



American
Association of
Neurological
Surgeons

SPORTS-RELATED NECK INJURY

PATIENT INFORMATION

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Cervical Spine Anatomy

The neck is part of a long flexible column, known as the spinal column or backbone, which extends through most of the body. The cervical spine (neck region) consists of seven bones (C1-C7 vertebrae), which are separated from one another by intervertebral discs. These discs allow the spine to move freely and act as shock absorbers during activity. The spinal cord, a very vulnerable structure which connects the brain to the body, is located in the middle of the cervical spine, protected by bony structures.

Sports can contribute to neck injuries of varying degrees of severity, including neck fractures and cervical spinal cord injuries (SCIs). A fractured (broken) neck is a very serious matter, but in many cases, the patient can make a full recovery and regain all neurological function. A neck fracture can sometimes lead to a complete SCI, which will result in some degree of paralysis or even death.

Sports-related cervical injuries can be categorized in the following terms:

- Acute cervical sprains/strains including whiplash injury
- Cervical fractures and dislocations
- Nerve root or brachial plexus injuries
- Intervertebral disc injuries
- Cervical stenosis

Fractured or Broken Neck

A neck fracture is a break in one or more of the cervical bones (vertebrae in the neck). A person with a neck injury should not be moved without competent medical care, which should be summoned immediately. It is important to recognize the possibility of a neck fracture. Injuries severe enough to cause head injury or other trauma often also cause neck fracture.

A severe, sudden twist to the neck or a severe blow to the head or neck area can cause a neck fracture. Sports involving violent physical contact carry a greater risk of neck fracture, including football, ice hockey, rugby and wrestling. Spearing an opponent in football or rugby can cause a broken neck. Neck fractures are also related to several non-contact sports such as skiing, swimming, diving, surfing, power weightlifting and horseback riding.

Incidence

The U.S. Consumer Product Safety Commission (CPSC) tracks product-related injuries through its National Electronic Injury Surveillance System (NEISS). According to the CPSC, there were an estimated 14,390 neck fractures treated at U.S. hospital emergency rooms in 2009. Of these, an estimated 2,692 were sports-related. The actual incidence of neck injuries may potentially be much higher for two primary reasons. First, in the 2009 report, the CPSC excluded estimates for product categories that yielded 1,200 injuries or less, those that had very small sample counts or those that were limited to a small geographic area of the country. Additionally, many less severe neck injuries, such as sprains, are treated at physician's offices, immediate care centers or self-treated, making these injuries untrackable through this system.

Included in the sports statistics are not only the sports/recreational activities, but the equipment and apparel used in these activities. For example, swimming-related injuries include the activity as well as diving boards, equipment, flotation devices, pools and water slides.

- A 12-year-old boy was sledding down a hill and was hit in the upper back by another sled, fracturing his neck at C-4 and C-5.
- A 19-year-old male jumped from a trampoline into a shallow pond, striking his head on the bottom, fracturing his neck at C-6 and C-7.
- A 15-year-old girl was riding her horse at home, was thrown off, fracturing her neck at C-1 and was admitted to the ICU.
- A 28-year-old male soccer goalie was kned in the face by another player, fracturing his neck at C-5.
- A 5-year-old boy was skateboarding, collided with a pole, and suffered trauma to his larynx and a fractured neck.
- A 17-year-old girl suffered a compression neck fracture at C-5 when her cheerleading teammate fell off the pyramid on top of her.
- A 49-year-old female crashed her ATV at the bottom of a ravine, fracturing her neck at C-2. She was not wearing a helmet.
- A 19-year-old male riding a 4-wheeler was thrown off into an embankment, fracturing his neck at C-6 and C-7.
- A 14-year-old boy was hit by a baseball, fracturing his neck at C-7.
- A 30-year-old male jumped 30 feet in the air on his snowboard, landing on his head, suffering multiple fractures to his neck.

Source: US Consumer Product Safety Commission, National Electronic Injury Surveillance System (NEISS), 2009.

Signs and Symptoms of Broken/Fractured Neck

- Pain, which may or may not be severe
- Pain radiating from the neck down to the shoulders and/or arms
- Swelling and bruising
- Tenderness
- Decreased feeling in the arms, legs or body
- Muscle weakness or paralysis of the arms or legs

Cervical SCI

The severity of an injury depends on the part of the spinal cord that is affected. The higher the SCI on the vertebral column, or the closer it is to the brain, the more effect it has on body movement and one's sense of feeling.

Quadriplegia (a.k.a. tetraplegia) results from injuries to the spinal cord in the cervical (neck) region, with associated loss of muscle strength in all four extremities.

Complete SCI

A complete SCI produces total loss of all motor and sensory function below the level of injury. Nearly 50 percent of all SCIs are complete. Both sides of the body are equally affected. Even in the case of complete SCI, the spinal cord is rarely cut or transected. More commonly, loss of function is caused by a contusion or bruise to the spinal cord or by compromise of blood flow to the injured part of the spinal cord.

Incomplete SCI

In an incomplete SCI, some function remains below the primary level of the injury. A person with an incomplete injury may be able to move one arm or leg more than the other or may have more functioning on one side of the body than the other.

"Spinal concussions" can also occur. These can be complete or incomplete, but spinal cord dysfunction is transient, generally resolving within one or two days. Football players are especially susceptible to spinal concussions and spinal cord contusions. The latter may produce neurological symptoms including numbness, tingling, electric shock-like sensations and burning in the extremities. Spinal fracture-dislocation injuries with ligamentous tears cannot be excluded until the opposite is proven.

The National Spinal Cord Injury Statistical Center at the University of Alabama tracks comprehensive information regarding SCI, including in-depth data on sports-related SCI. Many sports are tabulated as stand-alone categories; however, the following is an explanation of categories that include multiple sports. Winter Sports: sledding, snow tubing, tobogganing, ice hockey, snowboarding; Field Sports: field hockey, lacrosse, soccer, rugby. Other Sports includes all other unclassified sports.

Top 15 Sports Contributing to SCI

- Diving: 1,563 males, 135 females = 1,698
- Bicycling: 312 males, 35 females = 347
- All Terrain-Vehicle/All Terrain-Cycle (ATV/ATC): 133 males, 20 females = 153
- Football: 136 males = 136
- Snow Skiing: 118 males, 14 females = 132
- Horseback Riding: 61 males, 64 females = 125
- Winter Sports: 98 males, 26 females = 124
- Other Sports: 85 males, 18 females = 103
- Surfing (including body surfing): 101 males, 2 females = 103
- Wrestling: 82 males, 2 females = 84
- Trampoline: 53 males, 8 females = 61
- Gymnastics: 31 males, 18 females = 49
- Snowmobiles: 37 males, 5 females = 42
- Field Sports: 37 males, 1 female = 38
- Hang Gliding: 31 males, 2 females = 33

SCI Incidence

- An estimated 7.6 percent of all SCIs are related to sports.
- Diving accidents rank as the fourth leading cause of SCI in males and fifth leading cause in females. All sports combined follow the exact same male/female incidence rates.
- Of the 26,820 reported SCIs, a combined total of 2,801 were sports-related: Of these, 2,510 or 90 percent were in males, 70 percent were in people ages 16-30, 15 percent in people ages 31-45, and 7 percent in children ages 15 and younger.
- More than 86 percent of all sports-related SCIs resulted in tetraplegia.

Sports-related SCI by age at time of injury

- Ages 0-15: 23.9 percent
- Ages 16-30: 14.4 percent
- Ages 31-45: 6.9 percent
- Ages 46-60: 3.8 percent
- Ages 61-75: 2.2 percent
- Ages 76-98: 0.6 percent

Source: *The National Spinal Cord Injury Statistical Center, University of Alabama at Birmingham, NSCISC 2009 Annual Statistical Report and Facts at a Glance, February 2010.*

Signs and Symptoms of SCI

- Extreme pain or pressure in the neck, head or back
- Tingling or loss of sensation in the hand, fingers, feet or toes
- Partial or complete loss of control over any part of the body
- Urinary or bowel urgency, incontinence or retention

- Difficulty with balance and walking
- Abnormal band-like sensations in the thorax: pain, pressure
- Impaired breathing after injury
- Unusual lumps on the head or spine

Diagnosis

A neck fracture, as well as a SCI, is a medical emergency. The patient should undergo a full neurological exam as quickly as possible to assess for instability and/or SCI. Diagnosis is made based on the incident, symptoms, a physical examination and results of radiological tests, including the following:

- **Computed tomography scan (CT or CAT scan):** A diagnostic image created after a computer reads X-rays; can show the shape and size of the spinal canal, its contents and the structures around it.
- **Magnetic resonance imaging (MRI):** A diagnostic test that produces three-dimensional images of body structures using powerful magnets and computer technology; can show the spinal cord, nerve roots and surrounding areas, as well as enlargement, degeneration and tumors.
- **X-ray:** Application of radiation to produce a film or picture of a part of the body can show the structure and alignment of the vertebrae and the outline of the joints.

Treatment

Treatment varies depending on the following factors:

- The severity of the fracture
- If there is an associated dislocation or instability
- Which cervical bones are fractured
- Whether there is spinal cord or nerve injury, with muscle weakness or paralysis

A minor (compression) fracture is often treated with a cervical collar or brace worn for six to eight weeks until the bone heals on its own. A more severe or complex fracture may require traction or surgical interventions including spinal instrumentation (fusion etc) with or without surgical decompression.

Surgical decompression of the spinal cord is often done after an injury occurs, although the timing of this intervention varies widely. Surgery involves the removal of various tissue or bone fragments that are compressing and comprising the spinal cord. Depending on the unique circumstances of the injury, decompression is accomplished through a variety of surgical approaches, including, for example, approaching the compressed cord from either the front (anterior) or back (posterior). Increasingly it has become clear that decompression and stabilization in patients with SCI should be done as soon as medically save and reasonable.

Specific Sports

Biking

Biking-related head injuries are far more common than neck fractures, but it is not infrequent for a patient to incur both a head and neck injury during an accident. Of the estimated 2,692 sports-related neck fractures treated at U.S. hospital emergency rooms in 2009, 536 were related to biking.

An estimated 80 percent of fatal bicycle accidents involving motor vehicles among children 14 and younger occur because of the bicyclist's behavior, such as riding into the street without stopping, swerving into traffic, running stop signs or riding against the flow of traffic.

- A 13-year-old boy without a helmet flipped over the handlebars, striking his head, suffering head trauma, arm pain and fracturing his neck at C-7.
- A 51-year-old male was riding his bike while intoxicated, fell backwards, hitting his head and fracturing his neck.
- A 51-year-old female lost control of her bike riding down a hill, fell over a side rail landing face first, suffering face contusions, head pain and fracturing her neck at C-1.
- A 62-year-old male fell off his bike when his tire caught on a railroad track, suffering a medial clavicle fracture and hematoma and fracturing his neck at C-5 and C-6.
- A 41-year-old male fell off his bike on the street, fracturing his neck at C-6.
- A 24-year-old male wearing a helmet, hit a pedestrian with his bike, causing him to be thrown from the bike, fracturing his neck at C-2 and C-3.

Source: US Consumer Product Safety Commission, National Electronic Injury Surveillance System (NEISS), 2009.

Football

Football-related head injuries, in particular concussions, are more common than neck fractures, but it is not infrequent for a player to incur both a head and neck injury during an incident. Of the estimated 2,692 sports-related neck fractures treated at U.S. hospital emergency rooms in 2009, 268 were related to football.

Neck injuries are usually associated with high-velocity collisions between players, causing acceleration or deceleration of the head on the neck. Acceleration often causes a whiplash type of extension force on the neck, while deceleration often results in flexion forces. Spearing, which has been banned in American football since 1976, happens when a player uses the helmet/head as the first point of contact with another player. Spearing is a significant cause of cervical spine injuries and quadriplegia.

- Cervical-spine injuries are estimated to occur in 10-15 percent of all football players, most commonly in linemen and defensive players.
- Both past and present data show that the football helmet does not cause cervical spine injuries; rather it is poorly executed tackling and blocking techniques that are the major problem.
- During the past 33 years, there have been a total of 307 football players with incomplete neurological recovery related to cervical SCI: 253 high school players; 34 college players; 14 professionals; and six sandlot players. Data indicate a reduction in the number of cervical cord injuries with incomplete neurological recovery when compared to data published in the early 1970s.
- During the 33-year period from 1977-2009, 216 of the 307 players with cervical SCIs were playing defense.
- During the 2009 football season there were a total of nine cervical spinal cord injuries with incomplete neurological recovery. This is a decrease from the 14 cervical spinal cord injuries with incomplete neurological recovery in 2008. Seven of the injuries occurred at the high school level, one at the college level and one at the professional level.
- A majority of catastrophic SCIs occur in games. During the 2009 season, five injuries took place in games, two in practice and two in scrimmage games.
- Nearly 10 percent of catastrophic cervical SCIs took place while being tackled.
- A high school junior football player was injured while making a tackle. He was a defensive back and injured his cervical vertebra. He underwent surgery and his recovery was incomplete.
- A 16-year-old high school football player was injured in a JV scrimmage. He was a defensive back making a tackle with his head up. He underwent a 7-hour surgery fusing C-5 and C-6. His recovery was incomplete.
- An 18-year-old high school football player fractured his neck at C-4 during a scrimmage game when his head hit a runner while he was being blocked. He underwent surgery and is still experiencing fine motor skill problems.
- A high school senior playing defensive back was injured in a game while making a tackle with his head down. He was injured in the second quarter, but played the remainder of the game. He fractured his neck at C-5 and wore a neck brace for eight weeks. He has made a full recovery.
- A college football player fractured his neck at C-5 after a headfirst hit with a teammate while making a tackle. He wore a neck brace for three months and made a full recovery.
- A semi-pro World Football League player was paralyzed in a game while making a tackle on kick-off coverage. He fractured his neck at C-6, underwent surgery and his recovery was incomplete.

Source: National Center for Catastrophic Sport Injury Research, Annual Survey of Catastrophic Football Injuries 1977-2009.

Water Sports

- A 47-year-old male was surfing, fell off and possibly hit his head on a sandbar, suffering a compression fracture at C-1 and a thoracic compression fracture at T-1.
- An 11-year-old boy was riding an inner tube at a water park and was hit, suffering a fatal neck fracture.
- A 6-year-old boy dove into his backyard built-in swimming pool, hitting his head on the concrete bottom, fracturing his neck at C-2 and C-3.
- A 32-year-old male was swimming at home, hit his head on the side of the pool, fracturing his neck.

Source: US Consumer Product Safety Commission, National Electronic Injury Surveillance System (NEISS), 2009.

Prevention Tips

Biking

While many cycling injuries are head injuries, the proper usage of SNELL, American National Standards Institute (ANSI) or American Society for Testing and Materials (ASTM)-approved helmets can also help prevent SCI injuries. It is essential that the helmet fit properly and that the helmet strap is closed and tightened so that it doesn't fall off while riding or in a fall. Other SCI cycling prevention tips include:

- Children under one year of age should not be carried on a bicycle: necks are not strong enough to withstand the weight of a helmet on their heads.
- Bike a minimum of three feet from parked cars, in case a door swings open.
- Do not wear headphones.
- Obey local traffic regulations at all times.
- Never grab onto a moving vehicle to get a "free" ride.
- Use "hand-signs" to indicate the direction of turns

Football

- Football players should receive adequate preconditioning and strengthening of the head and neck muscles.

- Coaches and officials should discourage players from using the top of their football helmets as battering rams when blocking, hitting, tackling and ball carrying. Coaches, physicians and trainers should ensure that the players' equipment is properly fitted, especially the helmet, and that straps are always locked.
- Coaches must be prepared for a possible catastrophic SCI. The entire staff must know what to do in such a case, because being prepared and well-informed may make all the difference in preventing permanent disability.
- The rules prohibiting spearing should be enforced in practice and games.
- Ball carriers should be taught to not lower their heads when making contact with the tackler to avoid helmet to helmet collisions.

Skateboarding/In-line Skating

- Inspect skateboard or skates for any damaged parts and replace them before using again.
- Always wear a helmet, fastened securely to the head.
- Check the area for rocks, debris, cracks in the pavement or uneven surfaces.
- Wear well-fitting clothing, knee and elbow pads, wrist braces and gloves.

Swimming/Diving

- Do not dive in water less than 12 feet deep or in above-ground pools. Check the depth and check for debris in the water before diving.
- Follow all rules and warning signs at water parks, swimming pools and public beaches.
- The first time in a body of water, walk into the water.
- Never push or shove somebody into the water and do not allow children to do so.

General Sports

- Supervise younger children at all times and do not let them use sporting equipment or play sports unsuitable for their age. Do not let them use playgrounds with hard surface grounds.
- Do not participate in sports when are ill or very tired.
- Discard and replace sporting equipment or protective gear that is damaged.
- Never slide headfirst when stealing a base.

The AANS does not endorse any treatments, procedures, products or physicians referenced in these patient fact sheets. This information is provided as an educational service and is not intended to serve as medical advice. Anyone seeking specific neurosurgical advice or assistance should consult his or her neurosurgeon, or locate one in your area through the AANS' Find a Board-certified Neurosurgeon online tool.