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The Epidemiology of Injuries to the Nervous System Resulting from Sport and Recreation 1

Cory Toth

Sports and recreational activities are associated with a variety of injuries. Although many of these injuries are musculoskeletal in nature, both the peripheral nervous system and the central nervous system are at risk for injury as well. This article examines the incidence of nervous system injuries in particular sports. The association between particular forms of injuries and the sports in which they are likely to be incurred are also investigated. Further assessment of preventative measures is provided when possible.

Section 2 – Mechanisms of Injury and Activity

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Min S. Park and Michael L. Levy

With the increased conditioning, size, and speed of professional athletes and the increase in individuals engaging in sports and recreational activities, there is potential for rising numbers of traumatic brain injuries in sports. Fortunately, parallel strides in basic research technology and improvements in computer and video technology have created a new era of discovery in the study of the biomechanical aspects of sports-related head injuries. Although prevention will always be the most important factor in reducing the incidence of sports-related traumatic brain injuries, ongoing studies will lead to the development of newer protective equipment, improved recognition and management of concussions on the field of play, and modification of rules and guidelines to make these activities safer and more enjoyable.

The Neurophysiology and Assessment of Sports-Related Head Injuries 39

Mark Lovell

This article provides a review of contemporary standards for the management of athletes who have sustained a sports-related head injury. Recent research regarding concussion management is reviewed with specific reference to clinical care. The use of neuropsychologic testing in sports also

is reviewed, and a systematic protocol for the management of sports-related concussion is presented.

Spinal Injuries in Sports

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Barry P. Boden and Christopher G. Jarvis

Athletic competition has long been a known source of spinal injuries. Approximately 8.7% of all new cases of spinal cord injuries in the United States are related to sports activities. The sports activities that have the highest risk of catastrophic spinal injuries are football, ice hockey, wrestling, diving, skiing, snowboarding, rugby, and cheerleading. Axial compression forces to the top of the head can lead to cervical fracture and quadriplegia in any sport. It is critical for any medical personnel responsible for athletes in team sports to have a plan for stabilization and transfer of an athlete who sustains a cervical spine injury.

Recognition and Management of Spinal Cord Injuries in Sports and Recreation

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Charles H. Tator

Spinal injuries and spinal cord injuries in sports and recreation represent frequent and important causes of injury and disability. These injuries are virtually all preventable through strict adherence to the codes of conduct of the rules and regulations for sports and recreation and through an attitude of respect for one's own welfare and the welfare of the opponents or other participants. Adherence to guidelines for return to sport after injury can help to prevent worsening of deficits and the onset of new deficits.

Peripheral Nerve Injuries Attributable to Sport and Recreation

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Cory Toth

Many different sports and recreational activities are associated with injuries to the peripheral nervous system (PNS). Although some of those injuries are specific to an individual sport, other peripheral nerve injuries occur ubiquitously within many sporting activities. This review of sport-specific PNS injuries should assist in the understanding of morbidity associated with particular sporting activities, professional or amateur. Proper recognition of these syndromes can prevent unnecessary diagnostic testing and delays in proper diagnosis. The sports most commonly associated with peripheral nerve injuries are likely football, hockey, and baseball, but many other sports have unique associations with peripheral nerve injury. This article should be of assistance for the neurologist, neurosurgeon, orthopedic surgeon, physiatrist, sports medicine doctor, and general physician in contact with athletes at risk for neurologic injuries.

Muscle Physiology in Healthy Men and Women and Those with Metabolic Myopathies

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Michaela C. Devries and Mark A. Tarnopolsky

The relative contribution and source of the fuels used during endurance exercise is dependent on the intensity and the duration of the exercise. Much work has been done to investigate the potential performance-enhancing effect of manipulating training and dietary interventions in athletes, as well as the influence of gender. Studies show that even patients

with metabolic myopathies may derive benefits that counter the age-associated loss of muscle mass and strength. This article gives an overview of these different impacts on endurance exercise, concluding with an examination of the metabolic myopathies that impair substrate metabolism in skeletal muscle and result in exercise intolerance.

Section 3 – Variables in Sport

Enhancement Drugs and the Athlete

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Francesco Botrè and Antonio Pavan

This article considers the health risks associated with the abuse of performance-enhancing drugs (PEDs) in sport. After an overview on the evolution of doping substances and methods and on the current international organization of the antidoping tests, the potential risks correlated with abuse of PEDs are presented. Specific problems of drug associations, designer steroids, and nutritional supplements also are discussed. Data from randomized clinical trials may not be sufficient to identify the complete range of adverse effects possible with abuse of PEDs; more specific studies are necessary to assess their actual toxic potential.

Sleep, Recovery, and Performance: The New Frontier in High-Performance Athletics

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Charles Samuels

The relationship of sleep to post-exercise recovery (PER) and athletic performance is a topic of great interest because of the growing body of scientific evidence confirming a link between critical sleep factors, cognitive processes, and metabolic function. Sleep restriction (sleep deprivation), sleep disturbance (poor sleep quality), and circadian rhythm disturbance (jet lag) are the key sleep factors that affect the overall restorative quality of the sleep state. This article discusses these theoretic concepts, presents relevant clinical cases, and reviews pilot data exploring the prevalence of sleep disturbance in two groups of high-performance athletes.

Neuromuscular Fatigue in Racquet Sports

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Olivier Girard and Grégoire P. Millet

This article describes the physiologic and neural mechanisms that cause neuromuscular fatigue in racquet sports: table tennis, tennis, squash, and badminton. In these intermittent and dual activities, performance may be limited as a match progresses because of a reduced central activation, linked to changes in neurotransmitter concentration or in response to afferent sensory feedback. Alternatively, modulation of spinal loop properties may occur because of changes in metabolic or mechanical properties within the muscle. Finally, increased fatigue manifested by mistimed strokes, lower speed, and altered on-court movements may be caused by ionic disturbances and impairments in excitation-contraction coupling properties. These alterations in neuromuscular function contribute to decrease in racquet sports performance observed under fatigue.

Section 4 – Neurologic Injuries in Team Sports

Peripheral Nerve Injuries in Baseball Players

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Craig A. Cummins and David S. Schneider

Baseball players place significant stress across their shoulders and elbows during the throwing motion, causing unique patterns of injuries in the overhead throwing athlete. Specific nerve injuries include suprascapular neuropathy, quadrilateral space syndrome, and cubital tunnel syndrome. Nonoperative treatment includes cessation of throwing and symptom management. As symptoms improve, athletes should start rehabilitation, focusing on restoring shoulder and trunk flexibility and strength. The final rehabilitation phase involves an interval throwing program with attention directed at proper mechanics, with the goal of returning the athlete to competitive throwing. Surgery may assist in a positive outcome in particular patients who fail to improve with nonoperative treatment. Additional indications for surgery may include more profound neuropathy and nerve compression by a mass lesion.

Concussion in the National Football League: An Overview for Neurologists

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Ira R. Casson, Elliot J. Pellman, and David C. Viano

The authors' studies have yielded a great deal of data regarding the biomechanics of head injury and the clinical picture of mild traumatic brain injury (MTBI) in the National Football League (NFL). The research has demonstrated the link between the effects of biomechanical forces on the brain and the clinical symptomatology of the concussed players. New insights into the mechanisms of injury are leading to new ways of protecting football players from the effects of MTBI. The clinical data validate the effectiveness of the current NFL physician approach to the evaluation and treatment of the player who sustains MTBI. There are still many more questions to answer and much more knowledge to be gained from continuing research in this area.

Neurologic Injuries in Hockey

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Richard A. Wennberg, Howard B. Cohen, and Stephanie R. Walker

Ice hockey is a fast contact sport played on an ice surface enclosed by rigid boards. There is an intrinsic risk for injury in hockey, with many injuries potentially affecting the nervous system. This article provides an overview of neurologic injuries occurring in hockey as reported in the scientific literature. Among all injuries, a small but real risk for catastrophic cervical spinal cord injury and a high incidence of concussion emerge as the two most important neurologic issues.

Section 5 – Neurologic Injuries in Individual Sports

Neurologic Injuries in Boxing and Other Combat Sports

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Tsharni R. Zazryn, Paul R. McCrory, and Peter A. Cameron

Many sports have neurologic injury from incidental head contact; however, combat sports allow head contact, and a potential exists for acute and chronic neurologic injuries. Although each combat sport differs in which

regions of the body can be used for contact, they are similar in competitor exposure time. Their acute injury rates are similar; thus their injuries can appropriately be considered together. Injuries of all types occur in combat sports, with injuries in between one fifth to one half of all fights in boxing, karate, and taekwon do. Most boxing injuries are to the head and neck region. In other combat sports, the head and neck region are the second (after the lower limbs) or the first most common injury site.

Neurologic Injuries in Cycling and Bike Riding

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James Kennedy

Cycling is often considered a leisurely activity with minimal potential for severe or chronic injury. Acute head and spinal trauma can be devastating and can predominantly contribute to all-cause mortality in injuries attributed to cycling. Chronic overuse injuries primarily affecting the ulnar, median, and pudendal nerves are also a cause of significant morbidity for the cyclist.

Neurologic Running Injuries

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Kelly A. McKean

Neurologic running injuries account for a small number of running injuries. This may be caused by misdiagnosis or underdiagnosis. Nerve injuries that have been reported in runners include injuries to the interdigital nerves and the tibial, peroneal, and sural nerves. In this article, the etiology, symptoms, diagnosis, and treatment of these injuries are reviewed. Differences between nerve injury and more common musculoskeletal injury have been presented to aid in differential diagnosis.

Neurologic Injuries from Scuba Diving

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Jodi Hawes and E. Wayne Massey

Interest in scuba (self-contained underwater breathing apparatus) diving increased in the 1970s, and undersea diving continues to be a popular sport early in the 21st century, with approximately 3 million certified divers in the United States. The Divers Alert Network (DAN), an institution created in 1981 by the Commerce Department, National Oceanic and Atmospheric Administration, has collected diving injury data for US and Canadian divers since 1987 that can be studied to suggest the epidemiologic characteristics of diving. This article examines neurologic injuries resulting from scuba diving.

Neurologic Disorders Associated with Weight lifting and Bodybuilding

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Kevin Busche

Weight lifting and other forms of strength training are becoming more common because of an increased awareness of the need to maintain individual physical fitness. Emergency room data indicate that injuries caused by weight training have become more universal over time, likely because of increased participation rates. Neurologic injuries can result from weight lifting and related practices. Although predominantly peripheral nervous system injuries have been described, central nervous system disease

may also occur. This article illustrates the types of neurologic disorders associated with weight lifting.

Head Injuries in Winter Sports: Downhill Skiing, Snowboarding, Sledding, Snowmobiling, Ice Skating and Ice Hockey

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Brian Chaze and Patrick McDonald

Winter sports are often associated with high speed, which carries with it the potential for collision. As such, head injuries are among the more commonly encountered injuries in winter-related sporting activities. This article focuses on popular winter sports such as downhill skiing and snowboarding, sledding, snowmobiling, ice skating, and hockey. In virtually all of these activities, the incidence and severity of head injuries can be reduced by the use of appropriate protective headgear.

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