concussion Recovery*

Phase	Estimated Duration	Activity	Goal
Phase I	0 to 5 days	Patient symptoms limit cognitive and physical activity. Rest may be recommended by the treating physician. Medication may be used to manage symptoms.	To avoid exacerbation or worsening of symptoms
Phase II	2 to 10 days	Patient symptoms limit cognitive and physical activity to a lesser degree. Gradual return to activity may be recommended by the treating physician as symptoms allow. Medication may be tapered.	To gradually engage patients in usual daily activities that do not significantly exacerbate symptoms
Phase III	7 to 14 days	Patient no longer experiences symptoms upon return to regular activity. Increased physical and cognitive exertion may be recommended by the treating physician as symptoms allow. Medication should not be used.	To ensure that a patient can handle increased exertion without experiencing a return of symptoms and to allow for an accurate assessment of a patient's readiness to return to full a day of sport and school.

*Adapted with permission from: Kutcher JS, Giza CC. Sports concussion diagnosis and management. Continuum (Minneapolis). 2014 Dec;20(6 Sports Neurology):1552-69. <https://journals.lww.com/continuum/pages/default.aspx>.

the aim of this intervention and the complications that may arise if the physician recommendation is not followed³⁹. Patients should also be made aware that activities that may seem restful, such as watching television, reading, and texting on mobile devices, can be rather stimulating and, therefore, should be limited according to the symptom threshold³⁹.

Recent research suggests that prolonged rest may contradict the aim of this intervention. Thomas et al.⁴⁰ completed a randomized controlled trial on rest following concussion, which consisted of 2 groups: an intervention group who were recommended strict rest at home for 5 days before gradually returning to regular

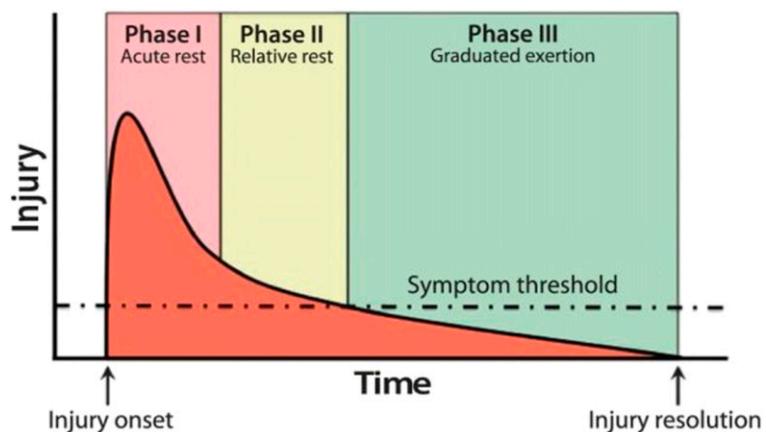
activity, and a control group who were typically recommended only 1 to 2 days of rest before gradually returning to activity⁴⁰. The study found no significant difference in neurocognitive or balance outcomes between the 2 groups, but the intervention group reported a greater number of post-concussive symptoms and was more likely to experience prolonged symptom recovery⁴⁰. Additionally, prolonged rest may be associated with psychological complications, such as anxiety and depression, and physical deconditioning^{29,30}. The current recommendation is that physicians advise patients to rest only during the acute phase (24 to 48 hours after the injury)⁴. After this period, patients may gradually

engage in activity according to their symptom threshold and physician recommendation⁴ (Fig. 1⁴¹).

Return to Sport

During the initial phase of a concussive injury, the brain is vulnerable to subsequent injury or second-impact syndrome⁴². Second-impact syndrome occurs when an individual sustains a second impact to the brain before recovering from a prior concussion and may be a real cause of permanent brain damage; therefore, extra caution should be taken to avoid this condition. Additionally, athletes who are diagnosed with subsequent concussions are likely to experience

Fig. 1
Three phases of concussion management. (Reprinted, with permission, from: Kutcher JS, Giza CC. Sports concussion diagnosis and management. Continuum [Minneapolis]. 2014 Dec;20(6 Sports Neurology):1552-69. <https://journals.lww.com/continuum/pages/default.aspx>.)



less common symptoms of concussion, specifically a loss of consciousness, and symptoms that persist beyond the initial phase of the injury^{4,3}. To prevent recurrent concussions and persistent symptoms in athletes, it is critical that sports medicine professionals make appropriate return-to-sport decisions⁶.

To assist medical professionals in making return-to-sport decisions, the CISG developed a return-to-sport strategy consisting of 6 stages^{4,15} (Table III). The first stage of this protocol is a period of rest, in which no activity is recommended to athletes^{4,15}. Afterwards, athletes may progress to the next stage in which light, symptom-limited physical activity is recommended^{4,15}. As long as concussion-related symptoms do not return, patients may continue to proceed to subsequent levels^{4,15}. However, if these symptoms do return, then it is recommended that the athlete returns to the previous asymptomatic level for at least 24 hours^{4,15}. Ultimately, athletes must pass through levels of sports-specific, complex physical

activity, and all concussion-related symptoms should be resolved before an athlete returns to unrestricted sports^{4,15}.

It is recommended that this step-wise approach is led by a physician who is familiar with the athlete, such as the team physician, as he or she will likely be best at determining an athlete's readiness to proceed to the next level¹⁵. Additionally, although the timing of this protocol may be individualized on the basis of factors such as age, symptom severity, and level of sport, all athletes should remain in each level for a minimum of 24 hours⁴. Thus, a minimum of 1 week should be provided for all athletes to complete this rehabilitation protocol^{4,15}. Lastly, it is recommended that physicians continue to monitor athletes who return to sport after concussion and that sideline observation is documented¹¹.

Persistent Symptoms

The current limitations in the prognostic indicators of concussion make it difficult for a physician to predict recovery

time. In most cases, patients experience a resolution of symptoms within a week⁴. However, a small subset of patients experiences symptoms that persist beyond this period⁴. Patients are said to have persistent symptoms if they continue to experience symptoms longer than 10 to 14 days after the injury in adults and longer than 4 weeks after the injury in children⁴.

Prognosis has been found to differ according to patients' sex and comorbid history²². In their study, Iverson et al.²² analyzed 101 articles and 13 abstracts that examined the predictors of clinical recovery. Most of the literature supported that female patients were more likely to experience a delay in symptom resolution and persistent symptoms for more than a month after concussion compared with male patients²². Individuals with a history of mental health problems or migraines before the injury or those who experienced depression or headaches after the injury may also be at greater risk of experiencing persistent symptoms²². Lastly, in another study,

TABLE III 2017 Berlin Consensus Statement Graduated Return-to-Sport (RTS) Strategy*,†,‡

Stage	Aim	Activity	Goal of Each Step
1	Symptom-limited activity	Daily activities that do not provoke symptoms	Gradual reintroduction of work/school activities
2	Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training	Increase heart rate
3	Sport-specific exercise	Running or skating drills. No head impact activities	Add movement
4	Non-contact training drills	Harder training drills, eg, passing drills. May start progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

*Reprinted, with permission, from: Consensus statement on concussion in sport-the 5th International Conference on Concussion in Sport held in Berlin, October 2016. McCrory P, Meeuwisse W, Dvořák J, Aubry M, Bailes J, Broglio S, Cantu RC, Cassidy D, Echemendia RJ, Castellani RJ, Davis GA, Ellenbogen R, Emery C, Engebretsen L, Feddermann-Demont N, Giza CC, Guskiewicz KM, Herring S, Iverson GL, Johnston KM, Kissick J, Kutcher J, Leddy JJ, Maddocks D, Makdissi M, Manley GT, McCrea M, Meehan WP, Nagahiro S, Patricios J, Putukian M, Schneider KJ, Sills A, Tator CH, Turner M, Vos PE. Br J Sports Med. 2017 Jun;51(11):838-47. Epub 2017 Apr 26. Copyright 2017, with permission from BMJ Publishing Group Ltd. †NOTE: An initial period of 24–48 hours of both relative physical rest and cognitive rest is recommended before beginning the RTS progression. ‡There should be at least 24 hours (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step. Resistance training should be added only in the later stages (stage 3 or 4 at the earliest). If symptoms are persistent (eg, more than 10–14 days in adults or more than 1 month in children), the athlete should be referred to a healthcare professional who is an expert in the management of concussion.

Iverson et al. found that, in a sample of 32,487 adolescent athletes, athletes with ADHD and/or a learning disorder reported a greater prevalence of prior concussion compared with athletes without neurodevelopmental conditions⁴⁴. Yet individuals with ADHD and learning disorders were not found to be at greater risk of persisting symptoms according to current literature²². Ultimately, researchers found that the most consistent predictor of prognosis between studies was the number and severity of symptoms experienced during the first few days following the injury, with less severe symptoms being more favorable prognostic indicators²².

When faced with a patient experiencing persistent post-concussive symptoms, physicians should complete a comprehensive clinical assessment, noting any other comorbidities or factors that may be contributing to such symptoms⁴. These patients should be referred to an experienced concussion specialist¹¹. Physicians should also take note of an individual whose condition fits the diagnostic criteria of post-concussion syndrome. The diagnostic criteria for post-concussion syndrome include a history of head injury and persistent symptoms for longer than 3 to 4 weeks²². Patients with post-concussion syndrome also experience symptoms in ≥ 3 symptom categories, which involve cognitive, somatic, and sleep-related symptoms²². These patients should be referred to a concussion specialist and should be encouraged to document changes in their symptoms for future discussion with their long-term physician^{45,46}.

Legal Implications

Concussion legislation was implemented in 2009, following the case of Zackery Lystedt, who had sustained a traumatic brain injury during a football game. A medical professional was not available during this game, and Lystedt was allowed to continue playing despite demonstrating clear signs of concussion injury. As a result of his injury and pre-

mature return to play, Lystedt was left severely disabled. The Lystedt law was enacted to protect young athletes from the complications of traumatic brain injuries. Currently, in all 50 states, concussion law follows 3 principles: concussion education, removal of the athlete with the suspected concussion injury with no same-day return to play, and clearance by a licensed medical professional^{11,23}.

Litigation continues to be a highly concerning topic in sports medicine because of a growing number of court cases with regard to sports-related injuries, particularly when head trauma is involved². Furthermore, second-impact syndrome has become a common theory of causation in lawsuits with regard to head trauma².

Whether or not defendants in sports-related injury cases are found to be liable is dependent on their conformity to the standard of care². In their study, Pachman and Lamba² defined the standard of care as “acting as a reasonable professional in that position or industry would have under the circumstances based on then-existing knowledge.” Orthopaedic surgeons who fail to follow current guidelines may therefore be in violation of the standard of care and may be found guilty of negligence².

As the scientific evidence and incidence of concussion continue to grow, it is expected that the standard of care of concussion will also evolve². To ensure that the standard of care is being met, it is recommended that orthopaedic surgeons stay updated on and act according to current guidelines and laws¹¹. It is also recommended that orthopaedic surgeons are thorough in following the return-to-sport protocol and in documenting their management plan². All initial and serial evaluations of concussion should also be documented, along with ongoing sideline observation, regardless of whether or not the athlete was diagnosed with a concussion¹¹. Ultimately, the more detailed the documentation, the greater the defense that an orthopaedic surgeon will have in the case of a sports-related injury lawsuit².

Conclusions

The heterogenous presentation of concussion, lack of understanding of pathophysiology, limitations in definitive diagnostic markers, and rapidly evolving research surrounding concussion make the diagnosis and management of concussion challenging. However, there is sufficient literature to guide orthopaedic surgeons in their care for concussed patients. Orthopaedic surgeons who are caring for athletes with concussion must remain current regarding guidelines for the safe management of athletes with sports-related concussion.

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