Characteristics of Prolonged Concussion Recovery in a Pediatric Subspecialty Referral Population

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Objective To identify pre-existing characteristics associated with prolonged recovery from concussion in a sample of patients referred to a pediatric sports medicine clinic.

Study design This was a retrospective, exploratory cohort study of 247 patients age 5-18 years with concussion referred to a tertiary pediatric hospital-affiliated sports medicine clinic from July 1, 2010, through December 31, 2011. A random sample of all eligible patient visits (3740) was chosen for further review and abstraction. Statistical comparisons between subsets of patients were conducted using exact χ^2 tests, logistic regression, quantile regression, and Kaplan-Meier survival curves.

Results The median time until returning to school part-time was 12 days (IQR 6-21); until returning to school full-time without accommodations was 35 days (IQR 11-105); until becoming symptom-free was 64 days (IQR 18-119); and until being fully cleared to return to sports was 75 days (IQR 30-153). Furthermore, 73% of all patients were symptomatic for >4 weeks, 73% were prescribed some form of school accommodation, and 61% reported a decline in grades. Characteristics associated with a prolonged recovery included a history of depression or anxiety; an initial complaint of dizziness; abnormal convergence or symptom provocation following oculomotor examination on physical examination; and history of prior concussion.

Conclusions Pediatric and adolescent patients with concussion may experience cognitive and emotional morbidity that can last for several months following injury. Clinicians should consider specific pre-existing characteristics and presenting symptoms that may be associated with a more complicated recovery for concussion patients. *(J Pediatr 2014;165:1207-15)*.

Sports- and recreation-related concussions are common childhood injuries. Prior studies have estimated that nearly 150 000 children and adolescents are seen in emergency departments for concussion each year.[1] Including adults, the total number of sports-related traumatic brain injuries has been estimated to be between 1.8 and 3.8 million annually.[2-5] Because of both increasing awareness and diagnosis, as well as increasing incidence of injury, the rate of concussion among children continues to rise and has been estimated to have doubled in the past 15 years.[6]

Pediatric and adolescent patients with concussion are at risk for significant cognitive[7,8] and emotional morbidity, including emotional lability, irritability, and depression.[5,9] Recent studies have begun to delineate factors predisposing youth athletes to a more prolonged recovery, including a history of 3 or more prior concussions[10-12] and adolescent age.[13,14] Certain presenting symptoms, including dizziness, headache, and migrainous-like symptoms (post-traumatic migraine) have also been associated with prolonged recovery in youth athletes.[12,15-17] Adult data have shown those with pre-existing depression have more severe acute neurocognitive deficits than those without depression.[18,19] Less is known, however, about pre-existing patient characteristics that predispose children and adolescents to prolonged recovery from concussions.

By examining a sample of patients referred to a specialty pediatric sports medicine clinic for management of concussion, this exploratory study aimed to further characterize pre-existing patient characteristics and presenting symptoms associated with prolonged recovery. We hypothesized that those with pre-existing mood disturbances and learning disabilities, those presenting with dizziness or loss of consciousness (LOC), those with abnormal near-point convergence and symptom provocation following oculomotor examination, and those with a history of prior concussion and younger age would suffer from prolonged symptoms.

LOC Loss of consciousness

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Supported by The Children's Hospital of Philadelphia Department of Pediatrics Chair's Initiative, the National Institutes of Health, National Center for Advancing Translational Sciences (UL1TR000003 for the University of Pennsylvania Health System), the Children's Hospital of Philadelphia Clinical Translational Sciences Award and Research Institute funding for the Comparative Effectiveness Program), and the National Institutes of Health, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (K08HD073241 [to M.Z.]). The authors declare no conflicts of interest.

http://dx.doi.org/10.1016/j.jpeds.2014.08.034

Methods

We conducted a retrospective cohort study approved by our institutional review board of patients treated for concussion in the subspecialty sports medicine clinics of a large pediatric tertiary care network. The data were collected via an electronic medical record query. A total of 3740 unique visits for patients age 5-18 years occurred in the clinics between July 1, 2010, and December 31, 2011. A convenience sample of 250 patients, chosen given estimated workload for data abstraction, was randomly selected for further evaluation. All visits for each patient were identified, and charts were abstracted electronically to obtain relevant data. Eligible patients were those who had received a diagnosis of concussion (by *International Classification of Diseases, Ninth Revision* codes 850.0, 850.1, 850.11, 850.12, 850.2, 850.3, 850.4, 850.5, or 850.9) by the referring provider. This diagnosis was confirmed by the sports medicine physician at the initial visit using the definition of concussion specified in the Consensus Statement on Concussion in Sport 4th International Conference on Concussion in Sport held in Zurich, Switzerland (mechanism of injury that results in direct or indirect forces to head resulting in symptoms including somatic, cognitive, and emotional disturbances),[20] a 16-point validated symptom scale,[21] and examination findings including balance, neurocognitive deficits, vestibular/oculomotor deficits, and near-point convergence deficits (obtained as a 1-time measure).[22,23] For the majority of patients seen at the clinics, the mechanism of injury is sports-related, although some injuries are trauma-related, including motor vehicle crashes, falls, and playground injuries. Those patients seen with non-sports, trauma-related injuries in the clinic experienced whiplash-type injuries, which were considered to be a low-impact injury mechanism and, therefore, comparable with sports-related concussion. Patients with high-impact, traumatic injury mechanisms (including motor vehicle crashes with patient ejection, death of another passenger, or rollover; and pedestrian/bicyclist without a helmet struck by a motorized vehicle) are not typically seen in our clinic. Patients with intracranial hemorrhage or prior neurologic surgery were excluded; however, those with a pre-existing vestibular disorder, substance abuse, or psychiatric disorder were not excluded. In addition, 3 of the 250 charts were duplicate patients and thus, excluded. The majority of patients seen in the sports medicine clinic are often referred for more severe or prolonged symptoms of concussion from a sports-related injury. There are patients, however, who are seen in the clinic at the time of injury regardless of severity or mechanism. Study data were collected and managed using Research Electronic Data Capture tools hosted at The Children's Hospital of Philadelphia.[24]

Demographics, injury details (date, mechanism), interventions by the referring physician (including recommendation of cognitive rest), initial symptoms at the time of injury, and physical examination findings during the initial patient visit at the sports medicine clinic were all collected from the patient visit record. For school outcomes, data were examined only for patients whose initial injury occurred between September 1 and May 31 in the years 2009, 2010, and 2011. The physical examination is a standardized concussion evaluation performed by the sports medicine physicians at The Sports Medicine and Performance Center at The Children's Hospital of Philadelphia and includes assessment for dysmetria, nystagmus, smooth pursuits, fast saccades (both horizontal and vertical),[25] gaze stability testing, near-point convergence testing,[26] and gait/balance testing. The physical examination, previously published,[22,23] is conducted in a standardized fashion by 3 sports-medicine trained pediatricians. The examination was administered only by these 3 physicians, and was documented in a standardized template in the electronic health record.

Exposures and Outcomes

Patient data were analyzed using 5 categories relating to different types of exposures (ie, potential risk factors) for prolonged recovery: (1) pre-existing conditions on initial presentation, specifically a history of depression, anxiety, attention deficit hyperactivity disorder, and a learning disability, all of which were reported by either patients or parents; (2a) patient- or parent-reported presenting symptoms, specifically dizziness and LOC; (2b) physical examination at the initial clinic visit, specifically symptom provocation following oculomotor examination (with smooth pursuits, saccades or gaze stability testing, or difficulty completing the testing), and abnormal near-point convergence (defined as convergence greater than 6 cm[27,28]); (3) patient age at time of injury; (4) patient- or parent-reported prior history of concussion; and (5) recommendation of cognitive rest by the referring provider (either an athletic trainer, primary care physician, or emergency room physician) prior to initial specialty visit, as ascertained from patient or parent report. During our visits and in our practice, we considered a patient to have a history of a certain condition or be symptomatic by either patient- or parent-report.

The sports medicine subspecialty group developed a "return to learn" protocol for cognitive rest patterned after the return to play protocol from the Consensus Statement on Concussion in Sport 3rd International Conference on Concussion in Sport held in Zurich, Switzerland.[22,23,29] This protocol begins with no school, homework, reading, or electronics (which includes texting, computers, video games), and gradually adds light reading, followed by schoolwork at home, and then school with accommodations as symptoms improve. Patients were documented to have received cognitive rest when, per patient- or parent-report, the rest prescribed by the referring provider was aligned with this protocol. Because of the retrospective nature of this study, monitoring of such rest was not performed.

For each risk factor category, recovery outcomes examined included time until a patient was symptom-free (as assessed by the treating sports medicine clinician) and time until a patient was fully cleared to participate in sports by the sports medicine clinic. To obtain clearance, patients receive a standard postexertion return-to-play protocol, as described in