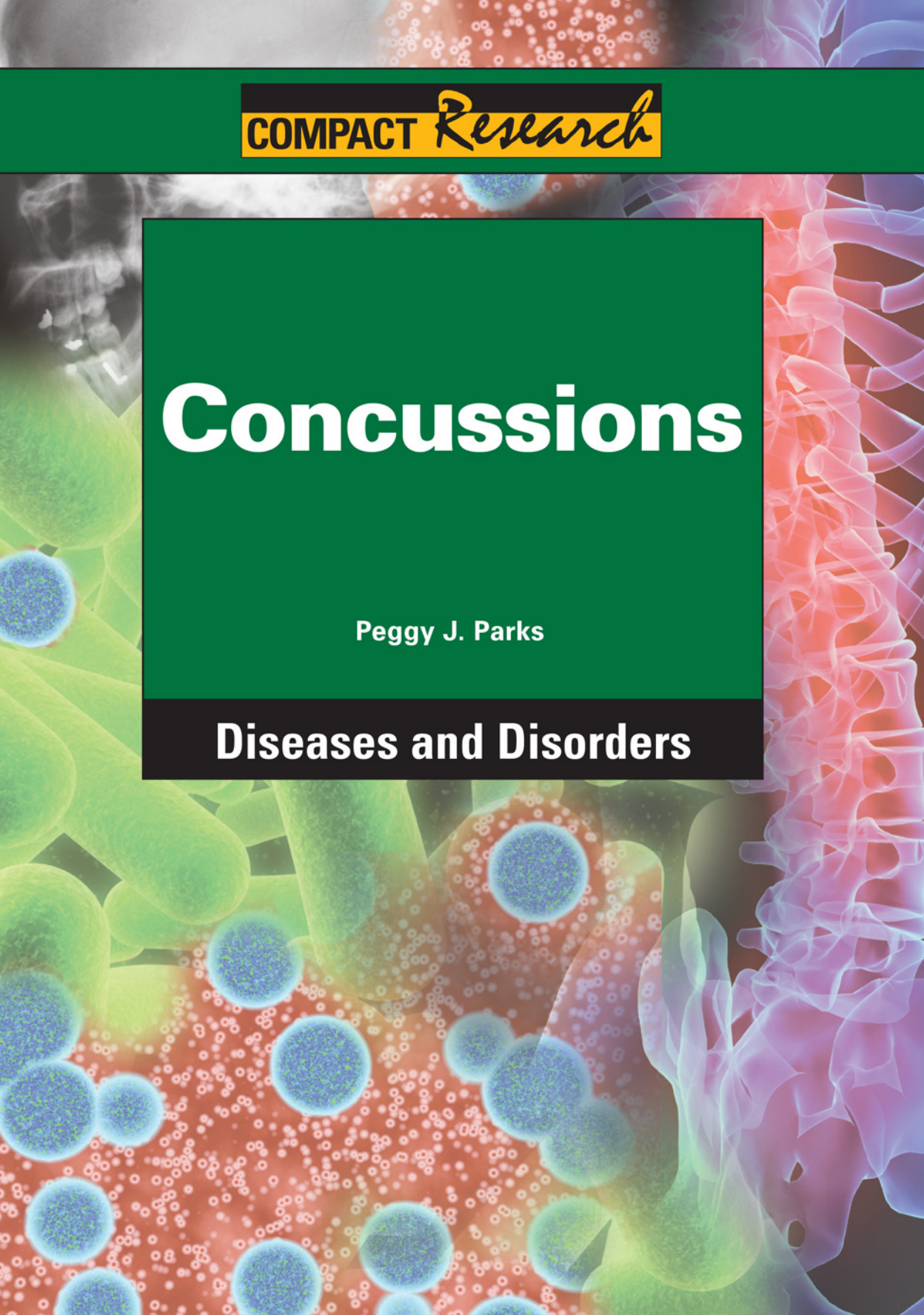
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San Diego, CA

Printed in the United States

For more information, contact:
ReferencePoint Press, Inc.
PO Box 27779
San Diego, CA 92198
www.ReferencePointPress.com

Picture credits:
Cover: Dreamstime and iStockphoto.com
Maury Aaseng: 33–35, 47–49, 61–62, 75–77
AP Images: 15, 17

LIBRARY OF CONGRESS CATALOGING-IN-PUBLICATION DATA

Parks, Peggy J., 1951–
Concussions / by Peggy J. Parks.
pages cm. -- (Compact research series)
Audience: Grade 9 to 12.
ISBN-13: 978-1-60152-513-0 (e-book)
1. Brain--Concussion--Juvenile literature. 2. Sports injuries--Prevention--Juvenile literature.
I. Title.
RC394.C7P39 2013
617.1'027--dc23

2012043650

Contents

Foreword

"Where is the knowledge we have lost in information?"

—T.S. Eliot, "The Rock."

As modern civilization continues to evolve, its ability to create, store, distribute, and access information expands exponentially. The explosion of information from all media continues to increase at a phenomenal rate. By 2020 some experts predict the worldwide information base will double every seventy-three days. While access to diverse sources of information and perspectives is paramount to any democratic society, information alone cannot help people gain knowledge and understanding. Information must be organized and presented clearly and succinctly in order to be understood. The challenge in the digital age becomes not the creation of information, but how best to sort, organize, enhance, and present information.

ReferencePoint Press developed the *Compact Research* series with this challenge of the information age in mind. More than any other subject area today, researching current issues can yield vast, diverse, and unqualified information that can be intimidating and overwhelming for even the most advanced and motivated researcher. The *Compact Research* series offers a compact, relevant, intelligent, and conveniently organized collection of information covering a variety of current topics ranging from illegal immigration and deforestation to diseases such as anorexia and meningitis.

The series focuses on three types of information: objective single-author narratives, opinion-based primary source quotations, and facts

and statistics. The clearly written objective narratives provide context and reliable background information. Primary source quotes are carefully selected and cited, exposing the reader to differing points of view, and facts and statistics sections aid the reader in evaluating perspectives. Presenting these key types of information creates a richer, more balanced learning experience.

For better understanding and convenience, the series enhances information by organizing it into narrower topics and adding design features that make it easy for a reader to identify desired content. For example, in *Compact Research: Illegal Immigration*, a chapter covering the economic impact of illegal immigration has an objective narrative explaining the various ways the economy is impacted, a balanced section of numerous primary source quotes on the topic, followed by facts and full-color illustrations to encourage evaluation of contrasting perspectives.

The ancient Roman philosopher Lucius Annaeus Seneca wrote, "It is quality rather than quantity that matters." More than just a collection of content, the *Compact Research* series is simply committed to creating, finding, organizing, and presenting the most relevant and appropriate amount of information on a current topic in a user-friendly style that invites, intrigues, and fosters understanding.

Concussions at a Glance

Concussions Defined

A concussion is a mild traumatic brain injury that affects the brain's normal functioning.

How Concussions Occur

A concussion can result when someone sustains a blow to the head or body, causing the brain to bounce around inside the head and bang into the hard, bony skull.

Warning Signs

The most obvious signs of concussion are dizziness, nausea, blurred vision, and problems with balance, although symptoms may vary depending on the severity of the injury.

Nonsports Causes

The most common causes of concussion are motor vehicle accidents and falls.

Concussion-Prone Sports

The risk of concussion is greatest in sports that involve intentional blows to the head (mixed martial arts and boxing) and contact sports such as football and hockey.

Prevalence

The Centers for Disease Control and Prevention (CDC) estimates that between 1.7 million and 3.8 million people in the United States sustain some form of traumatic brain injury each year, most of which are concussions.

Diagnosis and Treatment

Concussions are diagnosed based on symptoms, and the only treatment is complete physical and cognitive rest until the brain has healed.

Risks

Concussions may lead to long-term problems such as memory loss and depression; cumulative damage from concussions can result in severe brain deterioration and a condition known as chronic traumatic encephalopathy.

Prevention

Athletic organizations and schools throughout the United States have adopted policies to help prevent concussions, and legislation to help protect youth athletes has been passed in forty-one states and Washington, DC.

Overview

"The signs and symptoms of a concussion can be subtle and may not be immediately apparent. Symptoms can last for days, weeks or even longer."

—Mayo Clinic, a world-renowned medical facility headquartered in Rochester, Minnesota.

"It's important to understand exactly what a concussion is. It is a complex, functional disturbance of the brain that results from a traumatic force."

—Mandy Huggins, a sports medicine physician from South Florida.

Zach Brady is a teenager from Vancouver, Washington, who has loved the game of football since he was a little boy. By the time he got to high school, Brady was a standout defensive linebacker who dreamed of playing college ball after graduation. Throughout his years of playing football, he had sustained a number of concussions. But like most young athletes, he put the team first, ignored the pain, and went back to the game—until the summer of 2011, when a concussion at football camp took a devastating toll on his brain and shattered his dreams for a football career.

After the concussion Brady not only lost the ability to play the sport he loved, he also missed out on most of his senior year. Being at school was impossible because he could not focus and easily became overwhelmed by the activity and noise in the hallways. For months he had to stay home and take online classes. Above all, Brady became terribly frustrated that his brain no longer worked the way it had before. Whereas

in the past he was a top student who spent no more than an hour writing essays that easily earned A grades, the papers he wrote after his last concussion took ten times as long to complete. Worse yet, he found it devastating to go back and read them afterward and see how jumbled his reasoning was. "I wish I just had a bunch of broken bones," says Brady, "and it could heal."[1]

Protected Yet Vulnerable

To understand how concussions affect the brain, it helps to have an understanding of how the brain works. For an organ that weighs only about 3 pounds (1.4 kg), the brain holds an extraordinary amount of power. It is composed of billions of interconnecting cells (known as neurons) that constantly communicate with each other through rapid-fire electrical signals. These signals, which are facilitated by chemicals known as neurotransmitters, allow the brain to regulate everything from intelligence, emotions, sense of humor, and memory to movement and behavior. Neurosurgeon Keith Black writes: "Unlike any other organ in the body, our brain is the essence of what makes us human, our memories, our thoughts, our personalities—one hundred billion nerve cells, working in absolute harmony to allow us to see, to smell, to move, to understand, and to create."[2]

The brain is soft, gelatin-like, and fragile, but is protected in several ways. The first line of protection is the meninges (or meningeal layers), which include three layers of membrane: the pia mater (innermost layer next to the brain), the arachnoid layer (middle), and the dura mater (outermost layer). Wrapped in the meninges and encased inside the hard, bony skull (or cranium), the brain floats in a layer of cerebrospinal fluid, which cushions it like a liquid shock absorber. Together, these protective mechanisms do a good job of shielding the brain from normal everyday bumps and jolts—but it is still vulnerable to serious injury.

What Are Concussions?

The word *concussion* is derived from the Latin verb *concutere*, which means "to shake violently." This is a fitting description of what happens during a concussion: an outside force causes the brain to bounce around inside the skull and bump into its hard, bony surface. This is most common when an individual sustains a blow to the head, but concussion can

also result from a hit to the body or a whiplash-type injury that throws the head forward and backward. To illustrate this phenomenon, sports medicine physician Andrew M. Blecher uses the metaphor of an egg: "If you take an egg and shake it around, what happens to the yolk inside? You may not damage the shell by shaking the egg but the yolk moves around freely due to the acceleration and deceleration forces from the shaking. This motion of the yolk within the shell damages the yoke as it bangs up against the shell. . . . The same thing occurs in the brain."[3]

The word *concussion* is derived from the Latin verb *concutere*, which means 'to shake violently.'

Concussions are included in the category of traumatic brain injuries and are the most common type. In medical literature concussions are defined as mild traumatic brain injuries. Although this is often interpreted to mean they are not serious, that is an incorrect assumption. Rather, *mild* refers to how concussions compare to more severe brain injuries. In her book *Ahead of the Game*, neuropsychologist and concussion expert Rosemarie Scolaro Moser writes:

> Concussions are considered mild brain injuries because there is no skull fracture, there is no intracranial bleeding or hemorrhaging, and recovery is expected. But that doesn't mean that concussion is not *serious*. After all, you'd take even a 'mild' heart attack seriously, wouldn't you? The same principle applies to concussions.[4]

Concussion Warning Signs

Brain trauma experts say that people who sustain concussions are often unaware of the injury because they are not familiar with the symptoms. A widespread belief is that in order for someone to have a concussion, he or she must be knocked unconscious. This is not true, however, as Julian Bailes, a neurosurgeon who directs the Brain Injury Research Institute, explains: "With the vast majority of concussions in sports—90 percent of the time, in fact—athletes don't get knocked out. They're walking around and talking, and they look normal."[5]According to Bailes, the

mistaken belief that a concussion has occurred only if a player becomes unconscious is not only incorrect, it is dangerous.

Concussion symptoms are divided into four categories: physical, cognition/memory, emotional/mood, and sleep disturbances. Common physical symptoms include headache, fuzzy or blurry vision, sensitivity to noise and/or light, dizziness, feeling tired and lacking energy, and problems with balance. Warning signs related to cognition/memory include difficulty thinking clearly, feeling slowed down, trouble concentrating, and difficulty remembering new information. Emotional/mood symptoms include irritability, inexplicable sadness, nervousness and/or anxiety, and sleep disturbances are interruptions in normal sleep patterns.

Nonsports Causes

Although concussions are typically associated with sports and recreational activities, these injuries can and do happen in a variety of different ways. Reports by the CDC show that motor vehicle accidents are the most common cause of concussions, which health officials say often result from people not wearing seat belts. A 2012 study by the Trust for America's Health and the Robert Wood Johnson Foundation found that eighteen US states do not have seat belt laws in place. These states have injury rates (including concussions) that are significantly higher than states with seat belt legislation in place. Mehmet Oz, who is vice chair and professor of surgery at Columbia University, writes: "Always wear your seat belt, since automobile accidents are one of the more common causes of concussions—as any physician who has worked a shift in the ER could tell you."[6]

> **Brain trauma experts say that people who sustain concussions are often unaware of the injury because they are not familiar with the symptoms.**

Another leading cause of concussions is accidental falls, which are responsible for the majority of concussions in elderly people and children. The two-year-old daughter of Jeffrey Kluger, who is senior editor for *Time* magazine, sustained a concussion after colliding with another child on the patio of a museum

in Mexico City. After the collision Elisa Kluger fell down on her bottom, tipped backward, and then hit her head on the patio. Kluger writes: "The sound was one that parents dread: the singular clunk of skull striking cement. I winced, Elisa wailed, and I gathered her up."[7] About twenty minutes later the little girl became uncharacteristically withdrawn, started to vomit, and went into convulsions. Kluger and his wife rushed her to the hospital, where she was diagnosed with a concussion.

Concussion-Prone Sports

The risk for concussions is greatest in sports that involve intentional blows to the head, such as in mixed martial arts and boxing. Ken Reed, a physician and sports policy director for the sports reform organization League of Fans, writes: "Boxing, of course, is the ultimate sport for concussions. The goal is to knock out your opponent, in effect, to give the other person a concussion." Reed goes on to say that the popularity of boxing has lagged over the years, so sports such as hockey and football have "moved to the forefront when the subject of concussions in sports is brought up."[8] The number one sport for concussions is football, with hockey, lacrosse, rugby, and basketball also having a high incidence of concussions among players.

The risk for concussions is greatest in sports that involve intentional blows to the head, such as in mixed martial arts and boxing.

Even sports that are not hard-hitting collision sports have a high prevalence of concussions. Soccer, for instance, is the number one source of concussions among female athletes. One major reason for the high concussion rate is the practice of heading, in which players use their heads to direct the ball. Says Robert C. Cantu, who is a Boston neurosurgeon and world-renowned expert on sports-related concussions: "People who think of concussions as only being present mostly in guys and mostly in the sport of football are just plain wrong. Soccer is right at the top of the list for girls."[9] Because of the dangers associated with heading, Cantu recommends that the practice be eliminated from all youth soccer.

Among high school students, boys' sports account for 75 percent of all concussions, and football accounts for more than half of all concussions in high school sports. The usual cause of sports-related concussions is a blow to the head.

Concussion Prevalence

Health officials can make estimates about the number of concussions that occur each year, but they have no way of knowing the exact figure. That is largely because such data are compiled based on visits to emergency rooms, and most concussion sufferers never seek medical care. Says Julie Gilchrist, a physician with the CDC's National Center for Injury Prevention and Control: "There's a vast undercounting of the concussions in the general population."[10] According to the CDC, an estimated 1.7 million to 3.8 million people in the United States sustain some form of traumatic brain injury each year, with about 75 percent of those injuries being concussions. In a December 2011 paper, the American Association of Neurological Surgeons stated that more than three hundred thousand concussions occur each year as a result of sports-related injuries.

Research consistently shows that concussions are a serious problem among youth who participate in sports. In high school sports alone, for

example, the CDC estimates that more than sixty-two thousand concussions occur each year. But since concussions are underreported, even in youth sports, health officials believe that the actual number is significantly higher. In his book, *Kids, Sports, and Concussions*, Boston physician and brain trauma expert William Paul Meehan III writes: "Since a concussion cannot be 'seen,' athletes are able to conceal it from athletic trainers, team physicians, coaches, and parents. And many of them do." Meehan refers to a study of football players from American high schools that showed less than half who sustained a concussion reported it to anyone. "Many younger athletes do not realize they have sustained a concussion," he says. "Fewer realize that a concussion is a traumatic brain injury. They believe they have merely 'had their bell rung' or been 'dinged.'"[11]

The Female Factor

In sports played by both males and females, studies have shown that gender plays a role in who is most vulnerable to concussions. In at least two sports, basketball and soccer, female athletes sustain significantly more concussions than males. One report, which was published in a 2008 issue of the *Journal of Athletic Training*, showed that girls playing high school soccer suffered concussions 68 percent more often than boys who played soccer, and rates for basketball were nearly three times higher for female players. Although researchers are not clear on the reasons for this discrepancy, one theory is that females have weaker neck muscles than males. Cantu explains: "Girls as a group have far weaker necks. The same force delivered to a girl's head spins the head much more because of the weak neck than it does the guy's."[12]

"Along with having a higher risk of sustaining concussions, females typically take longer to recover from the injuries."

Along with having a higher risk of sustaining concussions, females typically take longer to recover from the injuries. This was one of the findings of a study that appeared in the June 1, 2012, issue of the *American Journal of Sports Medicine*. The research team, led by Tracey Covassin of Michigan State University, followed a group of high school and college athletes

Soccer is the number one source of concussions among female athletes. The high concussion rate is linked to the practice of heading the ball. Some medical experts have called for the elimination of this practice from all youth soccer.

for two years. They found that the female athletes who suffered concussions exhibited more symptoms and showed greater declines in cognitive skills than the male athletes in the study. Says Covassin: "Parents need to understand that if their daughter has a concussion, that they may potentially take longer to recover from that concussion than their son who is a football player."[13]

How Are Concussions Diagnosed and Treated?

Many types of injuries can be confirmed or ruled out by diagnostic testing; however, no such tests currently exist for concussions. This is true even of scanning technology such as computed tomography (CT) and magnetic resonance imaging (MRI), as Meehan explains: "Although the signs and symptoms of a concussion can be serious . . . it can be hard to see them when you look at images of concussed brains; CT scans and MRIs often don't clearly show how a concussed brain has been injured. There's no bruising, no bleeding and no swelling."[14] When a concussion is suspected, the physician takes a medical history, which includes asking detailed questions about how the injury occurred, and performs a complete physical examination. A concussion diagnosis is made based on symptoms and the patient's responses to visual and verbal stimuli, such as tests that gauge balance, thinking skills, and memory.

Just as no tests can precisely diagnose a concussion, there are no drugs or medical procedures specifically designed to help someone overcome the injury. Rather, the only "treatment" is complete rest. This includes avoiding not only physical exertion and exercise but also activities that require mental concentration. Cantu explains: "People have not been so aware of the need for resting the brain. Individuals with cognitive concussion symptoms who exert their brain by doing computer work, reading, doing lengthy homework assignments, playing video games, texting will exacerbate their symptoms in almost every instance."[15] Such restrictive requirements can be extremely difficult for patients, especially children and teens who are used to being active, but complete rest is essential for the brain to recover.

"Many types of injuries can be confirmed or ruled out by diagnostic testing; however, no such tests currently exist for concussions."

Lingering Effects

As serious as concussions can be, most sufferers recover fully in a relatively short time. Brain trauma specialists say that up to 85 percent of

concussion sufferers are able to recover within two weeks if they rest and are careful not to be injured again. For some, however, symptoms linger for a much longer period, as sports medicine physician Mandy Huggins explains: "For reasons still not completely clear, some will go on to experience post-concussion syndrome (PCS), which is diagnosed when symptoms persist, sometimes for months or even years."[16]

> **The most dangerous risk of sustaining a second concussion before the brain has properly healed from the first is the development of second-impact syndrome.**

This was the case with Lacey, a young woman living in Canada. In September 2011 she sustained a concussion after losing her balance and hitting her head on the bathroom sink. Nearly a year after the injury, she continued to feel emotionally unstable, suffered from headaches, and had anxiety attacks whenever she was in chaotic environments or heard loud noises. Lacey wrote in June 2012:

> I'm struggling, and that frustrates me. I've been to a few doctors about these issues and each time they say there is nothing they can do for me because the problems are caused by my post concussion syndrome, not a chemical imbalance or an inability to cope with a crisis. They say this could last from a few months, to several years, or the rest of my life. I wish I could take a pill for a while, or get some counseling and be better. But those remedies won't help me.[17]

What Are the Risks of Concussions?

Although any brain injury involves a certain amount of risk, concussions usually do not lead to serious problems or long-term complications. The American Association of Neurological Surgeons writes: "In most cases, a single concussion should not cause permanent damage."[18] After suffering a concussion, patients are at greatest risk when they fail to abstain from mental and physical activity for a long enough period. This is especially

true if they return to sports and put themselves in danger of further blows to the head or body.

The most dangerous risk of sustaining a second concussion before the brain has properly healed from the first is the development of second-impact syndrome. This is a rare but devastating condition, as Meehan explains:

> Every year during football season, there is an article in the newspaper about an athlete who returned to football before he had recovered completely from a concussion. Often, the athlete told his doctor, athletic trainer, and coach that he was better but confided to friends and teammates that he still had some lingering symptoms, such as headaches or nausea. And, although no one remembers any major blows to the head or collisions, the athlete develops massive brain swelling and dies.[19]

Meehan goes on to say that the athletes who have survived second-impact syndrome have been left severely brain damaged and disabled by the condition.

Can Sports-Related Concussions Be Prevented?

Helmets and other protective gear have become much more sophisticated over the years and can help prevent many types of serious injuries, including skull fractures. But whether the same is true of protecting against concussions is a topic of controversy. Many experts argue that even top-rated helmets lined with state-of-the-art padding cannot stop the brain from banging into the skull if someone sustains a blow to the body or head. Mark Lovell, a neuropsychologist from Pittsburgh, Pennsylvania, who cocreated a well-known diagnostic test called ImPACT, explains: "The brain is still moving around within the skull when somebody has a concussion, and that's what causes them. We can't put a helmet directly on the brain."[20]

Experts say that one of the most important ways to help prevent concussions is through greater public awareness. Reed shares his thoughts: "Coaches and parents are woefully uneducated when it comes to brain injuries. The result is too few concussions are properly identified, and the ones that are don't receive the recommended treatment. Education