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Case Report

Traumatic atlantoaxial dislocation with Hangman fracture

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Abstract

BACKGROUND CONTEXT: Traumatic bilateral-atlantoaxial dislocations are rare injuries. Hangman fractures, conversely, represent 4% to 7% of all cervical fractures and frequently involve a combination C1–C2 fracture pattern. Presently, there is no report in the English literature of a traumatic C2-spondylolisthesis associated with a C1–C2 rotatory dislocation. This injury complex cannot be cataloged using current classification schemes and no established treatment recommendations exist.

PURPOSE: To report a unique case of a Hangman fracture associated with bilateral C1–C2 rotatory-dislocation, which does not fit into existing classification systems, and discuss our treatment approach.

STUDY DESIGN: A clinical case report and review of the literature.

METHODS: Chart review and analysis of relevant literature. There were no study-specific conflicts of interest.

RESULTS: A 26-year-old man sustained a traumatic C2-spondylolisthesis along with C1–C2 rotatory subluxation in an automobile collision. The patient was originally placed in a halo crown and vest and then taken for an open reduction and stabilization through a posterior approach for persistent C1–C2 subluxation. The patient is currently 16 months postoperative and back to work as a plumber.

CONCLUSIONS: The injury complex encountered cannot be described using the available classification systems. Our treatment included initial stabilization with halo placement, followed by a posterior C1, C2, and C3 segmental reduction and fixation resulting in radiographic fusion and a good clinical outcome.

Keywords: Hangman fracture; Traumatic spondylolisthesis; Atlantoaxial; C1–C2; Rotatory dislocation; Subluxation

Introduction

Traumatic bilateral-atlantoaxial dislocation is exceedingly rare in adults with only 10 reported cases in the English literature [1]. Traumatic C2-spondylolisthesis, however, comprises 4% to 7% of all traumatic cervical-spine fractures [2] and up to 30% of these C2-Hangman fractures represent a combination of C1–C2 fractures [3]. In this report, we describe a unique combination of a Hangman fracture associated with bilateral C1–C2 traumatic dislocation.

Case report

A 26-year-old man presented after a motor vehicle accident. On initial assessment, the patient was neurologically intact. Computed tomography (CT) evaluation revealed a Type-IIa Hangman fracture and bilateral C1–C2 rotatory dislocation (Fig. 1). Magnetic resonance imaging revealed a right alar ligament injury, an intact transverse ligament, and disruption of the C1–C2 facet capsule. The C2–C3 disc and the anterior and posterior longitudinal ligaments were disrupted (Fig. 2). Magnetic resonance angiogram ruled out vertebral artery injury. Halo crown and vest were applied for immediate immobilization with improved sagittal alignment. Repeat lateral C-spine X-ray (Fig. 3) and a repeat CT scan showed persistent C1–C2 rotatory subluxation and therefore, an open reduction and surgical fixation was planned.

Surgical treatment was used to reduce the C1–C2 dislocation and stabilize the Type-IIa traumatic C2-spondylolisthesis.

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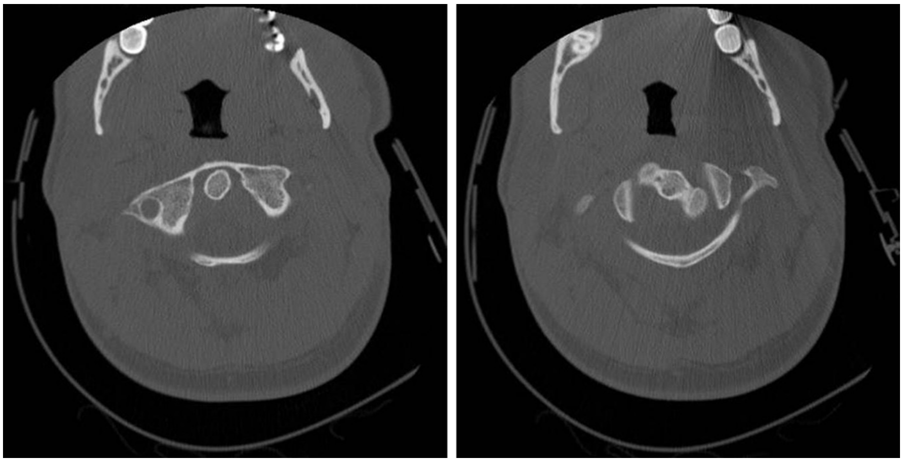

Fig. 1. (Left) Axial computed tomography (CT) reveals anatomic positioning of the atlas with maintenance of atlantodental interval. (Right) Axial CT displays bilateral rotatory deformity/dislocation of the axis on a normally positioned atlas.

Using a posterior approach, C1–C3 arthrodesis with iliac crest autograft was performed using lateral mass and pedicle fixation. To correct the severe rotational deformity, bilateral C2 pedicle screws were placed for rotational realignment. Once reduction was achieved and maintained on the left, the right-sided C2 screw was removed because of spinal cord proximity. C1 cables were used to assist with reduction and secure the iliac crest autograft strips across C1–C3 for a solid fusion (Fig. 4).

The patient remained neurologically intact postoperatively. Alignment remained satisfactory without signs of complications or need for additional surgery (Fig. 5).

Fig. 2. Sagittal T2–magnetic resonance imaging shows Anterior Longitudinal Ligament (ALL), Posterior Longitudinal Ligamant (PLL), and disc disruption with associated epidural hematoma and kyphotic deformity at C2–C3 and soft-tissue disruption posteriorly from the occipitocervical junction to C2.

Discussion

The combination of traumatic C2-spondylolisthesis with bilateral C1–C2 dislocation is extremely rare. Although C1–C2 fracture combinations are common and well-documented [3,4], to the author's knowledge, a C2 hangman fracture associated with C1–C2 traumatic dislocation

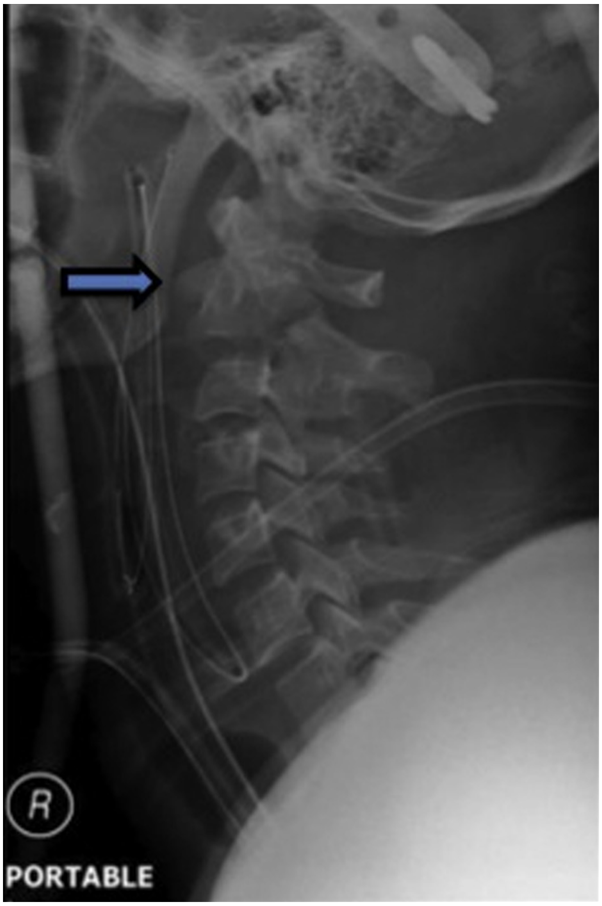

Fig. 3. Portable lateral C-spine film in a halo reveals improved sagittal alignment with extension, but a persistent rotatory deformity of the axis (arrow).

Fig. 4. (Left) Initial post-positioning fluoroscopic lateral reveals C2–C3 traumatic spondylolisthesis and C2 rotatory deformity (black arrow). (Middle) Intraoperative fluoroscopic view demonstrates the placement of bilateral C1 lateral mass and C2 pedicle screws. Notice the resultant anterior thrust with temporary worsening of the spondylolisthesis. (Right) Final construct with C1–C3 fixation and restoration of alignment. Note that the right-sided C2 screw was removed (because of the severe rotatory deformity, the right C2 pedicle screw was provisionally placed medial to the anatomic site and used for rotatory realignment and removed once the left sided fixation was finalized).

has not yet been reported in the English literature. The mechanism of injury can vary widely, often resulting from motor vehicle crashes, falls, and sports injuries [5–8]. Neurologic presentation depends on the integrity of the transverse ligament, amount of displacement, and the spinal canal compromise.

Radiologic assessment should include a CT scan to characterize the location of the pars fracture and the relationship of the occipitocervical and atlantoaxial joints [9]. Magnetic resonance imaging is critical in assessing the spinal cord, an extruded disc fragment, and the integrity of the ligamentous structures, especially the transverse and alar ligaments [10,11]. Two classification systems are available to describe C1–C2 rotatory instability [12,13]. Both systems are image-based and delineate subluxation-based on atlantal displacement on the pivotal axis. The Levine and Edwards classification system is most commonly used to identify and manage traumatic C2-spondylolisthesis [14,15]. The injury presented in this report cannot be adequately cataloged based on these current classification schemes. Unlike the usual presentation of atlantal dislocation on a fixed pivot point off the axis, this patient presented with a Type-IIa hangman fracture combined with C2 rotatory dislocation on a neutrally aligned atlas.

Management of both traumatic C2-spondylolisthesis and atlantoaxial rotatory subluxation is not free of controversy. However, nonsurgical management with rigid-immobilization has been a widely accepted treatment for most stable hangman fractures [16]. Similarly, nonsurgical treatment with early cranial traction and anatomic reduction followed by 6- to 12-week immobilization has yielded good long-term results in atlantoaxial rotatory subluxation [6,17,18].

The patient in this report had a complex injury pattern with a combination of bilateral pars fractures and ligamentous disruption with C1–C2 rotatory dislocation. Traction is contraindicated in managing Type-IIa hangman fractures, as the disrupted posterior discoligamentous complex would allow for worsening deformity and neurologic injury with applied tension. Consequently, surgical management after initial halo immobilization appeared appropriate as the rotatory dislocation could not be close-reduced [7,12,19–22]. Surgical fixation achieved solid fusion, avoiding deformity and delayed union that can occur with nonoperative treatment [21].

Fig. 5. Axial computed tomography scan reveals the postoperative C1–C2 rotatory realignment.

Diverse surgical techniques exist to address such complex injury patterns. Both anterior- and posterior-based procedures have been reported. Anterior cervical discectomy and fusion using a Smith-Robinson, transoral, or extraoral approach has been described [23,24]. Alternatively and preferentially, the posterior approach has been used in managing these injuries. Although the anterior approach may be useful in treating traumatic C2–C3 spondylolisthesis accompanied by a disc herniation and medullary compression [25], this technique is more complex and may require a bilateral extraoral approach if C1–C2 fusion is required. The approach can risk injury to the facial, hypoglossal, and superior laryngeal nerves and carotid sheath contents [26,27]. The posterior approach, on the contrary, has a lower complication rate and high fusion rate of 87% to 100% [28]. The posterior approach offers versatility including fixation options into C1 for combination injuries resulting in atlantoaxial instability [25]. Moreover, posterior fixation is biomechanically superior to anterior cervical plating [29].

Surgical intervention for this complex injury pattern can be challenging and fraught with pitfalls. For starters, careful prone positioning is critical to avoid distractive forces and risk of neurologic injury across the C2–C3 segment. It may be advisable to use the Jackson table rotating technique versus the manual log roll method to minimize angular motion. The reduction of the C1–C2 articulation can also be difficult. In addition to lateral mass and pedicle screw fixation at C1 and C2, respectively, C1 sublaminar cable and manual reduction techniques may be needed. The authors routinely use and support the use of multimodality intraoperative neuromonitoring to minimize iatrogenic neurologic injury for such cases. Hardware placement techniques may be varied based on the individual patient's pedicle and bony anatomy and the course of the vertebral artery. However, it is important to note that C2 translaminar screws or C2 posterior element wiring techniques are not viable options in managing patients with bilateral pars fractures.

The combination of a traumatic atlantoaxial dislocation with a hangman fracture has yet to be reported in the English literature. This injury cannot be classified based on the current schemes and there is an absence of management guidelines. Initial halo immobilization was critical in facilitating care for our polytrauma patient. Ultimately, an open reduction and posterior C1–C3 fusion was required to achieve anatomic alignment and solid arthrodesis.

References

[1] Venkatesan M, Bhatt R, Newey ML. Traumatic atlantoaxial rotatory subluxation (TAARS) in adults: a report of two cases and literature review. Injury 2012;43:1212–5.

[2] Shimamura Y, Kaneko K. Irreducible traumatic spondylolisthesis of the axis: case report and review of the literature. Injury 2008;39:371–4.

[3] Gleizes V, Jacquot FP, Signoret F, Feron JM. Combined injuries in the upper cervical spine: clinical and epidemiological data over a 14-year period. Eur Spine J 2000;9:386–92.

[4] Jefferson G. Fracture of the atlas vertebra. Report of four cases, and a review of those previously recorded. Br J Surg 1919;7:407–22.

[5] Corner EM. Rotary dislocations of the atlas. Ann Surg 1907;45:9–26.

[6] Robertson PA, Swan HA. Traumatic bilateral rotatory facet dislocation of the atlas on the axis. Spine 1992;17:1252–4.

[7] Moore KR, Frank EH. Traumatic atlantoaxial rotatory subluxation and dislocation. Spine 1995;20:1928–30.

[8] Fuentes S, Bouillot P, Palombi O, Ducolombier A, Desgeorges M. Traumatic atlantoaxial rotatory dislocation with odontoid fracture: case report and review. Spine 2001;26:830–4.

[9] Fielding JW, Stillwell WT, Chynn KY, Spyropoulos EC. Use of computed tomography for the diagnosis of atlanto-axial rotatory fixation. A case report. J Bone Joint Surg Am 1978;60:1102–4.

[10] Dickman CA, Mamourian A, Sonntag VK, Drayer BP. Magnetic resonance imaging of the transverse atlantal ligament for the evaluation of atlantoaxial instability. J Neurosurg 1991;75:221–7.

[11] Ono K, Yonenobu K, Fuji T, Okada K. Atlantoaxial rotatory fixation. Radiographic study of its mechanism. Spine 1985;10:602–8.

[12] Fielding JW, Hawkins RJ. Atlanto-axial rotatory fixation. (Fixed rotatory subluxation of the atlanto-axial joint). J Bone Joint Surg Am 1977;59:37–44.

[13] White AAP III, Manahar M. Clinical biomechanics of the spine. Philadelphia, PA: JB Lippincott Company, 1978.

[14] Levine AM, Edwards CC. The management of traumatic spondylolisthesis of the axis. J Bone Joint Surg Am 1985;67:217–26.

[15] Effendi B, Roy D, Cornish B, Dussault RG, Laurin CA. Fractures of the ring of the axis. A classification based on the analysis of 131 cases. J Bone Joint Surg Br 1981;63-b:319–27.

[16] Vaccaro AR, Madigan L, Bauerle WB, Blescia A, Cotler JM. Early halo immobilization of displaced traumatic spondylolisthesis of the axis. Spine 2002;27:2229–33.

[17] Jones RN. Rotatory dislocation of both atlanto-axial joints. J Bone Joint Surg Br 1984;66:6–7.

[18] Wise JJ, Cheney R, Fischgrund J. Traumatic bilateral rotatory dislocation of the atlanto-axial joints: a case report and review of the literature. J Spinal Disord 1997;10:451–3.

[19] Li X-F, Dai L-Y, Lu H, Chen X-D. A systematic review of the management of hangman's fractures. Eur Spine J 2006;15:257–69.

[20] Samaha C, Lazennec JY, Laporte C, Saillant G. Hangman's fracture: the relationship between asymmetry and instability. J Bone Joint Surg Br 2000;82:1046–52.

[21] Muller EJ, Wick M, Muhr G. Traumatic spondylolisthesis of the axis: treatment rationale based on the stability of the different fracture types. Eur Spine J 2000;9:123–8.

[22] Crockard HA, Rogers MA. Open reduction of traumatic atlanto-axial rotatory dislocation with use of the extreme lateral approach. A report of two cases*. J Bone Joint Surg Am 1996;78:431–6.

[23] Tuite GF, Papadopoulos SM, Sonntag VK. Caspar plate fixation for the treatment of complex hangman's fractures. Neurosurgery 1992;30:761–4; discussion 764–765.

[24] Wilson AJ, Marshall RW, Ewart M. Transoral fusion with internal fixation in a displaced hangman's fracture. Spine 1999;24:295–8.

[25] Ying Z, Wen Y, Xinwei W, Yong T, Hongyu L, Zhu H, et al. Anterior cervical discectomy and fusion for unstable traumatic spondylolisthesis of the axis. Spine 2008;33:255–8.

[26] ElMiligui Y, Koptan W, Emran I. Transpedicular screw fixation for type II Hangman's fracture: a motion preserving procedure. Eur Spine J 2010;19:1299–305.

[27] Bristol R, Henn JS, Dickman CA. Pars screw fixation of a hangman's fracture: technical case report. Neurosurgery 2005;56(1 Suppl):E204; discussion E204.

[28] Isolated fractures of the axis in adults. Neurosurgery 2002;50 (3 Suppl):S125–39.

[29] Duggal N, Chamberlain RH, Perez-Garza LE, Espinoza-Larios A, Sonntag VK, Crawford NR. Hangman's fracture: a biomechanical comparison of stabilization techniques. Spine 2007;32:182–7.