Cervical Fracture With Transient Tetraplegia in a Youth Football Player: Case Report and Review of the Literature

Robert Molinari, MD; William J. Molinari III, MS

University of Rochester Medical Center, Rochester, New York

Received June 12, 2009; accepted July 22, 2009

Abstract

Background/Objective: Serious cervical spinal injuries in organized youth football are rare. Cervical fracture with neurologic injury is rarely reported in organized youth football players with no pre-existing risk fractures for transient tetraplegia.

Methods: Case report and literature review.

Results: After being improperly tackled by an opponent of significantly larger body size, a player sustained a C7 posterior cervical fracture with transient tetraplegia. He was immobilized in a cervical collar and sent to a level 1 trauma center for evaluation. Initial examination showed bilateral paresthesia of the limbs with normal motor function (ASIA D). Initial radiographs of the cervical spine showed a displaced extension-compression fracture of the C7 spinous process. Magnetic resonance imaging of the cervical spine showed edema in the spinal cord in the region of the injury along with significant posterior injury. Imaging studies showed normal volumetric measurements of the spinal canal and no pre-existing risk factors for spinal stenosis or spinal cord injury. Radiographs showed that cervical fracture was healed at 9-month follow-up examination. At 1-year follow-up, the patient was asymptomatic. Radiographs showed healed fracture with no residual instability and full range of cervical spine motion on flexion-extension views.

Conclusions: This case underscores the potential for serious cervical spinal injuries in organized youth sports when players are physically overmatched, and improper tackling technique is used.

J Spinal Cord Med. Apr 2010;33(2):163–167

Key Words: Youth football; Sports injuries; Spinal injury; Cervical; Tetraplegia, transient; Neurapraxia; Fracture, cervical, hyperextension; Spinal stenosis, congenital

INTRODUCTION

Participation in organized, contact youth sports is very common throughout the United States. Estimates suggest that more than 5.5 million children participate in youth football annually, and 28% of youth football players are injured each year, resulting in 187,000 emergency room visits (1). Although serious injuries in youth football are rare, the potential for serious cervical spinal injuries may be accentuated when younger players are significantly overmatched by competitors of greater age or weight. Guidelines with respect to proper age and weight limits in organized youth football are not clearly established. Although youth football programs are ubiquitous throughout the United States, organizers often arbitrarily decide age and weight limits for players.

This report describes a rare, but serious cervical spinal injury in a boy playing organized youth football. Potential for serious injury may be increased when players are overmatched and improper tackling techniques are used.

CASE REPORT

An 11-year-old, 75-lb boy with no significant medical history and normal developmental milestones was participating in his first year of organized youth football. During the second week of contact practice drills, the player was paired against an opponent who outweighed him by 50 lb and had a significantly larger body habitus (Figure 1). The injured player was the ball carrier in a practice tackling drill. The injured player sustained a hit to his facemask and described his head snapping back and hitting the upper portion of his thoracic spine (Figure 2). He described an immediate “pinching” sensation with severe pain in the back of his neck. The injured player also described an electrical, “shock-like” sensation throughout his body that occurred on impact. He was physically unable to move or feel all 4 extremities

Please address correspondence to Robert Molinari, MD, University of Rochester Medical Center, 601 Elmwood Avenue, Box 665, Rochester, NY 14642; p: 585 275 1753; f: 585 756 4726 (e-mail: Robert_molinari@urmc.rochester.edu).

Figure 1. Photograph of two youth football players of dissimilar body types who meet league-established requirements for participation on the same team. These players are representative of the physical mismatch between the 2 youth players in this case report.

for 10 seconds. He was then able to move his arms and legs but reported severe pain in the posterior portion of his neck. His neck was immobilized, and he was transferred to a level 1 trauma center for evaluation.

Figure 2. Photograph showing the improper facemask to facemask tackling technique that caused the extension compression of the cervical spine.

Figure 3. Lateral cervical radiograph showing the displaced fracture of the posterior spinous process.

At the hospital, the patient reported severe pain in the posterior portion of his neck and limitation of range of motion secondary to the pain. He also reported persistent numbness and tingling in his arms and legs. Physical examination showed severe tenderness of the posterior subaxial cervical spine on palpation and diminished sensation to light touch in the distribution of the C5, C6, and C7 dermatomes bilaterally. Motor examination showed normal motor strength throughout the bilateral upper and lower extremities without any residual neurologic motor deficit. Reflexes were normoactive in biceps, triceps, knees, and ankles bilaterally. Hoffman's sign was not present and the patient did not have clonus. Rectal examination sensation was normal for tone and sensation and he was able to urinate voluntarily without difficulty. His American Spinal Injury Association classification was ASIA D.

Initial radiographs of the cervical spine showed a displaced fracture of the C7 spinous process (Figure 3). At the C7 spinal level, the sagittal canal diameter measured 18.4 mm, the C7 vertebral body diameter measured 15.6 mm, and the Torg ratio (SC/VB) was 1.18. Magnetic resonance imaging (MRI) of the cervical spine identified significant posterior injury to the subaxial cervical spine with displaced spinous process fracture of C7 and edema of the spinal cord in the region of the injury (Figure 4a and b). The MRI did not identify any pre-existing risk factors for spinal cord injury. There was no evidence of disk herniation or congenital narrowing of the spinal canal. Furthermore, there was also no evidence of pre-existing pathology of the spinal cord or in the spinal canal.

Figure 4. (a) Initial T2-weighted sagittal MRI image showing spinal cord edema in the region of C7 along with posterior element injury. (b) Coronal image showing edema of the spinal cord in the region of C7.

The patient was fitted with a Miami-J rigid cervical orthosis (Ossur, Aliso Viejo, CA), which was worn full time for 10 weeks. He was instructed not to engage in physical activity during this period. After 10 weeks of cervical immobilization, the cervical collar was discontinued. The patient showed some limitation of cervical range of motion and some posterior residual neck pain; neurologic examination including motor and sensory tests in all 4 extremities was normal. At 12-week follow-up, the

Figure 5. (a) Flexion and (b) extension radiographs at 9-month follow-up, showing normal stability and complete healing with remodeling of the fracture.

patient showed full range of motion of his extremities and a normal neurologic examination. Radiographs at 9-month follow-up showed complete healing of the cervical fracture; flexion–extension radiographs were within normal limits (Figure 5a and b). At 1-year follow-up, he remained asymptomatic. Despite normal cervical spine range of motion and demonstrable radiographic stability in the follow-up period, his parents discouraged him from future participation in contact sports.

DISCUSSION

With more than 30 million children participating in youth sports each year in the United States, significant injuries are to be expected. Although mild orthopedic injuries such as sprains, strains, and contusions predominate, there is potential for more serious injury (1–6). Athletic competition has long been a known source of spinal injuries. Approximately 8.7% of all new cases of spinal cord injuries (SCIs) in the United States are related to sports activities (7). Catastrophic spine injuries in sports are rare but tragic events. Boden and colleagues (8,9) performed reviews of severe spinal injuries in sports. The sports with the highest risk of catastrophic spinal injuries are football, ice hockey, wrestling, diving, snowboarding, rugby, cheerleading, and baseball.

A common mechanism of injury for all at-risk contact sports is an axial compression force to the top of the head with the neck slightly flexed. This mechanism can lead to cervical fracture and tetraplegia in any sport, especially in contact football with spear tackling maneuvers. Torg et al (10) has described “spear tackler’s spine” in players with predisposing risk factors for neurologic injury in contact football. These players show loss of normal cervical lordosis along with congenital cervical stenosis, pre-existing evidence of post-traumatic cervical abnormalities, and participation in contact football. Players with spear tackler’s spine should not engage in contact sports.

Although a large axial compression force combined with cervical flexion is a well-described football injury mechanism, it was not the mechanism of injury in this case (6,9–11). The mechanism of injury was extension and posterior compression of the cervical spine caused by physical contact during a full-contact tackling drill. Witnesses described the larger opposing larger player’s facemask hitting the facemask of the smaller player during an attempted tackle. Severe hyperextension of the cervical spine resulted in cervical fracture and neurologic deficit. There was no radiographic evidence of pre-existing cervical canal stenosis in this patient or any other pre-existing clinical or radiographic risk factors for neurologic injury or cervical injury in contact sports. Of further note, this injury occurred in an offensive player on the receiving end of a tackle—a skill position not previously identified as an “at risk” position.

Cervical spine fractures with SCI in youth football players who have no pre-existing risk factors for injury are extremely rare. These injuries have been well described in older high school and college players. Boden et al (9) described catastrophic cervical spine injuries in high school football players. The incidence was 1 per 100,000 high school players. Permanent tetraplegia occurred in 0.5 per 100,000 high school football players. Spear tackling by players on defense was the predominant mechanism of injury causing tetraplegia. Only 1 athlete with SCI reported a cervical cord neurapraxia event before the study period. Transient spinal cord neurapraxia was also rare. Only 3.3 per 100,000 players in this

study experienced transient cervical cord neurapraxia. In addition to hyperflexion and hyperextension injuries, axial forces were found to cause cervical cord neurapraxia. The incidence of tetraplegic events among high school and college football players is approximately 6 per year, with a higher incidence at the college level.

Cantu and Mueller (12) also reported catastrophic spine injuries in football from 1977 through 1989. A total of 128 players incurred permanent cervical cord injuries. Defensive players were at greater risk for tetraplegia than offensive players were, and most were injured while tackling. To further reduce the incidence of catastrophic spine injuries, players must stop using the head as a battering ram and use the shoulder for blocking and tackling instead. Gross mismatch of player body size should be avoided as well.

Congenital spinal stenosis has been shown to contribute to cervical cord neuropraxia after cervical SCI in adult athletes (11,13). A sagittal canal diameter less than 14 mm and/or a Torg ratio (sagittal diameter of the spinal canal: midcervical sagittal vertebral body diameter) of less than 0.8 mm are indicative of significant cervical spinal stenosis. Boockvar et al (3) described cervical spinal stenosis and sports-related cervical cord neurapraxia in children. The role of cervical canal stenosis in cervical spinal injuries in children remains unclear. Boockvar et al (3) measured the sagittal canal diameter and the Torg ratio in children presenting with cervical cord neurapraxia resulting from sports-related cervical SCI. A total of 13 children with an average age of 11.5 years were evaluated to determine the sagittal diameter and Torg ratio at the level of C4. Sagittal canal diameter was normal in all 13 patients and averaged 17.6 mm. Torg ratio was also normal in all 13 patients and averaged 1.4. Using the sagittal canal diameter and the Torg ratio as a measurement of congenital spinal stenosis, the authors did not find evidence of congenital spinal stenosis in a group of children with sports-related cervical spinal cord neurapraxia. With a spinal canal diameter of 18.4 mm and a Torg ratio of 1.18, there is no evidence of congenital spinal stenosis in this patient. Cervical cord neurapraxia can be attributed to the mobility of the pediatric cervical spine rather than to congenital spinal stenosis.

Malina et al (4) performed a prospective study over 2 seasons involving 678 youth football players (9–14 years of age) and reported the incidence and player risk factors for orthopedic injury in organized youth football. The authors assessed the relationship between player-related risk factors such as age, body size, and biologic maturity status and injury in youth football. A total of 259 reportable orthopedic injuries occurred with 178 injuries occurring during practice and 81 during games. Practice injury rates increased with grade level. Game injury rates were similar among fourth- through sixth-grade players and about twice as high among seventh- and eighth-grade players. The majority of the injuries during the 2 seasons were minor (64%); only 13% were considered

major. Injured fourth- through fifth-grade players were significantly lighter in weight and had lower BMI; otherwise, injured and uninjured players within each grade did not differ in age, body size, and estimated biologic maturity status. However, this injured player was a sixth-grade student paired against a much larger player who used improper tackling technique.

Stuart et al (14) also performed a prospective observational analysis among youth football players 9 to 13 years of age; 915 players participated during 1 season. The incidence of injury was 6%, and most of the injuries were mild extremity contusions. Injury risk for an eighth-grade player was 4 times greater than the injury rate for a fourth-grade player. There was no correlation between body weight and injury in this study. Only 4 injuries were serious enough to prevent players from participating for the rest of the season, and no serious injuries to the cervical spine were reported. According to this study, risk of injury in youth football does not seem to be greater than for other recreational or competitive sports. Roser and Clawson (15) also concluded that junior league organized football was safer than free play based on an analysis of 70 youth teams.

Additional research is needed to better define those youth players who are at risk for serious cervical injury. Dec et al (2) described screening for catastrophic neck injuries in youth sports. Screening methods suggested include a concise history, physical examination, and appropriate radiographic methods based on the history and physical examination findings. Coaches at all levels of play should emphasize proper tackling with the use of the shoulder rather than the helmet. There is currently no universal classification system using imaging of the cervical spine that has been validated as a screening method for catastrophic neck injuries. Although many of these injuries are preventable, better definition with respect to guidelines is needed. Prevention strategies include protective equipment, rule changes, safety measures, better coaching, education, and a societal awareness of the potential for serious injury and prevention (16,17). The facemask-to-facemask contact tackling technique should be strongly discouraged in youth football because it may predispose players to extension-compression cervical injury as in this case. Coaches at all levels of play should strongly emphasize proper tackling technique using the shoulder instead of the helmet. This case report also underscores the need for greater awareness among youth football coaches when pairing players of significantly different weight and body habitus in practice contact drills.

CONCLUSION

This case underscores the potential for serious cervical spinal injuries in contact collision organized youth sports

when players are significantly physically overmatched by their opponent and when improper tackling technique is used. Better coaching, proper technique, thorough screening, and more research are needed to minimize the risk of these injuries.

REFERENCES

1. Dompier TP, Powell JW, Barron MJ, Moore MT. Time-loss and non-time-loss injuries in youth football players. *J Athl Train*. 2007;42(3):395–402.
2. Dec KL, Cole SL, Dec SL. Screening for catastrophic neck injuries in sports. *Curr Sports Med Rep*. 2007;6(1):16–19.
3. Boockvar JA, Durham SR, Sun PP. Cervical spinal stenosis and sports-related cervical cord neurapraxia in children. *Spine*. 2001;26(24):2709–2712.
4. Malina RM, Morano PJ, Barron M, Miller SJ, Cumming SP, Kontos AP. Incidence and player risk factors for injury in youth football. *Clin J Sport Med*. 2006;16(3):214–222.
5. Adickes MS, Stuart MJ. Youth football injuries. *Sports Med*. 2004;34(3):201–207.
6. Torg JS, Pavlov H, Genuario SE, et al. Neurapraxia of the cervical spinal cord with transient tetraplegia. *J Bone Joint Surg Am*. 1986;68(9):1354–1370.
7. Platzner P, Jandl M, Thalhammer G, et al. Cervical spine injuries in pediatric patients. *J Trauma*. 2007;62(2):389–396.
8. Boden BP, Prior C. Catastrophic spine injuries in sports. *Curr Sports Med Rep*. 2005;4(1):45–49.
9. 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(8):1223–1232.
10. Torg JS, Naranja RJ Jr, Pavlov H, Galinat BJ, Warren R, Stine RA. The relationship of developmental narrowing of the cervical spinal canal to reversible and irreversible injury of the cervical spinal cord in football players. *J Bone Joint Surg Am*. 1996;78(9):1308–1314.
11. Cantu RC, Mueller FO. Catastrophic spine injuries in American football, 1977–2001. *Neurosurgery*. 2003;53(2):358–362.
12. Cantu RC, Mueller FO. Catastrophic spine injuries in football (1977–1989). *J Spinal Disord*. 1990;3(3):227–231.
13. Torg JS. Cervical spinal stenosis with cord neurapraxia and transient tetraplegia. *Clin Sports Med*. 1990;9(2):279–296.
14. Stuart MJ, Morrey MA, Smith AM, Meis JK, Ortiguera CJ. Injuries in youth football: a prospective observational cohort analysis among players aged 9 to 13 years. *Mayo Clin Proc*. 2002;77(4):317–322.
15. Roser LA, Clawson DK. Football injuries in the very young athlete. *Clin Orthop Relat Res*. 1970;69:219–223.
16. Demorest RA, Landry GL. Prevention of pediatric sports injuries. *Curr Sports Med Rep*. 2003;2(6):337–343.
17. Noakes TD, Jakoet I, Baalbergen E. An apparent reduction in the incidence and severity of spinal cord injuries in schoolboy rugby players in the western Cape since 1990. *S Afr Med J*. 1999;89(5):540–545.