

## CASE REPORT

## Atlantoaxial Instability After a Header in an Amateur Soccer Player

Stephan Werle, MD, Kais Abu Nahleh, MD, and Heinrich Boehm, MD

**Study Design.** Case report and literature review.**Objective.** To report a unique case of atlantoaxial instability after a header in a 37-year-old amateur soccer player and to discuss the injury pattern in relation to the impact of heading.**Summary of Background Data.** Although there is potential for cervical spine injuries, the rates in soccer are low compared with other contact or even noncontact sports. No cases of acute post-traumatic atlantoaxial instability after heading have ever been reported in a MEDLINE-listed article.**Methods.** A 37-year-old male soccer player experienced acute upper neck pain and transient quadriplegia after heading a long-distance ball on 2 occasions during a match. Imaging revealed atlantoaxial instability. Persistent neurological symptoms on conservative treatment led to his referral to our department. The considerable instability required surgical intervention.**Results.** Transarticular C1–C2 fixation and posterior fusion with structural iliac crest grafting were performed. The procedure immediately led to complete relief of the neurological symptoms. After an uneventful postoperative recovery, follow-up at 9 months revealed solid fusion. The patient remained symptom free.**Conclusion.** Heading the ball in soccer can potentially lead to atlantoaxial instability. Ligamentous damage can theoretically be caused by anteriorly directed and rotational overload. However, the causative mechanism remains unclear. Diagnostic workup should consider dynamic imaging in players with transient neurological symptoms after minor trauma to the cervical spine.**Key words:** cervical spine, atlantodental dislocation, atlantoaxial instability, soccer, heading, atlantoaxial fixation, C1–C2 fixation.**Level of Evidence:** N/A**Spine 2015;40:E317–E320**

From the Department of Spinal Surgery and Paraplegiology, Zentralklinik Bad Berka, Germany.

Acknowledgment date: June 21, 2014. First revision date: October 14, 2014. Second revision date: November 19, 2014. Acceptance date: December 10, 2014.

The devices are FDA-approved or approved for this indication by a corresponding national agency.

No funds were received in support of this work.

No relevant financial activities outside the submitted work.

Address correspondence and reprint requests to Stephan Werle, MD, Department of Spinal Surgery and Paraplegiology, Zentralklinik Bad Berka, Robert-Koch-Allee 9, 99438 Bad Berka, Germany; E-mail: stephan.s.werle@asklepjos.com

DOI: 10.1097/BRS.0000000000000748

According to FIFA (Federation Internationale de Football Association), in 2006, 265 million people worldwide play soccer regularly.<sup>1</sup> Although soccer is classified as a contact sport, injuries to the spine are rare.<sup>2,3</sup> Acute injury to the head or neck results either from contact with other players or from heading the ball. In the case of the latter, the impact on the skeletal structures depends on how well the player is prepared for heading. Although players head the ball on a regular basis during training and matches, injuries to the craniocervical junction and the subaxial spine are most unusual. To the best of our knowledge, there are no previous reports of craniocervical instability related to heading.

## CASE REPORT

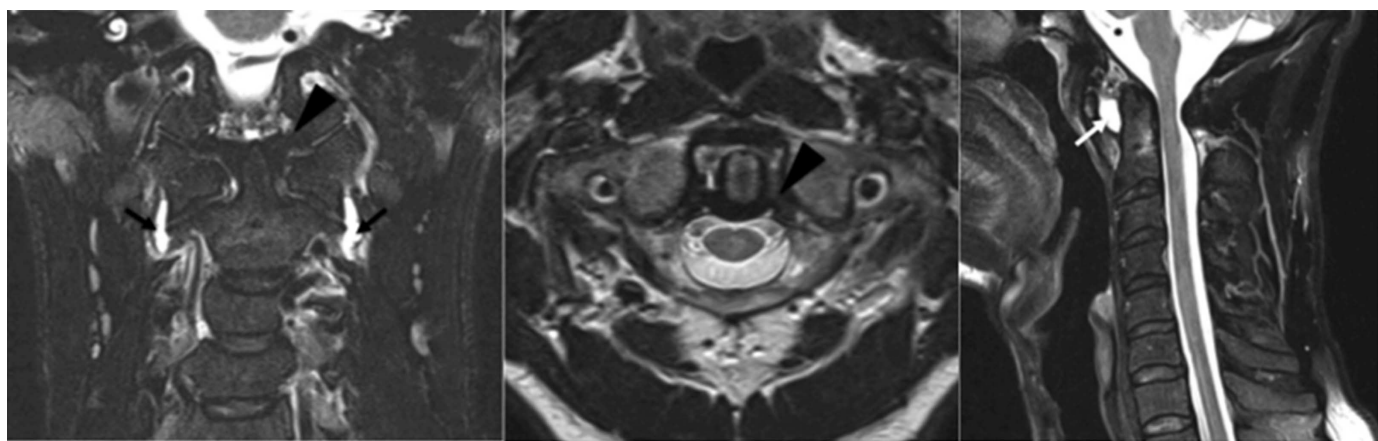
A 37-year-old male soccer player experienced acute post-traumatic atlantoaxial instability after a header. The patient reported that after heading a long-distance ball kicked by the goalkeeper, he immediately felt pain in his neck and electrical radiating pain through his whole body. The latter symptom was short-lived, but the neck pain persisted. The patient was well prepared for the maneuver, heading with the forehead while standing with the trunk slightly rotated. His cervical spine was somewhat extended because the ball had approached more nearly vertically. The player attempted to force the ball to go in the opposite direction. During the second half of the game, a second heading maneuver, which was similar regarding impact and position, led to transient quadriplegia of some minutes' duration. The symptoms resolved completely, except for the neck pain. After immobilization in a cervical orthosis, the patient was immediately referred to a local trauma unit, where conventional radiographs revealed atlantoaxial dislocation. The patient was treated conservatively.

This patient had been playing soccer on an amateur basis for the past 20 years, with a match each week. Different ways of heading the ball were part of the training, which he attended once or twice a week. He had no history of cervical spine symptoms, such as neck or radicular pain, sensory or motor deficits, or of injuries to the cervical spine.

Intermittent numbness of the hands and feet on conservative treatment led to the patient being referred to our department 7 weeks after the injury. His neurological status on admission was normal. Investigations revealed marked atlantoaxial instability. Dynamic films were avoided, since instability became evident comparing lateral radiograph with



**Figure 1.** Conventional lateral radiograph in neutral position at the day of trauma (left): atlanto-dental dislocation; magnetic resonance imaging T1 sagittal at first day after trauma (right): minimal atlantodental distance.



**Figure 2.** Magnetic resonance imaging T2 sequences: coronal (left), axial (middle), and sagittal (right); hyperintensity of the alar ligament and rupture of the transverse ligament (arrowheads), C1–C2 joint and predental space effusions (arrows).



**Figure 3.** Conventional radiographs anteroposterior (left) and lateral (right), at 14-week follow-up: complete atlanto reduction and posterior fusion.

magnetic resonance image (Figure 1). Magnetic resonance imaging detected grade 4 damage to the transverse ligament (rupture) and grade 3 damage to the left alar ligament (high-signal intensity in more than two-thirds of the cross-section), according to the classification of Li *et al.*<sup>4</sup> Marked effusions

were seen within the atlantoaxial and atlantodental joints (Figure 2).

Surgical treatment consisted of transarticular fixation of C1–C2, modified according to the study by Magerl and Seeman.<sup>5</sup> A structural graft from the iliac crest was fixed to the C1 arch

and C2 lamina by the technique proposed by Gallie,<sup>6</sup> using a synthetic nonresorbable USP 2 suture (DAGROFIL USP 2 B, Braun, Melsungen, Germany). The surgical setup, patient positioning, and surgical technique followed the less invasive procedure described by ElSaghir *et al*,<sup>7</sup> using 2.7-mm diameter screws. Somatosensory evoked potentials were monitored throughout the procedure. Fixing C1–C2 temporarily, as described by Harms and Melcher<sup>8</sup> was not considered to be a therapeutic option due to the severe instability and ligament rupture. Postoperative recovery was uneventful. The patient wore a Philadelphia collar for 12 weeks. At the most recent follow-up, 9 months after surgery, the patient had no neck pain, no sensory or motor dysfunction, and no symptoms at the donor site. Clinical examination revealed slight loss of cervical spine rotation, but normal neurological function. Conventional anteroposterior and lateral radiographs of the cervical spine showed osseous fusion, with no implant breakage or dislocation of the screws, and no loss of reduction (Figure 3). He returned to his previous job after 21 weeks and is working full time without problems.

## DISCUSSION

The literature reports a few cases of atlantoaxial instability, 1 in a sumo wrestler,<sup>9</sup> 2 in professional footballers,<sup>10</sup> and 2 in rugby players.<sup>11,12</sup> Neck injuries are rare in soccer.<sup>2</sup> An epidemiological investigation of sports-related spinal injuries revealed an incidence of 7.6%, only 6.0% of which were due to playing soccer.<sup>3</sup> This was relatively low in comparison with American football, riding, and swimming. The majority of soccer injuries are apparently caused by contact with other players, while contact with the ball accounts for only 2.8% of cases.<sup>13</sup>

The different ways of heading the ball during matches and training can potentially damage the spine, as the force transmission of a ball striking the player's head can be considerable.<sup>14,15</sup> Analysis of the maneuver to estimate the impact on the cervical spine has to consider how well the player is prepared to meet the ball, and whether the header is made while standing or running. Attempting propulsive force transmission to redirect the ball requires a forward motion of the head. This is provided mainly by forward movement of the trunk, whereas the positions of the head and cervical spine remain unchanged in relation to the trunk.<sup>16</sup> Depending on the position of the player in relation to the approaching ball and the desired change of direction, heading can induce considerable rotational moments at the craniocervical segments.<sup>15</sup> Activation of the neck muscles plays an important role in stabilizing the spine and the craniocervical junction, thus avoiding injury due to head acceleration.<sup>14</sup>

From a biomechanical point of view, the mechanism of injury in this case remains unclear. Although the force transmitted to the spine was considerable, the well-trained and experienced player was prepared for the maneuver; in addition, it was done from a standing position. Lesions of the transverse and alar ligaments result from anteriorly directed and rotational forces, respectively, analogous to the biomechanical properties of these structures.<sup>17,18</sup> This suggests rotational overload being the main mechanism of injury in this case.

## CONCLUSION

Damage to the cervical spine in sport is probably more frequent than it is detected, as suggested by the prevalence of post-traumatic changes in former soccer players.<sup>19</sup> Even more than fractures, instability due to ligamentous injuries is underdiagnosed and under-reported. The diagnostic algorithm should consider functional imaging in athletes with transient neurological symptoms after minor trauma to the cervical spine.

### ➤ Key Points

- ❑ When playing soccer, the impact of the striking ball while heading can lead to injury of the atlantoaxial ligaments.
- ❑ There are no reports of similar cases in the literature.
- ❑ The mechanism of injury suggests rotational overload.
- ❑ Transarticular atlantoaxial fixation and fusion led to the relief of symptoms.

## References

1. FIFA bigcount. Available at: [http://www.fifa.com/mm/document/fifafacts/bcoffsurv/emaga\\_9384\\_10704.pdf](http://www.fifa.com/mm/document/fifafacts/bcoffsurv/emaga_9384_10704.pdf). Accessed January 28, 2015.
2. Chomiak J, Junge A, Peterson L, et al. Severe injuries in football players. Influencing factors. *Am J Sports Med* 2000;28:S58–68.
3. Hitchcock ER, Karim MZ. Sports injuries to the central nervous system. *Coll Surg Edinb* 1982;27:46–9.
4. Li Q, Shen H, Li M. Magnetic resonance imaging signal changes of alar and transverse ligaments not correlated with whiplash-associated disorders: a meta-analysis of case-control studies. *Eur Spine J* 2013;22:14–20.
5. Magerl F, Seeman PS. Stable posterior fusion of the atlas and axis by transarticular screw fixation. In: Kehr P, Werdner PA, eds. *Cervical Spine*. Vienna; Springer; 1987:322–7.
6. Gallie WE. Fractures and dislocations of the upper cervical spine. *Am J Surg* 1939;46:495–9.
7. ElSaghir H, Boehm H, Greiner-Perth R. Mini-open approach combined with percutaneous transarticular screw fixation for C1–C2 fusion. *Neurosurg Rev* 2005;28:59–63.
8. Harms J, Melcher RP. Posterior C1–C2 fusion with polyaxial screw and rod fixation. *Spine* 2001;26:2467–71.
9. Nakagawa Y, Miki T, Nakamura T. Atlantoaxial dislocation in a sumo wrestler. *Clin J Sport Med* 1998;8:237–40.
10. Funk FF, Wells RE. Injuries of the cervical spine in football. *Clin Orthop Relat Res* 1975;109:50–8.
11. Miyamoto H, Doita M, Nishida K, et al. Traumatic anterior atlantoaxial subluxation occurring in a professional rugby athlete: case report and review of literature related to atlantoaxial injuries in sports activities. *Spine* 2004;29:E61–4.
12. Scher AT. Rugby injuries to the cervical spine and spinal cord: a 10-year review. *Clin Sports Med* 1998;17:195–206.
13. Frenguelli A, Ruscito P, Bicciolo G, et al. Head and neck trauma in sporting activities. *J Crani-Maxillo-Fac Surg* 1991;19:178–181.
14. Tysvaer AT. Head and neck injuries in soccer. Impact of minor trauma. *Sports Med* 1992;14:200–13.
15. Naunheim RS, Bayly PV, Standeven J, et al. Linear and angular head accelerations during heading of a soccer ball. *Med Sci Sports Exerc* 2003;35:1406–12.

16. Lynch JM, Bauer JA. Acute head and neck injuries. In: Garrett WE, Kirkendall DT, Coniguglia SR, eds. *The U.S. Soccer Sports Medicine Book*. Baltimore: Williams & Wilkins, 1996:185–190.
17. Dvorak J, Panjabi MM. Functional anatomy of the alar ligaments. *Spine* 1987;12:183–9.
18. White AA, Panjabi MM. The clinical biomechanics of the occipitoatlantoaxial complex. *Orthop Clin North Am* 1978;9:867–78.
19. Sortland O, Tysvaer AT, Storli OV. Changes in the cervical spine in association football players. *Br J Sports Med* 1982;16:80–4.

Copyright of Spine is the property of Lippincott Williams & Wilkins and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.