

## **Selected Topics: Sports Medicine**



### **THE DANGERS OF SPEAR TACKLING: A CASE REPORT OF A NEXUS-NEGATIVE HIGH SCHOOL FOOTBALL PLAYER**

Jason S. Ferderber, MD and Allan B. Wolfson, MD

Department of Emergency Medicine, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

Reprint Address: Jason S. Ferderber, MD, Department of Emergency Medicine, University of Pittsburgh Medical Center, 230 McKee Place, Suite 500, Pittsburgh, PA 15213

**Abstract—Background:** Although “spear tackling” is known to be a risk factor for cervical spine injury due to axial loading of the neck, and although this technique was officially banned from American football in 1976, football-associated cervical spine injuries continue to be reported. This case highlights the importance of recognizing high-risk mechanisms for cervical spine injury, and specifically the danger of spear tackling among football players at all levels. **Case Report:** A 16-year-old male high school football player presented to the pediatric emergency department for a neck injury sustained after spear tackling during a football game. He had no neurologic symptoms and met the NEXUS criteria for omitting x-ray evaluation. However, the description of spear tackling as the mechanism of injury led to the ordering of cervical radiographs, which revealed a C5 fracture. The patient was ultimately taken to the operating room for internal fixation, with a final surgical diagnosis of a C5 teardrop fracture. On outpatient follow-up at 1 year, the patient has had no neurologic sequelae. **Why Should an Emergency Physician Be Aware of This?:** This case serves as a reminder that all evaluations of trauma patients should begin with an attempt to determine, as precisely as possible, the mechanism that was in play at the time of injury. The reassurance provided by a normal physical examination may be misleading. Spear tackling is not an uncommonly encountered cause of injury in American football, despite the practice being prohibited since a rule change in 1976. Continued education and increased awareness of the association of axial load injury with spear tackling may make it possible to avoid missing a potentially devastating cervical spine injury. © 2018 Elsevier Inc. All rights reserved.

**Keywords—spear tackling; axial loading; cervical fracture; NEXUS C-spine decision tool; Canadian C-spine rule**

#### **INTRODUCTION**

“Spear tackling” is a form of tackling an opponent in American football that has long been known to be a risk factor for cervical spine injuries due to the associated axial loading of the neck. The NEXUS C-spine decision tool has been broadly incorporated into clinical practice to help determine when plain radiographs can be omitted in patients where there is concern for an acute cervical spine injury. We report one of the few patients described in the literature who were NEXUS-negative on initial evaluation, but were found to have a clinically significant cervical spine injury, and we emphasize the importance of determining that a mechanism of injury of spear tackling was involved in the injury, thus making possible an accurate diagnosis and appropriate management of a clinically significant cervical spine injury.

#### **CASE REPORT**

A 16-year-old male high school football player presented to the pediatric emergency department after a neck injury sustained during an American football game. The patient stated that when attempting tackles

on separate plays, he began experiencing increasing neck discomfort. After the first tackle, he felt only minimal discomfort. After a subsequent tackle, however, he felt “dazed” for a brief instant and remained on the field to be evaluated by the trainer. The patient described leading with his helmet into the tackles. He stated that he never lost consciousness and he denied any confusion or headache. He denied numbness, tingling, or weakness during or after the incident, and denied any significant medical history. He was placed in a cervical collar by the athletic trainer and was sent to the emergency department for further evaluation.

Upon examination, the patient was resting comfortably in the examination room. His mother, who was at the bedside, confirmed the patient’s account of the injury. The patient had full range of motion on flexion and extension, with minimal discomfort on extreme lateral rotation to both sides. He had normal mental status and there was no evidence of intoxication, no posterior midline tenderness, and no other injury. On neurologic examination, conducted by two separate physicians, there were no abnormal findings. After this evaluation, by which the patient was negative for all NEXUS criteria (Figure 1), the cervical collar was removed (1). The patient and his mother were told that there was little if any suspicion for a serious injury.

After the removal of the cervical collar and prior to discharge, however, cervical spine plain films were ordered by the emergency physician due to concern for the mechanism of injury. These showed a cervical spine fracture at C5 (Figure 2), and the cervical collar was replaced. Subsequent computed tomography (CT) and magnetic resonance imaging (MRI) scans confirmed a C5 burst compression fracture with no spinal cord involvement (Figures 3 and 4). The neurosurgery service was consulted, and they took the patient to the operating room for posterior fixation (Figure 5). The ultimate operative diagnosis was a C5 teardrop fracture and was a career-ending injury. The patient, however,



**Figure 2.** Lateral cervical x-ray image showing possible burst fracture at C5. Note the increased size of the soft-tissue shadow denoting soft-tissue swelling, anterior to cervical vertebrae 5, 6, and 7.

remained free of neurologic sequelae throughout his hospitalization and outpatient follow-up at 1-year post-injury.

## DISCUSSION

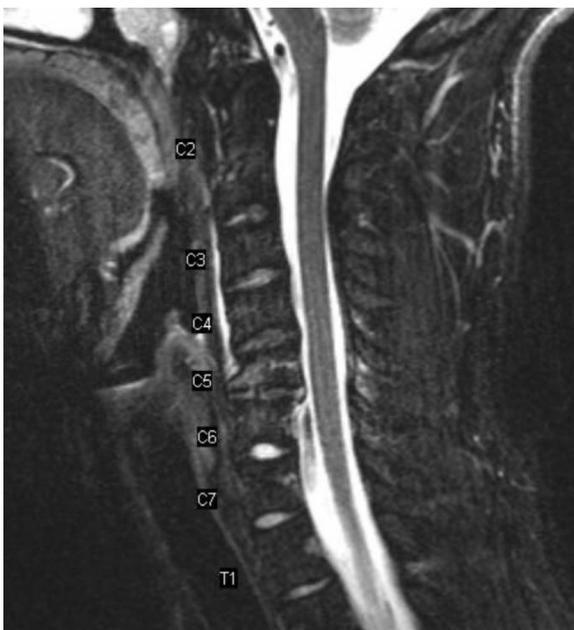
This patient’s primary assessment was not concerning for a serious cervical spine injury. Although the patient met the NEXUS criteria for omitting x-ray evaluation (as there was no focal neurologic deficit present, he had no midline c-spine tenderness, he had no alteration of his level of consciousness, he had no intoxication, and he had no “distracting injury”), the description of spear tackling as the mechanism of injury with the possibility of significant axial loading led to the ordering of cervical radiographs (1). This case highlights the importance of recognizing high-risk

NEXUS Low-Risk Criteria*
No posterior midline cervical-spine tenderness
No focal neurological deficit
Normal level of alertness
No evidence of intoxication
No painful distracting other injury

**Figure 1.** NEXUS low-risk criteria. \*Criteria from Hoffman et al. (1).



**Figure 3.** Computed tomography cervical spine image showing C5 burst fracture.



**Figure 4.** T2-weighted cervical spine magnetic resonance image showing re-demonstration of C5 burst fracture with no involvement of the spinal canal.



**Figure 5.** Cervical spine x-ray image showing posterior fixation of C5/C6.

mechanisms for cervical spine injury, and specifically the potential danger of spear tackling among football players at all levels.

In the original NEXUS trial, which included more than 33,000 patients aged 8 years and older, only 2 patients with clinically significant injuries were missed after application of the decision tool, only 1 of whom required surgical intervention (1). Both individuals had been in motor vehicle accidents, and the patient who required surgical intervention exhibited neurologic symptoms (1). In a follow-up study examining the NEXUS trial's data on 3065 pediatric patients younger than 18 years old, no injuries were seen in those who had met the NEXUS criteria, and no patient who lacked cervical spine tenderness had a clinically significant injury (2).

Nearly 50% of all high school football injuries occur when tackling or being tackled, and spear tackling has been identified as one of the primary mechanisms of injury resulting in quadriplegia in high school and college football (3,4). In 2012, three cervical cord injuries with incomplete neurologic recovery were reported among high school and college athletes, an incidence of 0.07 per 100,000 participants. In addition, 3 students with cervical spine fractures and complete neurologic recovery were reported (5).

Despite the introduction of changes in equipment, most cervical spine injuries in football continue to be associated with axial loading (6). Equipment alone cannot prevent axial loading injuries, however (6). "Cowboy collars" (Figure 6) have been used to



Figure 6. Examples of a “cowboy collar.”

decrease cervical hyperextension injuries, but do not protect against axial loading (7). Another safety device, the standard American football helmet face mask (Figure 7), was introduced to decrease cervical spine injuries but does not appear to prevent injuries resulting in quadriplegia, as it allows the player to make a tackle with less than ideal technique, putting the cervical spine at risk (8). After spear tackling was officially banned in all levels of football in 1976, there was a significant reduction in quadriplegia, but the incidence has remained relatively stable in recent years (9).

We describe one of a small number of reported “misses” using the NEXUS decision tool. Stiell et al. described two clinically important injuries found after an axial load during contact sports in a 20-year-old man and a 29-year-old man, who were both deemed to be NEXUS-negative (10). Bales et al. reported a college football player who sustained an axial load injury after making contact with the vertex of his helmet during a game (11). He was neurologically intact and



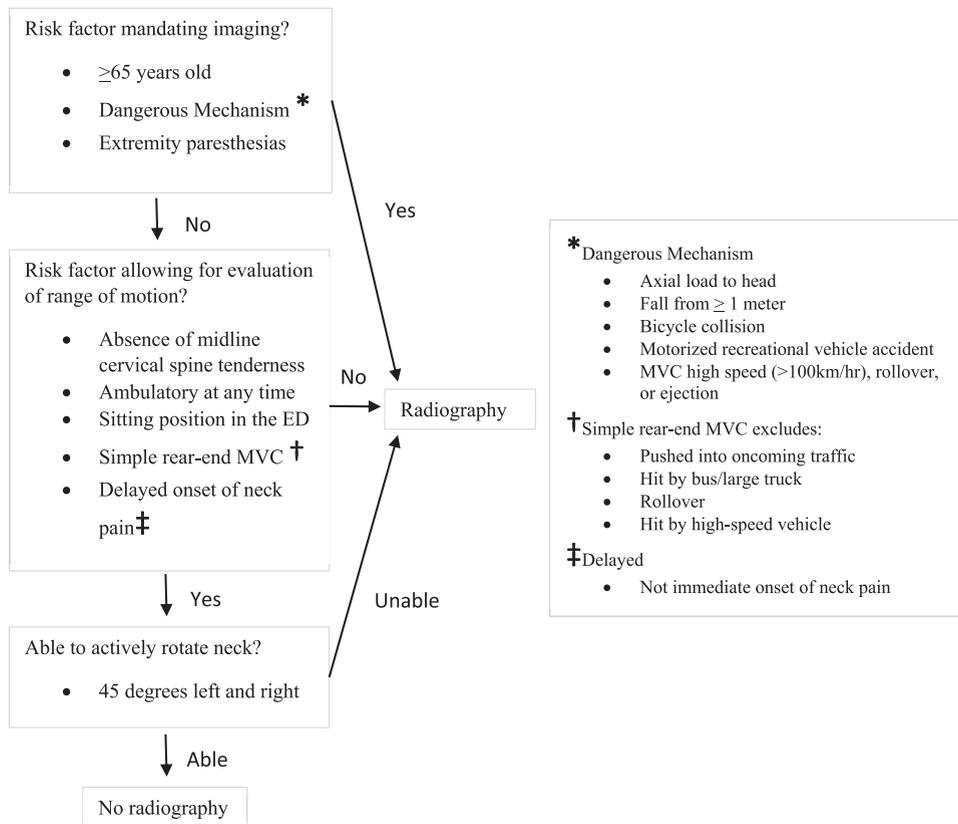
Figure 7. Example of a standard American football helmet face mask.

continued to play without complaints. After the game, he had normal range of motion and a reassuring neurologic examination. The next day, however, he had worsening neck pain and decreased range of motion and was found to have a C1 burst fracture on CT. He underwent a C1–C2 fusion and recovered with no neurologic deficits (11).

A case of partial spinal cord injury in a National Football League linebacker has also been reported after an axial load while making a tackle. The player had known congenital cervical stenosis and a history of extremity tingling with neck flexion but had had no prior symptoms during play. He experienced numbness in all four extremities, though no neck pain. MRI showed no injury to the discs, bones, or spinal cord, but a repeat study during his hospitalization showed an increased signal at C5 in the spinal cord. The injury forced the player to retire from football (12).

Another case report described a 3-year-old girl, seen after a 70-mph head-on collision, who was reportedly NEXUS-negative on initial examination (13). She had a normal neurologic examination with bruising of her left upper limb, shoulder, and lower abdomen from the seat restraint. CT scanning showed a type 2 odontoid fracture. The NEXUS criteria have not been fully validated in this younger age group and, given a high-risk mechanism and the poor reliability of the physical examination in toddlers, imaging is typically ordered based on the clinician’s gestalt rather than by reliance on a clinical decision tool. Due to the concern for radiation exposure in the pediatric population, radiographs are typically first-line testing, with CT scan reserved for those patients with high clinical suspicion.

Several “dangerous mechanisms” have been enumerated and applied in clinical practice, most notably in the Canadian C-spine rule (Figure 8) (14). These mechanisms include axial load to the head, a fall from a height > 1 m, bicycle collisions, motorized recreational vehicle accidents, motor vehicle collisions at a high speed (>100 km/h), rollover, or ejection. In comparison, the NEXUS criteria, shown in Figure 1,



**Figure 8. The Canadian C-spine rule. From Stiell et al. (14). For alert (Glasgow Coma Scale score = 15) and stable trauma patients where cervical spine injury is considered. ED = emergency department; MVC = motor vehicle crash.**

are preferred by many physicians because of ease of clinical application. Although the addition of more criteria to the NEXUS decision tool is not preferred, our case, as well as a review of other similar cases in the literature, strongly suggests that spear tackling and similar axial loading injuries should be considered a dangerous mechanism of injury that should prompt radiologic evaluation.

### WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?

This case serves as a reminder that all evaluations of trauma patients should begin with an attempt to determine, as precisely as possible, the mechanism that was in play at the time of injury. The reassurance provided by a normal physical examination may be misleading. Spear tackling is not an uncommonly encountered cause of injury in American football, despite the practice being prohibited since a rule change in 1976. Continued education and increased awareness of the association of axial load injury with spear tackling may make it possible to avoid missing a potentially devastating cervical spine injury.

### REFERENCES

1. Hoffman JR, Mower WR, Wolfson AB, Todd KH, Zucker MI. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. National Emergency X-Radiography Utilization Study Group. *N Engl J Med* 2000;343:94–9. Erratum in: *N Engl J Med* 2001;344:464.
2. Viccellio P, Simon H, Pressman BD, Shah MN, Mower WR, Hoffman JR, NEXUS Group. A prospective multicenter study of cervical spine injury in children. *Pediatrics* 2001;108:E20.
3. Badgeley MA, McIlvain NM, Yard EE, Fields SK, Comstock RD. Epidemiology of 10,000 high school football injuries: patterns of injury by position played. *J Phys Act Health* 2013;10:160–9.
4. Boden BP, Tacchetti RL, Cantu RC, Knowles SB, Mueller FO. Catastrophic cervical spine injuries in high school and college football players. *Am J Sports Med* 2006;34:1223–32.
5. Mueller FO, Cantu RC. National Center for Catastrophic Sports Injury Research: Annual Survey of Catastrophic Football Injuries 1977–2012. Chapel Hill, NC: National Center for Catastrophic Sports Injury Research; 2013.
6. Heck JF, Clarke KS, Peterson TR, Torg JS, Weis MP. National Athletic Trainers' Association Position Statement: head-down contact and spearing in tackle football. *J Athl Train* 2004;39:101–11.
7. Gorden JA, Straub SJ, Swanik CB, Swanik KA. Effects of football collars on cervical hyperextension and lateral flexion. *J Athl Train* 2003;38:209–15.
8. Torg JS, Truex R Jr, Quedenfeld TC, Burstein A, Spealman A, Nichols C 3rd. The National Football Head and Neck Injury Registry. Report and conclusions 1978. *JAMA* 1979;241:1477–9.

9. Chao S, Pacella MJ, Torg JS. The pathomechanics, pathophysiology and prevention of cervical spinal cord and brachial plexus injuries in athletics. *Sports Med* 2010;40:59–75.
10. Stiell IG, Clement CM, McKnight RD, et al. The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. *N Engl J Med* 2003;349:2510–8.
11. Bales CP, Chang I, Matheson G, Ouyang D, Drago JL. College football player with unstable C1 fracture: a case report. *Am J Sports Med* 2009;37:195–8.
12. Brigham CD, Adamson TE. Permanent partial cervical spinal cord injury in a professional football player who had only congenital stenosis. A case report. *J Bone Joint Surg Am* 2003;85-A:1553–6.
13. Maxwell MJ, Jardine AD. Paediatric cervical spine injury but NEXUS negative. *Emerg Med J* 2007;24:676.
14. Stiell IG, Wells GA, Vandemheen KL, et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. *JAMA* 2001;286:1841–8.