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Case Report

The axis body of chance-type fracture associated with Hangman's fracture: a case report and literature review

Wei Wang[1,2*], Xianhua Cai[1*], Feng Xu[1], Ximing Liu[1], Hui Kang[1]

[1]Department of Orthopedic Surgery, Wuhan General Hospital of Guangzhou Command, Wuhan 430070, Hubei Province, China; [2]Department of College of Acupuncture and Orthopedics, Hubei University of Chinese Medicine, Wuhan 430065, Hubei Province, China. [*]Equal contributors.

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Abstract: Transverse fracture through the axis body is quite different from Anderson and D'Alonzo type III odontoid fracture, and its combination with hangman's fracture has not been reported on a literature review, which is a combination fracture involving multiple areas of axis and the classification relative to multiple axis fractures that have not been put forward yet. Although there was no neurologic complication in our case, the poor stability and high risk with conservative treatment has been mentioned. Therefore, surgical management was taken into consideration and the operation was based on the fracture patterns and patient's characteristics. It was operated successfully through the anterior odontoid screwing fixation combined with anterior C2-3 discectomy and bone grafting and anterior cervical plate fixation. Satisfactory clinical and radiological outcomes were obtained in two years' follow-up. The surgical treatment was recommended for complex multiple areas fracture of axis.

Keywords: Axis, upper cervical spine, chance-type fracture, hangman's fracture

Introduction

Owing to particular and complex anatomical structure and biomechanical characteristic of the axis, there are diversified patterns for the fracture of the axis [1-3]. At present, most researches about the axis fracture concentrate on the lesion of the isolation structure (the odontoid process and the posterior arch), and few researches have been conducted to investigate the fracture modalities and classification of the axis body or the whole axis vertebra [4, 5]. Korres et al. [6] reported that a combination of two or even three distinct axis fracture type in a single patient accounted for 1% in their series, and the most common composite patterns were the teardrop fracture combined with hangman's fracture and the odontiod combined with hangman's fracture.

In this paper, an interesting case involved a Chance-Type Fracture through the body of axis combined with hangman's fractures was treated successfully with anterior internal fixation operation. To our knowledge, this case hasn't been reported yet. The purpose of this study is to investigate the classification and injury mechanism of the complex axis fractures, furthermore, the design of its operation was discussed and the literature of similar fracture was reviewed. We hope that our report can be helpful in strategy making for the combined fracture of axis.

Case report

A 61-year-old male was involved in a road traffic accident. The patient was the driver of the minivan and came across a head-on collision against a roadside wall. The patient was reported a brief loss of consciousness at the accident scene, and a hard cervical collar was applied before being transferred to the hospital. There was an abrasion over his forehead. After recovering consciousness the patient complained with severe pain in upper neck and chest. Neurological examination revealed no signs of abnormality. The computed tomography (CT) examination of cranial was normal. Cervical spine radiograph and CT scan and reconstructions showed that hangman's fracture with a slight flexion angulation and a horizontal displaced fracture of the axis body was observed, and the horizontal fracture line ran from the

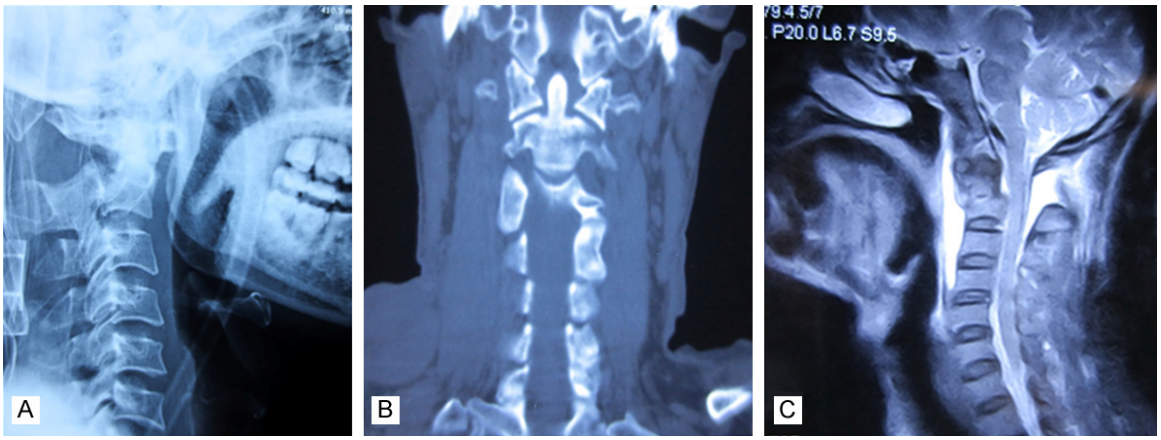

Figure 1. Lateral X-rays of the cervical spine after injury (A); CT scan and coronal reconstruction of the cervical spine (B); T2-weighted sagittal magnetic resonance imaging scans reveal obvious hematoma and the rear part of the C2-3 disk space repture, but no neural compression was evident (C).

lower level of the superior articular facets to the bilateral pedicle, the atlanto-axial junction remained intact (**Figure 1A**, **1B**). Magnetic resonance imaging (MRI) scan revealed disruption of the rear part of the C2-3 disk space, but no neural compression was observed (**Figure 1C**). Besides, the patient was found with two fractures of the right ribs with pulmonary contusion.

After diagnosis, the hard cervical collar was removed for skull traction, and extension was maintained to reduce anterior displacement and angulation of the fracture. No deterioration of neurological status was observed. A week after the traction, radiographs showed the displacement and angulation of the fracture was reduced. However, the second week after the traction, the patient complained with poor tolerance of traction and refused to undergo this treatment. Then, radiographs and a CT scan were done again, and the examination revealed displacement of the fracture with rotation. In view of the complex axis fracture-a combination of a "triple" (the cranial-the caudal-the posterior part) performance, high instability of this fracture is not suitable for the conservative treatment, especially the patient refused any more traction treatment, so surgical stabilization was considered. The operation was performed with anterior odontoid screwing fixation combined with anterior C2-3 discectomy and bone grafting and anterior cervical plate fixation through a right-side subhyoid presternocleidomastoid approach. The cranial and caudal segment of the axis were stabilized effectively by the odontoid screwing and anterior plate, the ruptured C2-3 intervertebral disk was replaced by autologus tricortical iliac crest bone graft in order to achieve inter body fusion, the screws had good purchase in the vertebral body (**Figure 2A**, **2B**). There was no intra-operative complication and no cases of vascular injury or neurological impairment from hardware placement.

Three days after the operation, the patients were encouraged to stand and the cervical spine was immobilized in rigid head-neck-chest orthotics. Three months of postoperative immobilization, dynamic radiographs and CT scan showed healing of the fracture and C2-3 fused without any signs of instability. Two years after the surgery, radiographic showed the further solid fusion and with no residual deformity of the axis (**Figure 2C**, **2D**), and the patient experienced full range of motion of the cervical spine with pain-free.

Discussion

The fracture of axis accounts for approximately 17%-25% of the acute cervical vertebrae injuries [7, 8]. Jakim and Sweet [9] attempted firstly to define axis body fracture, they reported a case of transverse fracture through the axis body and proposed three different types for this fracture: a) Anderson and D'Alonzo type III fracture, b) transverse fracture of the body of the axis with an intact ring, c) and tear drop fracture. Burke et al. [10] put forward two types (hyperextension dislocation and extension tear-

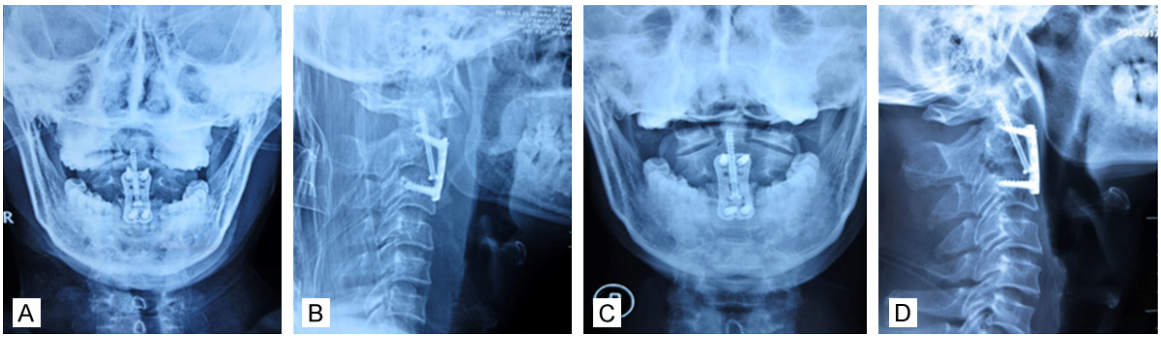

Figure 2. A/P mouth open X-rays of the cervical spine (A) and Lateral (B) after the surgery showing satisfactory fracture reduction and appropriate position of the implants; A/P mouth open X-rays (C) and Lateral (D) after the surgery of 2 years showing the solid fusion of the fracture.

drop fracture) of this classification based on 31 cases. The most widely-used classification was advocated by Benzel et al. [4] who divided the axis body fractures into three types: coronal, sagittal and horizontal based on the fracture line orientation of the body. Furthermore, he believed that the Anderson and D'Alonzo's type III odontoid fractures belonged to a part of the horizontal fracture of the C2 body. However, none of the three classifications were based on injury mechanism. Until 1996, Fujimura et al. [5] followed the fracture line location of the vertebral body and divided the axis body fractures into four grades: avulsion, transverse, sagittal, and burst fractures. In addition, he found out the horizontal fracture of the C2 vertebral body which was different from Anderson and D'Alonzo type III odontoid fracture, and defined it as an independent fracture type. Although the classification was proposed by Fujimura et al. [5] based on treatments over 31 cases of axis body fracture, he didn't consider the combination fracture through multiple areas of the axis being restricted to axis body only. Few research papers definitely distinguished the transverse axis body fracture from the type III odontoid fracture (**Table 1**).

With regard to the fracture of the axis isthmus (Traumatic spondylolisthesis of the axis or hangman's fracture), Williams et al. [11] defined hangman's fracture as a pioneer based on the injury mechanism. Several classification systems were proposed successively, including Francis et al. [12] proposed (I-V), Effendi [13] (I-III), Levine and Edwards [8] modified (I, II, IIA, III). Nevertheless, based on the injury mechanism, the last classification was used widely in clinical practice, which described hyperextension and axial loading followed by flexion as an injury mechanism of the type II but type IIA fractures were caused by flexion-distraction.

Maki [14] reported a case of transverse fracture through the axis body, and he deemed the injury mechanism was a flexion-distraction injury which was similar to the "chance-type fracture" in the thoracolumbar spine. Jakim and Sweet [9] also described a similar case, in which he attributed it to a result of hyperextension injury. Although hyperflexion and distraction or hyperextension forces both could produce horizontal fracture of axis body (**Table 1**), the main conflict lied in the difference between the posterior part attached to the upper and lower segment after a transverse fracture through the axis body. Korres et al. [15] reported 2 patients (0.3%) with the horizontal fracture of the C2 vertebral body in 674 cases with cervical spine injury. He defined it as the chance-type fractures of axis according to the pattern of fracture which was similar to a chance-type fracture in the thoracolumbar. By contrast, in our case the transverse fracture line ran through the axis body to the lower level of the superior articular facets and extended the upper bilateral pedicle. Although the ring was disrupted by Hangman's fracture, the posterior part attached to the caudal segment was similar. The characteristics of the transverse fracture in our case was similar to the description by Maki [14] and Korres et al. [15]. Furthermore, the type II hangman's fracture combined with disruption of the rear part of the C2-3 disk space in our case. Therefore, the most likely injury mechanism in present case involved hyperflexion and distraction force, which was similar to the chance-type fracture or combined

Table 1. Summary of papers reported transverse fractures of axis body

Reference	Description of Study	Fracture Type	Mechanisms of Injury	Circumstances Of Neurological injury	Treatment method
Maki NJ. (1985) [14]	A case report	Transverse fracture through the body of the axis (chance fracture)	Flexion-distraction	Intact	Conservative treatment (Skull traction + halo vest)
Jakim I and Sweet MB (1988) [9]	A case report	Transverse fracture of the axis body	Extension	Intact	Conservative treatment (Skull traction)
Fujimura Y, et al. (1996) [5]	Retrospective report of 31 cases of axis body fracture; classified the axis body fracture with radiographic imaging	Transverse fracture of the axis body	Flexion-distraction or traction in extension	Intact	Conservative treatment (Philadelphia collar)
Korres DS, et al. (2005) [15]	Retrospective review of 674 cervical fractures; reported 2 cases of Chance-type fractures of the axis; 2/674 (0.05%)	Two cases of horizontal fractures of the axis body (chance fracture)	Hyperflexion and distraction	Intact	Conservative treatment (skull traction + Philadelphia collar or halo Vest)
Goldschlager T, et al. (2012) [20]	A case report	Oblique fracture through the axis body combined a hangman's fracture	Flexion-distraction and lateral compression	Intact	Non-operative management was failure and surgical fixation was preformed
Zhang YS, et al. (2014) [17]	Retrospective review of 28 axis body fractures; the indications for surgical treatment were defined.	Transverse Fracture of axis body	No refer	Intact	Operation with posterior atlanto-axial pedicle screws fixation and fusion
Shinbo J, et al. (2014) [18]	2 cases report	Multiple fractures of the axis (odontoid Type II fracture and a Type IA hangman fracture)	No refer	Intact	Concurrent insertion of an anterior odontoid screw and bilateral posterior pedicle screws.

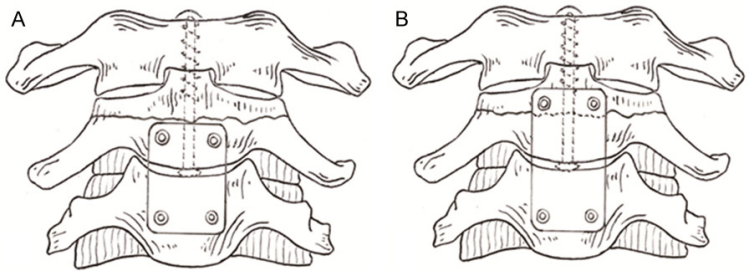

Figure 3. Graphical illustration of A/P view of the Chance-type fractures associated with Hangman's fractures of the axis showing two schemes for the implants: the technology of anterior odontoid screwing fixation combined with anterior C2-3 discectomy and bone grafting and anterior cervical plate fixation. The upper two screws of the anterior plate of the C2-3 were fixed in the caudal segment (A) and cranial segment of the horizontal fracture (B).

with rotating injury. The fracture pattern had not been described in any classification of axis and was different from previously reported cases (**Table 1**).

Similar to the majority of thoracolumbar chance-type fracture or simplex hangman's fracture, the occurrence of neurologic deficits or spinal cord compression is very rare. In our case, the patient has not appeared any neurological symptoms from injury to postoperation. Although previous literature identified transverse fracture of the axis body as an unstable injury, most surgeons adopted conservative treatment as primary therapy. Besides, there were still large series literatures managing it as type III odontoid fractures and reporting nonunion rates of conservative treatment up to 2% [2], they also indicated these patients could be treated by surgery successfully. In terms of the management of hangman's fracture, whether requires operative or nonoperative treatment, it is still controversial, particularly for type II and type IIA. However, for patients with complex multiple areas of axis fracture showing unstable status, the treatment is still a challenge for spinal surgeons, and most literatures recommended surgical intervention for better clinical outcomes [16-19]. At present case, although the reduction was observed after the first week of traction, the displacement of the fracture with rotation was also observed in the second week. The patient showed poor tolerance to traction and refused conservative treatment. We considered that the characteristic of fracture pattern was similar to that of three-column injury, potential instability of the C2-3 joint might induce upper cervical spine instability. Due to the high risk of the conservative treatment, it was necessary to stabilize the upper cervical spine with positive surgical management.

The literature addressing the treatment method of this type fracture is very limited and there is no relevant evidence (**Table 1**). Goldschlager et al. [20] reported a case of oblique axis body fracture accompanying hangman's fracture, in which he eventually performed posterior instrumented fusion with screw-rod construct from C1 to C4. Although the follow-up revealed satisfactory radiological outcomes, the result was a loss of most activities section of the cervical spine. In our opinion, the aim of the operation was to provide strong fixation and reserve cervical mobility, therefore, the treatment should be tailored according to the fracture pattern and individual patient's characteristics. In order to retain the rotation function between the intervertebral arthrosis of C1-2 and avoid expanding fixed segment, the operation utilized the anterior odontoid screwing by anterior approach, a single 3.5 mm-diameter cannulate cancellous compression screw was drilled in from the middle of the anterior edge of the axis to the odontoid process, which could provide good stability between the cranial segment and caudal part of the axis body from the axial orientation. Then the procedure of discectomy of the C2-3 and graft autologous iliac was performed. Whereas, when the anterior plate of the C2-3 was implanted, there were two schemes for the location of the plate-crews system were designed preoperatively: the first design (**Figure 3A**), the upper two screws of the anterior plate of the C2-3 were inserted into the caudal fragment of the axis body. But we considered the scheme would lead to the rotating instability between the upper and lower part of the horizontal axis body fracture. Therefore, the second scenario was chosen (**Figure 3B**), and it took full advantage of the space of the cranial segment of the axis body intraoperation, which consisted of a small part of the body together with the dens. A long anterior plate was chosen and the upper two screws were inserted into the cranial fragment whilst the lower two screws were inserted into

the C3 vertebra body. The combination fixation was used to increase entire constructing stiffness and resist rotating instability. As a result, the stability of the anterior and middle column were reconstructed and the mobility of C1-C2 joint was reserved. The patient was required to wear a rigid head-neck-chest orthosis for three months until dynamic radiographs showed healing of the fracture without any signs of instability. Because the special design and the limited internal fixation for the complex fractures were adopted and the arthrosis of C1-2 intraoperation hadn't been invaded as well, the patient had experienced satisfactory function recovery of the cervical spine in the follow-up.

Conclusion

The combination of transverse fracture through the body of axis and hangman's fracture is rare and the injury mechanism is complex. The present case may be caused by hyperflexion-distraction or concomitant rotating injury. The stability of this fracture is poor. Conservative external immobilization is regarded as the primary management for single axis body fracture, but it is still advocated. In terms of complex multiple area of axis fracture, the therapeutic management should be individualized according to the different fracture patterns and patient's characteristics. In order to avoid the risk of displacement and complication, early internal fixation should also be considered. The strategy of the operation is very important, and the management of surgery is essentially based on the opinion that operation design should utilize the space of injured vertebral body to reconstruct the stability, furthermore, to retain the mobile segment of the cervical spine as well.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Xianhua Cai, Department of Orthopaedics, Wuhan General Hospital of Guangzhou Command, 627 Wuluo Road, Wuhan 430070, Hubei Province, China. Tel: (+86)-027-50772521; E-mail: wgcaixh@126.com

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