Cervical spine injury management in the helmeted athlete.

Kevin N. Waninger MD
Lehigh Valley Health Network, kevin.waninger@lvhn.org

Erik E Swartz

Published In/Presented At

Waninger KN, Swartz EE. Cervical spine injury management in the helmeted athlete. Curr Sports Med Rep. 2011 Jan-Feb;10(1):45-9. doi: 10.1249/JSR.0b013e3182073767.

Cervical Spine Injury Management in the Helmeted Athlete

Kevin N. Waninger, MD, MS, FAAFP, FACSM, FACEP, CAQSM,[1] and Erik E. Swartz, PhD, ATC[2]

Abstract

The relative incidence of catastrophic cervical spine injury in sports is low compared to other injuries. However, the potential catastrophic and life-altering consequences of spine injury cause understandable concern regarding the prehospital management and care of the cervical-spine-injured athlete. This is complicated when injured athletes participate in equipment-intensive sports, such as football, where helmets and facemasks are potential barriers to obtaining immediate access to the athlete's airway. Cervical spine injuries in these cases necessitate delicate and precise management, often involving the combined efforts of multiple health-care providers. The outcome of a catastrophic cervical spine injury is dependent on the efficiency of this management process and timeliness of transfer to a controlled environment for diagnosis and treatment.

Introduction

Sports participation accounts for 8% of all spinal cord injuries since 2005, following the more common causes of cervical spine injury due to motor vehicle accidents (41%), violence (15%), and falls (27%) (17). Contact sports such as football and ice hockey carry an inherent risk of cervical spine injury (16). While the incidence of these injuries is small in comparison to less serious injuries, such as contusions or lower extremity sprains and strains, improper handling of the cervical spine column on the field or during transport may cause or worsen spinal cord dysfunction. Failure to appropriately manage a catastrophic neck injury even may compromise the athlete's cardiac and respiratory status. Therefore, this high-risk situation requires the responsible medical staff to have specialized knowledge and training to act efficiently and effectively in this unique clinical setting (3).

[1]Primary Care Sports Medicine, Department of Family Medicine, St. Luke's Hospital, Bethlehem, PA; [2]Athletic Training Education Program, University of New Hampshire, Durham, NH

Address for correspondence: Kevin N. Waninger, MD, MS, FAAFP, FACSM, FACEP, CAQSM, Fellowship Director, Primary Care Sports Medicine, Department of Family Medicine, St. Luke's Hospital, Bethlehem PA (E-mail: knwaninger@aol.com).

1537-890X/1001/45–49
Current Sports Medicine Reports

Preparation

Individuals who are responsible for the emergency care of athletes should be familiar with sports-specific causes of catastrophic cervical spine injury and the acute resultant physiologic response to spinal cord injury. Coaches, certified athletic trainers, administrators, and the physicians responsible for the care of these athletes should all be aware of the mechanisms of catastrophic spine injuries, the consequences of axial loading associated with tackling, instruction of proper safe-tackling techniques, and enforcement of rule changes enacted for the prevention of cervical spine injuries in athletes (22).

There is the potential for spinal instability following cervical trauma, and full assessment of the cervical spine often is difficult in the prehospital setting. The role of on-field management of the potentially spine-injured athlete is stabilization for transport to a facility where further evaluation in a controlled environment can be obtained, with radiographic studies if indicated. A specific emergency management plan should be prepared in advance, with all personnel involved having the opportunity to practice the skills required for on-field management of these subjects (4). This may include manual head and neck stabilization techniques, methods of transferring injured players, airway and equipment management, and immobilization techniques. Communication between sports medicine personnel, prehospital first responders, and emergency department staff members should be stressed during the emergency planning phase in preparation for a multidiscipline-coordinated approach to cervical spine management (1). Hospital personnel should understand the standards for on-field care of the athlete with a potential spine injury and should receive training regarding the proper approach to equipment management and removal.

Initial Assesment

Any athlete with a mechanism consistent with a head or neck injury who complains of significant midline cervical neck pain or tenderness on palpation, bilateral neurologic

findings or complaints, or obvious spinal column deformity should be treated as a potential cervical spine injury until proven otherwise (10). Any athlete who is unconscious or has another significant distracting injury that may inhibit a valid examination should be stabilized in a similar way. When a potential cervical spine injury is suspected, rescuers should ensure that the cervical spine is in a neutral position and apply immediate manual cervical spine stabilization to minimize motion. No traction should be applied, as excessive distraction may cause subluxation of the injured cervical spine, which could further compromise the spinal cord. If the spine is not in a neutral position, rescuers should attempt to realign the cervical spine, if possible, to minimize secondary injury to the spinal cord and to allow for optimal airway management, if required (22).

Airway Management

When serious injury occurs involving the head and/or spine, at times complicated by altered levels of consciousness, protective equipment such as helmets and shoulder pads may provide a hindrance to safe airway management. Airway obstruction from the tongue, mouth guard, or a foreign body may occur, with restoration of breathing as simple as establishing a patent airway. Chin lift-jaw thrust maneuvers should be accomplished initially without removing the football helmet or the facemask. In most unconscious athletes, these maneuvers will result in restoration of a patent airway. If these maneuvers do not succeed in restoring airway and breathing, alternative methods to gain rapid access to the airway and restore breathing must be started, such as a CPR pocket mask, bag valve mask, and/or advanced airway maneuvers with helmet and facemask removal (26).

Despite the fact that neurologic causes of cardiac arrest can occur with cervical spine injury above the fourth cervical vertebrae, respiratory arrest secondary to spinal cord injury or cardiac arrest in the helmeted athlete is rare (15). The majority of football-related cervical spine injuries occur anatomically below the level that controls respiration, and respiratory compromise requiring airway control does not occur often. However, the potential for respiratory compromise requiring ventilatory support does exist, and protocols for airway management, equipment removal and cardiopulmonary resuscitation have been established, although the safety and efficiency of these protocols have not been well studied (25,26).

When the decision is made that the helmeted athlete requires airway control, standard techniques with in-line stabilization are recommended. The airway maneuvers and techniques that cause the least cervical spine movement have been debated and are not well studied in the helmeted athlete. Initial management should include an attempt to expose the airway, removing any existing barriers such as facemasks and mouthpieces if not already removed. If rescue breathing and airway control becomes necessary, the individual with the most training and experience should establish the airway and start rescue breathing using the technique with which they have the greatest experience and skill. The jaw-thrust maneuver is recommended over the head-tilt technique, which may cause unnecessary motion at the head and in the cervical spine. Advanced airway management techniques (laryngeal mask airway, endotracheal intubation) are recommended in the presence of appropriately trained and certified rescuers, as these methods have been shown to cause less motion during airway management (5,5a,14).

Equipment Considerations

The management of the injured helmeted athlete begins on the field with proper positioning and immobilization of the cervical spine. Immobilization of the neck in a neutral position restricts movement of the unstable vertebral column in an effort to prevent damage to the enclosed spinal cord and nerve roots. Flexion and extension posturing of the traumatized neck may result in cord deformation and elongation of the neutral axis. In the transport of an athlete with a potential cervical spine injury, proper immobilization includes leaving both the helmet and shoulder pads in place, because removal of athletic equipment such as helmet and shoulder pads may cause unwanted movement of the cervical spine. Therefore, removal should be deferred until the athlete has been transported to a facility where controlled removal of equipment can occur (25,26).

However, there may be situations where removal of one or more pieces of equipment may be necessary in the prehospital setting. In the past the decision to remove an athlete's equipment was guided by the "all or nothing" principle. This principle dictates that if it is determined that either the helmet or shoulder pads need to be removed, both should be removed simultaneously because independent removal of the helmet or shoulder pads in American football and ice hockey may compromise spinal alignment (20). However, since removal of any equipment can cause motion in the head and neck, recent recommendations (22) suggest that as long as neutral cervical alignment is maintained, it may not be necessary to remove both pieces of equipment. For example, if removal of the helmet is deemed necessary it may be appropriate to place padding underneath the helmet-less head to maintain alignment (22). Either way, helmet or helmet and simultaneous shoulder pad removal may be warranted in the following situations: 1) the helmet is not properly fitted to prevent movement of the head independent of the helmet; 2) the design of the helmet and chin strap is such that even after removal of the facemask, the airway cannot be assessed or managed properly; 3) the facemask or visor interferes with adequate airway management and cannot be removed after a reasonable period of time; 4) there is evidence of a head injury requiring direct inspection of the scalp (very rare); 5) there is evidence suggesting cardiovascular support may be necessary (very rare); or 6) the patient has arrived at the emergency department or athletic training room for reevaluation (22).

No general recommendation regarding removal of equipment can be made for other sports that require a helmet (with or without shoulder pads) because of considerable variation in the capacity of that equipment to maintain a neutral cervical spine or immobilize the head. The primary acute treatment goals in these sports are to ensure that the cervical spine is properly aligned and that the head and neck are immobilized. If the equipment being worn does not

permit the cervical spine to rest in neutral or does not immobilize the head adequately, then removal of one or more pieces of equipment in a safe manner is advisable to achieve neutral alignment and adequate stabilization (22). Whenever and wherever removal of athletic helmets or shoulder pads takes place, the equipment should be removed by qualified trained personnel if possible, as spinal immobilization during removal of helmet and shoulder pads may pose a challenge to those unfamiliar with the technique, and it requires training, practice, and multiple personnel.

Individuals responsible for the emergency care of athletes in equipment-laden sports should be familiar with the equipment and tools and techniques required for removal of barriers to treatment (*e.g.,* airway management). Facemasks that interfere with the ability to access the airway should be completely removed from the helmet (22,25,26). Facemask removal should be initiated once the decision to immobilize and transport has been made. Rescuers should be aware of, and well trained in, established facemask-removal techniques (25). The facemask should be removed with the tool and technique that performs the task quickly and with minimal movement and difficulty. A powered (cordless) screwdriver generally is faster, produces less head movement, and is easier to use than cutting tools; it should be the first tool used in attempting to remove a facemask attached with loop straps that are secured with screws (23). Because in some helmets it may be impossible to remove the screws, a backup cutting tool, specifically matched to the sports equipment used, should be available. Recent facemask attachment designs have incorporated quick-release systems, which allow for faster facemask removal (6,11). A backup cutting tool still should be available because it currently is not known whether these systems might fail. Regarding helmet care, corrosion-resistant hardware should be used in all helmets, each helmet must be regularly maintained throughout the season, and helmets should undergo regular reconditioning and recertification (22,26).

If the facemask cannot be removed in a reasonable amount of time, then the helmet should be removed from the athlete in the safest manner possible. Helmet style will dictate the technique necessary to remove the helmet safely. A neutral cervical spine position should be preserved during and after this process by removing additional pieces of equipment (*e.g.*, shoulder pads) or by placing an object underneath the head (*e.g.*, towel, padding) to maintain neutral alignment. Similarly, if the athletic helmet is dislodged during the injury, removed (by either the medical team or the athlete), or if the shoulder pads cannot be removed easily, care must be taken to place padding beneath the head to maintain neutral cervical spine alignment. A rigid cervical immobilization collar should be placed on the athlete before transfer to a spine board (22,26). In equipment-laden sports, this may be difficult or impossible, although a cervical vacuum immobilization device has been shown to limit cervical spine range of motion in the fully equipped football player (21).

Transfer and Immobilization

Manual stabilization of the head should be converted to immobilization using a combination of external devices (cervical collars, foam blocks), and stabilization of the cervical spine should be continued until a destabilizing injury has been ruled out. If possible, manual stabilization should be resumed after application of the external devices. Injured athletes should be immobilized with a long spine board or another similar full-body immobilization device such as the full-body vacuum splint. For supine subjects, a lift-and-slide technique of transferring the athlete to an immobilization device should be used, whereas for the prone athlete, potential rescuers should use the log-roll method of transferring to an immobilization device (22).

Radiographic studies may be required to identify accurately the presence or absence of a fracture or injury that would render the cervical spine unstable. Although guidelines for clearance of the cervical spine without radiographic studies have been published, most injured athletes would not qualify for clearance under these guidelines because of mechanism of injury. Because a potential cervical spine injury cannot be ruled out fully on the field in most cases, the goal for emergency management is the safe, expeditious transport of the injured player to a medical facility with radiographic capabilities (25,26). Emergency medical service providers must take into account the method of removal of a player off the field, because standard emergency medical service immobilization equipment may be inadequate for the large size of the athlete. The location of rescue vehicles for transport and the safety of methods to transport the athlete to the rescue vehicle all are issues that need to be discussed as part of the emergency action plan (1).

Emergency Department Management: Equipment Removal and Imaging

Once the injured helmeted athlete has arrived at the emergency department, any protective equipment should be removed by appropriately trained professionals in a controlled environment. Previous recommendations had called for clearance plain radiographs to be taken before equipment removal; however, two reports document that adequate radiographs in healthy, helmeted football players were difficult at best (8,24). Although the process of removal of athletic equipment can cause motion in the cervical spine (7), the amount of significant motion is unknown, and it was shown that it is possible to remove a football helmet and shoulder pads from healthy volunteers without creating significant motion (18). Missed diagnoses with negative consequences in nonhelmeted patients with cervical spine injuries have been reported, with delayed diagnoses related to improper radiographic choices or interpretations (9,19). The advent of readily available multidetector computerized topography scans (CT) has replaced the use of plain radiography at many trauma centers, and initial CT evaluation has been recommended in cases involving acute cervical spine trauma (2,13). Not only is CT more sensitive, but it carries lower rates of missed primary and secondary injuries, which may spur reconsideration of guidelines for the implementation of CT as the primary diagnostic test for helmeted athletes with suspected cervical spine injuries (12). CT films with helmet and shoulder pads in place allow adequate visualization for initial diagnosis and triage (27). It is acceptable

to perform the initial radiographic evaluation in the emergency department or athletic training room either with or without equipment in place. Removal of football equipment by qualified trained personnel before initial radiographs and/or CT scan is an acceptable management plan, as is initial CT scan before helmet and shoulder pads removal. Although magnetic resonance imaging (MRI) of acute spinal cord injury in the unhelmeted patient provides excellent visualization of neurologic and soft tissue structures, the amount and type of metal within the modern football helmet results in field inhomogeneity and skew artifact (*i.e.*, errors in the image), precluding adequate evaluation of the cervical structures and limiting the value of MRI in this setting (28).

Hypothermia Treatment and High-Dose Methylprednisolone

Although the role of hypothermia in the treatment of myocardial infarction and brain injury has been investigated and has shown potential to reduce morbidity, evidence currently is insufficient to justify its use in the acute management of the athlete with a spine injury. Similarly, the use of high-dose methylprednisolone has been used in the initial management of acute spinal cord injury but remains controversial in the prehospital setting. When possible, each patient or patient's family should be informed of the risks and benefits of each treatment modality and/or medication before use (22).

Conclusion

The unique characteristics of the well-fitted football helmet allow safe access to cervical spine stabilization and airway management, and helmets and shoulder pads should not be removed in the prehospital management of the football player with a potential cervical spine injury unless absolutely necessary. Prehospital and emergency department personnel must be trained in the proper removal of the football helmet, shoulder pads, and facemask. If required, both helmet and shoulder pads should be removed simultaneously. No injuries have been reported from the policy of keeping the equipment in place. In this clinical scenario, it is best to do no harm.

There is a need for greater communication between sports medicine and local emergency providers regarding management of the helmeted athlete. Prehospital and sports medicine teams should formulate an action plan in advance to prepare for unexpected clinical scenarios such as cervical spine injuries, and skills such as facemask and helmet removal should be practiced. All health-care providers that treat these injuries need to be aware of the guidelines for managing injured helmeted athletes with equipment in place, and if necessary, protective equipment should be removed by appropriately trained professionals in the training room or emergency department to minimize motion. Emergency departments should consider implementing guidelines for the use of CT rather than plain radiographs as the primary diagnostic test for a suspected cervical spine injury in a helmeted athlete. Obtaining plain radiographs adequate for clearance with sport equipment in place is a procedure unsupported by research. CT may be more sensitive than plain radiographs and is associated with lower rates of missed primary and secondary injuries. Emergency department personnel should be aware that MRI is limited clinically for helmeted athletes and may not be suitable as an initial diagnostic tool.

Acknowledgments

Some of the material presented in this article was adapted with permission from: Swartz EE, Boden BP, Courson RW, *et al.* National Athletic Trainers' Association position statement: acute management of the cervical spine–injured athlete. *J. Athl. Train.* 2009; 44(3): 306–331.

References

1. Andersen J, Courson RW, Kleiner DM, *et al.* National Athletic Trainers' Association Position Statement: Emergency Planning in Athletics. J Athl Train. 2002; 37(1):99–104.
2. Bailitz J, Starr F, Beecroft M, *et al.* CT should replace three-view radiographs as the initial screening test in patients at high, moderate, and low risk for blunt cervical spine injury: a prospective comparison. J Trauma. 2009; 66(6):1605–9.
3. Banerjee R, Palumbo MA, Fadale PD. Catastrophic cervical spine injuries in the collision sport athlete, part 1: epidemiology, functional anatomy, and diagnosis. Am J Sports Med. 2004; 32(4):1077–87.
4. Bell K. On-field issues of the C-spine-injured helmeted athlete. Curr Sport Med Rep. 2007; 6(1):32.
5. Burkey S, Fedor P, Stromski C, *et al.* Airway management of the helmeted athlete: standard ETI versus LMA (Abstract). Clin J Sports Med. 2010; 20(2):136–7.

5a. Burkey S, Fedor P, Stromski P, *et al.* Airway management of the helmeted athlete: direct versus assisted laryngoscopy (Abstract). Clin J Sport Med. 2010; 20(2):147.

6. Copeland AJ, Decoster LC, Swartz EE, *et al.* Combined tool approach is 100% successful for emergency football face mask removal. Clin J Sport Med. 2007; 17(6):452–7.
7. Dahl MC, Ananthakrishnan D, Nicandri G, *et al.* Helmet and shoulder pad removal in football players with unstable cervical spine injuries. J Appl Biomech. 2009; 25(2):119–32.
8. Davidson RM, Burton JH, Snowise M, *et al.* Football protective gear and cervical spine imaging. Ann Emerg Med. 2001; 38(1):26–30.
9. Davis JW, Phreaner DL, Hoyt DB, *et al.* The etiology of missed cervical spine injuries. J Trauma. 1993; 34(3):342–6.
10. Domeier RM, Frederiksen SM, Welch K. Prospective performance assessment of an out-of-hospital protocol for selective spine immobilization using clinical spine clearance criteria. Ann Emerg Med. 2005; 46(2):123–31.
11. Gale SD, Decoster LC, Swartz EE. The combined tool approach for face mask removal during on-field conditions. J Athl Train. 2008; 43(1): 14–20.
12. Griffen MM, Frykberg ER, Kerwin AJ, *et al.* Radiographic clearance of blunt cervical spine injury: plain radiograph or computed tomography scan? J Trauma. 2003; 55(2):222–6; discussion 226–7.
13. Holmes JF, Akkinepalli R. Computed tomography versus plain radiography to screen for cervical spine injury: a meta-analysis. J Trauma. 2005; 58(5):902–5.
14. Jaworski C. Advances in emergent airway management. Curr Sports Med Rep. 2002; 1:133–40.
15. Mueller FO, Cantu RC. Annual survey of catastrophic football injuries (1977–2009) [National Center for Catastrophic Sport Injury Research Web site]. 2010. Available from: www.unc.edu/depts/nccsi.
16. Mueller FO, Cantu RC. National Center for Catastrophic Sport Injury Research: Twenty Fourth Annual Report Fall 1982 — Spring 2009. Chapel Hill: University of North Carolina; 2010.
17. National Spinal Cord Injury Statistical Center. Spinal Cord Injury: Facts and Figures at a Glance. Birmingham: National Spinal Cord Injury Statistical Center, University of Alabama Birmingham; 2010.
18. Peris MD, Donaldson WF 3rd, Towers J, *et al.* Helmet and shoulder pad removal in suspected cervical spine injury: human control model. Spine. 2002; 27(9):995–8; discussion 998–9.

19. Poonnoose PM, Ravichandran G, McClelland MR. Missed and mismanaged injuries of the spinal cord. J Trauma. 2002; 53(2):314–20.
20. Prinsen RK, Syrotuik DG, Reid DC. Position of the cervical vertebrae during helmet removal and cervical collar application in football and hockey. Clin J Sport Med. 1995; 5(3):155–61.
21. Ransone J, Kersey R, Walsh K. The efficacy of the rapid form cervical vacuum immobilizer in cervical spine immobilization of the equipped football player. J Athl Train. 2000; 35(1):65–9.
22. Swartz EE, Boden BP, Courson RW, *et al*. National Athletic Trainers' Association position statement: acute management of the cervical spine-injured athlete. J Athl Train. 2009; 44(3):306–31.
23. Swartz EE, Norkus SA, Cappaert T, *et al*. Football equipment design affects face mask removal efficiency. Am J Sports Med. 2005; 33(8): 1210–9.
24. Veenema K, Greenwald R, Kamali M, *et al*. The initial lateral cervical spine film for the athlete with a suspected neck injury: helmet and shoulder pads on or off? Clin J Sport Med. 2002; 12(2):123–6.
25. Waninger KN. Emergency management of the helmeted football player with cervical spine injury. Am J Sports Med. 2004; 32(5):1331–50.
26. Waninger KN. On-field management of potential cervical spine injury in helmeted football players: leave the helmet on! Clin J Sport Med. 1998; 8(2):124–9.
27. Waninger KN, Rothman M, Foley J, *et al*. Computed Tomography is Diagnostic in the Cervical Imaging of Helmeted Football Players With Shoulder Pads. J Athl Train. 2004; 39(3):217–22.
28. Waninger KN, Rothman M, Heller M. MRI is nondiagnostic in cervical spine imaging of the helmeted football player with shoulder pads. Clin J Sport Med. 2003; 13(6):353–7.