Return to play criteria for the athlete with cervical spine injuries resulting in stinger and transient quadriplegia/paresis

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Abstract

Background context: Fortunately, catastrophic cervical spinal cord injuries are relatively uncommon during athletic participation. Stinger and transient quadriplegia/paresis are more frequent injuries that have a wide spectrum of clinical severity and disabilities. Although the diagnosis of these injuries may not be clinically difficult, the treatment and decision about when or if the athlete may return to play after such an injury is often unclear.

Purpose: This article reviews the current literature to help determine reasonable guidelines for return-to-play criteria after cervical spine injuries in the athlete.

Methods: The contemporary English literature and experience-based guidelines for return to play after cervical spine injuries in the athlete were reviewed.

Results: Despite the frequency of cervical-related injuries among athletes participating in contact and collision sports, no consensus exists within the medical field as to a standard guideline approach for return to preinjury activity level.

Conclusion: The issue of return to play for an athlete after a cervical spine injury is controversial. Tremendous extrinsic pressures may be exerted on the physician from noninvolved and involved parties. The decision to return an athlete to a particular sport should be based on the mechanism of injury, objective anatomical injury (as demonstrated by clinical examination and radiographic evaluation) and an athlete’s recovery response. © 2002 Elsevier Science Inc. All rights reserved.

Keywords: Cervical spine; Spinal cord injury; Spinal stenosis; Spinal fractures; Quadriplegia; Transient quadriplegia; Athletic injuries; Sports; Stinger; Return to play; Practice guidelines; Treatment outcomes; Sports medicine

Introduction

Cervical spine injuries in the athlete account for 10% of the 10,000 cervical spine injuries that occur in the United States annually [1]. Cervical spine injuries can happen to the athlete at any level of participation ranging from unsupervised activities to organized contact and collision sports. These injuries may occur in such sports as diving, surfing, skiing, football, boxing, lacrosse, wrestling, soccer, rugby, ice hockey and gymnastics. The incidence of complete quadriplegia among high school and college football athletes has been reported to be as high as 2.5 per 100,000 in 1976 and as low as 0.5 per 100,000 in 1991 because of system-wide protective equipment and rule changes [2]. The potential catastrophic nature of cervical spine injury has invoked considerable effort by both the medical and athletic communities to determine risk factors and return to play criteria.

The following article was developed by the North American Spine Society (NASS) for Contemporary Concepts in Spine Care, a series of focused, edited reviews on topics of critical importance. Authored and reviewed by leading experts, Contemporary Concepts provide the latest information on selected spine care issues.

In this issue of The Spine Journal, we are pleased to publish “Return to play criteria for the athlete with cervical spine injuries resulting in stinger and transient quadriplegia/paresis,” the newest of the Contemporary Concepts in Spine Care from NASS.
The decision on whether to let an athlete return to play should be based on medical parameters, such as the athlete’s medical history, physical examination, the presence of imaging abnormalities, as well as psychosocial and demographic factors such as age and level of competition. Several authors have recommended guidelines for return to play [3–9], but such standardized criteria have not been uniformly accepted by the medical community. Morganti et al. [10] surveyed 113 physicians in reference to their return-to-play recommendations for 10 case histories. The authors were unable to reach a consensus on the postinjury management because of each injury’s unique and individual presentation. In addition, in the majority of the cases there was no relationship between return-to-play recommendations and the medical consultant’s years in practice, subspecialty training or the use of published guidelines.

Anatomy/pathophysiology

Transient quadriplegia/paresis

Cervical spinal cord neurapraxia with transient quadriparesis usually presents as temporary bilateral burning paresthesia and is associated with various degrees of bilateral extremity weakness. Its incidence in collegiate football players is approximately 1.3 per 10,000 athletes [11]. The mechanism of injury is usually cervical hyperextension, although other pathomechanisms can result in cervical spinal cord injury. The neurologic abnormalities include varying degrees of motor and/or sensory disturbance affecting two to four limbs. The duration of these symptoms and signs is usually relatively short, on the order of 10 to 15 minutes. However, some patients may have residual symptoms for up to 36 hours. Sensory disturbances vary from burning pain to loss of sensation. Motor abnormalities range from bilateral upper and lower extremity weakness to complete paralysis. Transient quadriplegia is associated with developmental cervical stenosis, kyphosis, the presence of a congenital fusion, cervical instability and/or an intervertebral disc protrusion or herniation. Vascular and metabolic etiologies may also play a role in transient quadriplegia [11].

Torg et al. [12] developed the Torg ratio (defined as the anterior-posterior diameter of the spinal canal measured as the distance from the midpoint of the posterior aspect of the vertebral body to the nearest point on the corresponding spinolaminar line divided by the anteroposterior width of the vertebral body) to evaluate congenital stenosis of the cervical spine. They found that this radiographic sign was extremely sensitive (greater than 90%) but had an extremely low positive predictive value for determining future injury. This low positive predictive value precludes its use as a screening method for participation in contact sports. Further Herzog et al. [13] determined that the Torg ratio has a very low positive predictive value (approximately 13% in professional football players) for the presence of true spinal stenosis, thereby limiting its value for even evaluating the athlete for cervical stenosis.

Maroon and Bailes [1] have developed a three-stage classification system for the treatment of athletes with cervical spine injuries based on the neurologic symptoms involved. Type 1 injuries consist of patients with permanent spinal cord dysfunction. These include patients with a complete spinal cord injury or incomplete lesions, such as an anterior cord syndrome, Brown-Sequard syndrome, central cord syndrome or mixed incomplete syndrome. Type 2 injuries are transient spinal cord injuries, such as spinal concussion, neurapraxia or “burning hands syndrome.” Type 3 injuries consist of disorders involving radiologic abnormalities without neurologic deficit, that is, congenital and acquired spinal stenosis, herniated discs, unstable fractures and/or dislocations, stable spinal fractures (lamina, spinous process and minor portion of vertebral body), unstable ligamentous injuries and spear tackler’s spine.

Stingers

The “stinger,” which is common in contact and collision sports, such as football and rugby, is described as a temporary episode of upper extremity unilateral burning dysesthesia with motor weakness. Stingers may occur in as many as 50% of athletes involved in contact/collision sports [3,14]. Patients usually describe a painful sensation that radiates from their neck to their finger tips after an impact load to the neck or shoulder. The deltoid (C5), biceps (C5,6) and spinati muscles (C5,6) are most commonly involved. The complaints of pain usually last for a few seconds to minutes, but symptoms and signs (particularly weakness) may persist for as long as a few weeks [1,15,16].

Three different mechanisms have been proposed for a stinger: 1) stretch or traction injury to the brachial plexus, 2) extension of the cervical spine resulting in nerve root compression within the neural foramina and 3) a direct blow resulting in injury to brachial plexus. This last mechanism in a football injury is thought to result from compression of the fixed brachial plexus between the player’s shoulder pad and the superior medial scapula as the pad is pushed into the area of Erb’s point (point of fixation of the upper trunk of the brachial plexus to the transverse process) [16]. Chronic recurrent stingers have been described as a recurrent neurapraxia or axonotmesis of the cervical nerve roots, often in the setting of cervical disc degeneration [15–17]. The C5 and C6 nerve root distributions are most commonly affected. The reported annual incidence of a stinger is between 49% and 65% in collegiate-level football players.

Meyer et al. [17] studied 266 collegiate football players and found that 40 of these players (15%) had reported a symptomatic stinger with 31 athletes (11.6%) complaining of associated neck pain. Of the 40 symptomatic patients, 34 (85%) reported an extension-compression mechanism, whereas 6 players (15%) noted a brachial plexus stretch etiology. The mean Torg ratio was lower for the athletes with a history of a stinger (less than 0.8 in 47.5% of the players) as compared with the asymptomatic group (less than 0.8 in 25.1% of the players). Players with a Torg ratio of less than...
0.8 had a three times greater risk of incurring a stinger than the players with ratios greater than 0.8. The authors noted that 45% of the athletes with a previous history of a stinger would have recurrent episodes. It should be noted that theingers these athletes sustained were probably a result of foraminal compromise, resulting in radiculopathy. It should also be noted that the Torg ratio was not developed to assess for foraminal narrowing, and therefore studies like this by Meyer et al [17], although confirming the role of foraminal stenosis in the development of a stinger, tend to confuse the literature regarding the value of the Torg ratio.

**Clinical research**

**Return to sports**

A difficult management scenario for the team’s physician is deciding when an athlete may return to a competitive level of activity after his or her spinal injury. Several authors have published guidelines for return to play after cervical spinal cord injury.

Torg and Ramsey-Emrhein [6] outlined a series of guidelines for the return-to-collision activities in patients with developmental stenosis of the cervical spinal canal after cervical cord neurapraxia. He categorized cervical congenital, developmental and posttraumatic conditions as no contraindication, relative contraindication or absolute contraindication to the return-to-collision activities. Relative contraindication to play was defined as the possibility for recurrent injury despite the absence of any absolute contraindication to participate in contact/collision sports. The patient had to understand that the degree of risk for re-injury was uncertain. For example, an asymptomatic athlete with a Torg ratio of less than 0.8 without any other cervical abnormality may return to sports without contraindication. However, a Torg ratio of less than 0.8 and one previous episode of a spinal cord neurapraxia with or without intervertebral disc disease and/or degenerative changes represent a relative contraindication for return to play. Absolute contraindications to return to play include a previously documented episode of neurapraxia with magnetic resonance imaging (MRI) findings of a cord abnormality, that is, edema, a documented episode of cervical cord neurapraxia associated with ligamentous instability, neurologic symptoms for greater than 36 hours and/or multiple episodes of neurapraxia [6].

Using a newly developed computer technique for measuring anatomic structures by means of MRI, Torg et al. [5] measured the spinal cord and canal diameters of 53 of 110 cases of documented cervical cord neurapraxia. The author found an overall recurrence rate of 56% in players returning to contact/collision sports, although individuals with uncomplicated cervical cord neurapraxia did not have a higher risk for permanent neurologic injury. The risk of recurrence was increased with small Torg ratios (strongly predictive), smaller absolute disc level canal diameters and less space available for the cord. Unfortunately, only 48% of patients in this study were evaluated with MRI, making anatomic and imaging comparisons between those who returned to play and those who did not impossible. Additionally, in the population of players who returned to contact/collision sports, follow-up averaged only 3.3 years, making definitive conclusions as to the risk of future neurologic injury uncertain [18].

After reviewing the literature and clinical data, Torg and Ramsey-Emrhein [6] set out to determine reasonable guidelines for the return to contact and collision sports for an athlete after a cervical spine injury. The following spinal conditions are considered by Torg to have no contraindications to participation in contact/collision sports:

1. Congenital conditions, such as a type 2 Klippel-Feil anomaly (which involves only a one- or two-level cervical fusion with full range of motion, no evidence of instability or the presence of cervical disc disease or other degenerative changes).
2. Spina bifida occulta.
3. Patients with healed stable nondisplaced fractures without sagittal malalignment.
4. Patients with asymptomatic disc herniations treated conservatively in the past.
5. Asymptomatic patients after a one-level anterior or posterior cervical fusion for miscellaneous reasons who are neurologically intact, pain free and have a solid fusion.

Relative contraindications [6] to returning to contact/collision sports include a patient with full cervical motion, no pain and a normal neurologic examination with:

1. A previous upper cervical spine fracture, such as a healed nondisplaced Jefferson fracture, a healed type 1 or type 2 odontoid fracture and/or a healed lateral mass fracture of C2.
2. A healed stable, minimally displaced, vertebral body compression fracture without sagittal malalignment.
3. A healed stable fracture of the posterior elements, excluding spinous process fractures.
4. The presence of minimal residual facet instability after surgical or conservative treatment of cervical disc disease.
5. After a healed two- or three-level cervical fusion.

Absolute contraindications [6] to returning to contact/collision sports include:

1. Odontoid anomalies.
2. An atlantooccipital fusion.
3. Atlantoaxial instability.
4. Atlantoaxial rotatory fixation.
5. Certain Klippel-Feil anomalies (type 1, defined as a mass fusion of the cervical and upper thoracic vertebrae, or a type 2 lesion with associated limited motion and/or associated occipitocervical anomalies or instability with or without disc disease and other degenerative changes).
6. The radiographic presence of a spear tacklee’s spine, defined as a subset of football players who exhibit developmental stenosis of the cervical canal, persistent reversal of the normal lordotic cervical spine on neutral lateral X-ray films, posttraumatic findings on roentgenograms and/or documented history of using a spear tackling technique [19].

7. Subaxial spinal instability defined by lateral roentgenograms that show 3.5 mm or more of horizontal displacement of one vertebrae on the other or greater than 11 degrees of rotation difference as compared with the adjacent vertebrae as measured on a lateral or flexion-extension radiograph [20].

8. An acute fracture of either the body or posterior elements with or without ligamentous instability.

9. Healed subaxial vertebral body fractures with sagittal malalignment.

10. An acute fracture of the vertebral body with associated posterior arch fractures and/or ligamentous laxity.

11. Residual bony canal compromise from retropulsed bony fragments.

12. Continued pain, abnormal neurological findings or limited motion from a healed cervical fracture.

13. The presence of a symptomatic acute soft or chronic disc herniation with associated neurological findings, pain or limited motion.

14. After a successful one-level fusion in the presence of diffuse congenital narrowing of the cervical canal.

Cantu et al. [3,4] presented guidelines for return-to-contact/collision sports after transient quadriplegia based on case studies. They proposed that an athlete may return to contact/collision sports after the first episode of transient quadriplegia if there is complete resolution of symptoms, full range of motion and a normal cervical spinal curvature without evidence of spinal stenosis on MRI, computed tomography (CT) or myelography. Relative contraindication to the return to sports included the presence of mild or minimal disc herniations and transient quadriplegia caused by minimal contact. They thought that “functional” spinal stenosis (defined as a loss of the cerebrospinal fluid around the cord or as deformation of the spinal cord as documented by MRI, CT with contrast or myelography) was an absolute contraindication to return to sports.

Using their injury classification system described above, Maroon and Bailes [1] concluded that patients with type 1 injuries should not be allowed to return to sports. Patients with type 2 transient injuries may be allowed to return to contact activities if a thorough workup is negative and neurologic symptoms do not recur. If the athlete experiences multiple episodes of these type 2 injuries, serious consideration for disallowing return to contact and collision sports should be given. Type 3 injuries need to be evaluated on a case-by-case basis, because some injuries may not be stable under high-impact athletic activities. Athletes with a spear tacklee’s spine, unstable fracture and/or dislocation, as described by White et al. [20] and ligamentous instability requiring a orthosis or surgical treatment should be prevented from returning to contact/collision sports. Other type 3 injuries, such as herniated intervertebral discs treated surgically, stable fractures of the cervical spine, congenital spinal stenosis and cases of congenital spinal fusion (except Klippel-Feil syndrome, a narrowed spinal canal, multilevel fusion or instability on flexion/extension views) may safely return to contact sports [1].

Weinstein [7] has recommended that the decision for return to play after a stinger be based on both clinical and electrodiagnostic studies. After a stinger, those individuals who have demonstrable weakness that persists beyond 2 weeks are scheduled to undergo electromyographic evaluation. Players who demonstrate clinical weakness and moderate fibrillation potentials are withdrawn from play. Should sequential electromyographic studies reveal no spontaneous potentials or only mild or scattered positive waves, and if motor unit recruitment reveals changes consistent with reinnervation, the athlete may return to his or her preinjury level of activity, providing there is also clinical improvement with full pain-free cervical motion and return of normal strength.

**Conclusions with key points**

The issue of return to play for an athlete after a cervical spine injury is controversial. It should be emphasized that there are no firm criteria for return to play, although most authors agree on many specific issues. Tremendous extrinsic pressures may be exerted on the physician from noninvolved and involved parties in regard to returning an athlete to competitive activities. The decision to return an athlete to a particular sport should be based on the mechanism of injury, objective anatomical injury (as demonstrated by clinical examination and radiographic evaluation) and an athlete’s recovery response. Because of the potential for significant catastrophic sequel of premature or inappropriate resumption of athletic participation, an understanding of the natural history of specific clinical syndromes and inherent risk factors should be familiar to the treating physician.

**Recommended clinical pathway for an athlete with cervical spine injury**

At the time of cervical injury, the patient should be removed from the sport in which he or she is participating [21]. A complete history and physical examination should be performed at the scene of the injury.

After an episode of transient quadraparesis, the athlete should be removed from the sport for at least that particular event, even if a full recovery occurs during the sporting activity. If symptoms are momentary or resolve, a complete neurologic and radiographic examination should be performed on a timely basis and repeated as necessary if any persistent motor or sensory deficits are present. If the pa-
Return to play criteria for athletic participation

I. No contraindications to return to play

1. Healed, stable C1 or C2 fracture (treated nonoperatively) with a normal cervical range of motion.
2. Single-level Klippel-Feil deformity (excluding the occipital-C1 articulation) with no evidence of instability or stenosis noted on MRI.
3. Spina bifida occulta.
4. Torg ratio less than 0.8 in an asymptomatic individual.
5. History of cervical degenerative disc disease that has been treated successfully in the clinical setting of occasional cervical neck stiffness with no change in baseline strength profile.
6. Healed stable subaxial spine fracture with no sagittal plane kyphotic deformity.
7. Status after anterior single level cervical fusion (any level excluding the atlantoaxial articulation) with or without instrumentation that has healed.
8. Previous history of two stingers within same or multiple seasons.
9. Asymptomatic clay shoveler’s fracture (C7 spinous process).
10. Status after single- or multiple-level posterior cervical microlaminoforaminotomy.

II. Relative contraindications to return to play

1. The absence of any absolute contraindication to play. The patient and family understand that recurrent injury is a possibility and the degree of risk is uncertain.
2. Previous history of transient quadriplegia or quadriparesis. The athlete must have full return-to-baseline strength and cervical range of motion with no increase in baseline cervical neck discomfort with imaging evidence of mild to moderate spinal stenosis.
3. A healed single-level posterior fusion with lateral mass segmental fixation.
4. Three or more stingers in the same season.
5. A healed stable two-level anterior or posterior subaxial cervical fusion with or without instrumentation.
6. An occipital-C1 assimilation.

III. Absolute contraindications to participation

1. Clinical history or physical examination findings of cervical myelopathy.
2. Presence of cervical spinal cord abnormality noted on MRI.
3. History of a C1–2 cervical fusion.
4. Asymptomatic ligamentous laxity (ie, greater than 11 degrees of kyphotic deformity as compared with the cephalad or caudal vertebral functional spinal unit or more than 3.5 mm movement on lateral flexion-extension films.
5. Radiographic evidence of C1–2 hypermobility with an anterior dens interval of 4 mm or greater.
6. C1–2 rotatory fixation.
7. Evidence of a spear tackler spine on radiographic analysis.
10. Radiographic evidence (ie, MRI) of basilar invagination.
11. MRI evidence of Arnold-Chiari malformation.
12. Radiographic evidence of ankylosing spondylitis or diffuse idiopathic skeletal hyperostosis.
13. More than two previous episodes of transient quadriplegia or quadriparesis.
15. A healed subaxial spine fracture with evidence of a kyphotic sagittal plane or coronal plane abnormality.
16. Radiographic evidence of significant residual cord encroachment after a healed stable subaxial spine fracture.
17. Continued cervical neck discomfort or any evidence of a neurologic deficit or decreased range of motion from baseline after a cervical spine injury.
18. Symptomatic disc herniation.
19. Clinical or radiographic evidence of rheumatoid arthritis.
20. Three-level cervical spine fusion.
References


One Hundred Twenty Years Ago in Spine . . .

Friedrich Daniel von Recklinghausen, a pupil of Virchow’s, prepared as his contribution to a Festschrift for Virchow the classic description of neurofibromatosis, which has come to be known as von Recklinghausen disease. He published his work in 1882 [1].

References