Neurologic Injuries in Cycling and Bike Riding

James Kennedy, MD, PhD

KEYWORDS

• Cycling • Biking • Bicycle • Nerve entrapment
• Head injury • Pudendal nerve

Bicycling is one of the most popular means of transportation, recreation, fitness, and sport among millions of people of all ages. The bicycle has undergone extensive refinements since its initial beginnings as the velocipede in 1817 by Karl von Drais, remaining a readily available form of aerobic nonimpact exercise with established beneficial cardiovascular effects. Bicycling also continues to be a popular means of city transport, especially within Asian and European countries. Commercial interests, such as the postal service and law enforcement, continue to use cycling for transportation. Additionally, in the past, bicycles were an effective vehicle for mobilizing soldiers and supplies to combat zones during World Wars I and II.

Cycling was part of the inaugural first modern Olympic Games in 1896. Since this time, the International Olympic Committee has recognized the popularity of various forms of cycling and included mountain biking in the 1996 games in Atlanta with plans to incorporate bicycle motocross (BMX) in the 2008 games in Beijing. Bicycle sales have steadily increased in each decade, with mountain bikes currently accounting for 62% of new bicycle sales in the United States.[1] The increasing attractiveness is not limited to the adult population, however. In 1994, the Centers for Disease Control and Prevention estimated that 73% of children aged 5 to 14 years ride bicycles.[2]

Cycling is not generally considered a high-risk activity. Given the increased number of people riding bicycles and the development of ''extreme forms'' of the activity, such as mountain biking, however, there has been a continued increase in injury incidence. Generally, bike-related injuries can be classified into acute physical trauma or chronic overuse patterns. The annual incidence of bicycle deaths has been reported as 900, with 23,000 hospital admissions, 580,000 emergency department visits, and greater than 1.2 million physician consults per year.[3] Bicycle crashes rank second only to riding animals as a sports- or recreation-associated cause of serious injury. Although injuries to mountain bikers of all ages account for only 3.7% of bike injuries overall, up to

This article originally appeared in *Neurologic Clinics*, Volume 26, Issue 1.
Division of Plastic Surgery, Department of Surgery, University of Calgary; Foothills Hospital, Resident's Mailroom, 1403 29th Street NW, Calgary, Alberta, Canada T2N 2T9
E-mail address: jmckenne@ucalgary.ca

Phys Med Rehabil Clin N Am 20 (2009) 241–248
doi:10.1016/j.pmr.2008.10.015 **pmr.theclinics.com**
1047-9651/08/$ – see front matter

51% of recreational and 85% of competitive mountain bikers sustain injuries each year.[4,5] The peak incidence of bike-related injuries and fatalities is within the group aged 9 to 15 years, whereas 20- to 39-year-old riders comprise the group incurring the most mountain bike injuries.[5,6] Mortality and morbidity rates attributable to bicycle accidents remain highest in older individuals, male cyclists, and cyclists involved in collisions with motor vehicles.[7]

Most bicycle-related injuries involve superficial trauma, such as abrasions, contusions, and lacerations. Significant trauma to the upper and lower extremities and to the head, face, abdomen, and thorax are also commonly seen.[3,6,8] Neurologic involvement, unfortunately, may represent a large proportion of the more severe injury patterns. Head injuries, in particular, often involve collision with a motor vehicle and are responsible for more than 60% of all bicycle-related deaths and most long-term disabilities.[9,10]

CENTRAL NERVOUS SYSTEM INJURIES

Head Injuries

Off-road cyclists seem to have a lower incidence of head, facial, and dental injuries compared with on-road cyclists. This is presumably attributable to physical segregation from vehicular traffic and the tendency to more frequent helmet use.[4,5,8] A recent report analyzed severe cycling injuries over a 10-year period and found that 18% involved a head injury with 10% spinal involvement.[11] Principal risk factors for head injury include not wearing a helmet, crashes involving motor vehicles, an unsafe riding environment, and male gender.[5,6] The effect of rider errors, such as losing control, performing stunts, inexperience, or bike mechanical failure, remains unclear. Elevated riding speeds do seem to be linked to more severe head injury, however.

Severe head injuries, such as intracranial hemorrhage and contusions, generally have a low incidence among cyclists but do remain the top culprit contributing to mortality.[5,12–14] Intracranial hemorrhage and contusions, if present, typically involve the cerebral cortex, followed by the cerebellum and brain stem.[15] Conversely, the most common head injury is a closed head injury without an overt structural lesion, presenting as a brief loss of consciousness. Given the relative infrequent nature of structural closed head injuries, it is not unexpected that only 1.5% of all cases require operative intervention.[15]

Helmets are known to reduce the risk for head injuries by 69% to 85% and are strongly advocated by various preventative health and government agencies.[16–18] It has been estimated that although nearly 50% of children have helmets, only 15% to 25% wear them consistently or correctly.[2,19] Proposed barriers to helmet use include poor fit, cost, discomfort, and negative pressure from peers, particularly among school-aged children. Helmet legislation has been shown to be effective for increasing helmet use and for decreasing the frequency of head injuries.[20,21] Strong community-based programs designed to provide free or subsidized helmets are also effective for promoting helmet use among children.[22] Most cycling organizations now mandate bicycle helmet use, and many state jurisdictions in the United States have added mandatory use legislation, but with restrictions only applied to children.[23]

Further preventative measures have aimed to educate riders to anticipate the errors of motorists and to become familiar with the risks of different road surfaces and weather conditions. Younger children are encouraged to avoid riding in the vicinity of traffic. Environmental solutions have centered around separating cyclists from road traffic by the use of designated cycle lanes on streets. Furthermore, the design of bike pathways has included the use of smoother surfaces, avoidance of obstacles, and discouraging ''wrong-way'' riding. The impact of these design strategies so far