INTRODUCTION

Sports injuries: diagnosis and management strategies

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It has been widely quoted that approximately 3.8 million sports-related traumatic brain injuries (TBIs) occur each year in the US. The first issue of *Neurosurgical Focus* dedicated to this topic was almost 10 years ago, in October 2006, and in that issue the role of the neurosurgeon in sports medicine was seen to be rapidly expanding. This was then followed by another issue on sports-related neurosurgical injuries in November 2011. Today, 5 years later, the primary focus on these sports injuries among clinicians and the public has been on concussions. Although most concussions do not present acutely to the emergency room, the breadth and scope of the problem are framed in this issue of *Neurosurgical Focus* by a pair of articles by Yue et al. and Winkler et al. describing the incidence and predictors of outcome following pediatric and adult sports-related TBI in US trauma centers. This is followed by a review by Hobbs and colleagues on the diagnosis and pathophysiology of concussion, its on-field management, neuroimaging techniques, treatment strategies, and the sequelae of concussions such as postconcussion syndrome (PCS), second-impact syndrome (SIS), and chronic traumatic encephalopathy (CTE).

Despite 4 Consensus Meetings on Concussion in Sport, the diagnosis of concussions remains challenging. Symptoms vary from individual to individual and often masquerade as other coexisting conditions such as neck injuries. The on-field diagnosis is even more challenging, because only 10% of concussions are associated with loss of consciousness and up to 10% may remain asymptomatic for the first 24 to 48 hours. Concussion diagnosis is still heavily reliant on clinical evaluation, with no other diagnostic modality of adequate sensitivity and specificity yet available. On the sidelines, the Sport Concussion Assessment Tool (SCAT) has been widely adopted, including in several professional sports leagues. Yengo-Kahn et al. report on a systematic review of the SCAT3 in preparation

for its next iteration, and they also provide a historical perspective and evolution of the SCAT and its components. Sussman et al. discuss the role of oculomotor assessments in aiding the diagnosis of concussions.

This issue of sports-related TBI is particularly compelling for youth sport, where obtaining an accurate diagnosis in a timely fashion is critical due to the possibility of SIS. The contemporary theory is that the appropriate clinical management of sports-related TBI should accelerate return to school and return to play. Particularly challenging are athletes who have sustained multiple concussions, experienced increasing recovery times, and suffered from prolonged postconcussive symptoms. Ellis and colleagues discuss their institutional approach toward return to play and retirement considerations in youth athletes, using 3 cases as illustrations. They acknowledge that evidence is lacking in making these recommendations, and this reinforces the urgent need for further high-quality studies to help guide treatment decisions in the field.

Neurosurgeons are often consulted following the discovery of intracranial and intraspinal lesions in concussed athletes who have undergone neuroimaging. Important incidental findings could include Chiari malformations, colloid cysts of the third ventricle, and vascular malformations of the brain and spinal cord. These findings create major dilemmas regarding the future participation of these athletes in sporting activities. Zuckerman et al. perform a systematic review of sports-related TBI associated with arachnoid cysts. They also analyze predictors for outcome and make recommendations for sports participation in such patients. While discussing sports-related TBI, we should not forget about the connection between the head and the rest of the body. Joaquim et al. review the literature on the outcomes of cervical spine surgery in professional or elite athletes.

Considerable research will need to focus on key areas

such as gender differences in the predisposition to injury and recovery from injury, and helmet innovation. Tripathi et al. raise the important question about the protective value of current helmets by discussing the cranio-facio-ocular injuries faced by cricket players and reviewing the performance of various helmets under different testing conditions. Research in helmet technology is ongoing, but the role of education should not be underestimated. This is best exemplified by the survey conducted by Menger and colleagues on headgear use in rugby players and the association with more aggressive play.

It is also hoped that the development of optimal management strategies will decrease any potential long-term effects of these injuries. In their second article, Zuckerman and colleagues used data from the National Collegiate Athletic Association (NCAA) injury surveillance database to investigate factors leading to the development of PCS. Further research is also required to identify the risk factors for the development of long-term degenerative manifestations of head injury. Pan et al. consider the pathology behind sports-related TBI and CTE in the quest for biomarker discovery. Finally, Ban et al. tackle the controversial and much-publicized topic of CTE by discussing the current state of research and the evidence behind the various claims put forth in the scientific literature and popular press. Directions for future research are also suggested.

We hope that you will find this issue of *Neurosurgical Focus* informative and enjoyable, and we look forward to the advances in the field in the next issue.

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