

## Chance-Type Fractures of the Axis

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**Study Design.** A retrospective study was performed to identify horizontal fractures of the body of the axis, with special attention to their pattern, prevalence, and clinical outcome.

**Objective.** The prevalence of this type of injury and the long-term clinical behavior are examined.

**Summary of Background Data.** Although isolated cases have been reported, horizontal Chance-type fractures of the body of the axis are not common cervical spine injuries.

**Methods.** The medical records of 674 consecutive patients with fractures of the cervical spine admitted to the authors' institute from 1970 to 2002 were reviewed. Of them, 2 (0.3%) had a horizontal Chance-type fracture of the body of the axis. Neurologic deficits were not diagnosed at admission. Mechanism of injury, treatment, and long-term follow-up were evaluated.

**Results.** Both patients were treated nonoperatively. At the latest follow-up, 3 and 12 years, respectively, both patients had a satisfactory clinical outcome.

**Conclusion.** Horizontal fractures of the Chance-type of the body of the axis are rare. Conservative treatment proved to be effective.

**Key words:** Chance-type fracture, upper cervical spine, axis. **Spine 2005;30:E517–E520**

Because of its unique anatomy and biomechanical behavior, the axis vertebra is prone to different patterns of injuries.<sup>1,2</sup> There are few studies<sup>3–7</sup> that report on the pattern of these fractures, and classify them according to the fracture line in the sagittal and the coronal plane. Fractures of the body of the axis are not common compared to the fractures of the odontoid process or the ring.

Horizontal or Chance-type fractures are mostly observed in the thoracolumbar junction,<sup>8</sup> as a result of hyperflexion and distraction, and are potentially unstable, involving 2 or often all 3 columns of the spine. In the upper cervical spine, horizontal fractures are most likely associated with hyperextension or combined hyperflexion and distraction.<sup>5–7</sup>

Similar to the majority of the thoracolumbar Chance-type fractures, Chance-type fractures of the cervical spine are biomechanically unstable, usually do not com-

promise the spinal canal, and heal to stability with non-operative treatment.<sup>5–7</sup> The purpose of this study was to identify horizontal fractures of the body of the axis, with special attention to their pattern, treatment, and clinical outcome. The prevalence, biomechanical, and clinical behavior of these injuries are discussed.

### Materials and Methods

From 1970 to 2002, 674 patients with a cervical spine injury were admitted to the authors' institution. A total of 182 patients had a fracture of the axis; of these, 90 had fracture of the dens, 69 had traumatic spondylolisthesis, and 23 had fracture of the body of the axis. Of the 23 patients with a fracture of the body of the axis, 19 had a teardrop fracture, 2 had a horizontal fracture, and 2 had a longitudinal fracture through the body of the C2 vertebra.

**Case 1.** A 55-year-old female was admitted at the Emergency Room after an automobile accident. The patient was involved in a rear collision. She was the driver, and she was wearing a seatbelt. A hard cervical collar has been applied at the site of the accident, and the patient has been transferred to the hospital. At admission, the patient was alert and fully conscious, complaining of neck pain. Initial and repeated clinical examinations revealed no neurologic deficits. Radiographic investigation showed an avulsion fracture of the tip of the odontoid process and a horizontal fracture of the body of the axis. The fracture line extended posteriorly to the left pedicle (Figures 1, 2).

The patient was treated conservatively. Skull traction was applied for 6 weeks, followed by a Philadelphia collar for another 6 weeks. At this time, radiographic evaluation showed satisfactory fracture healing. Six months after the injury, dynamic radiographs showed healing of the fracture without any signs of instability (Figure 3). Twelve years after the initial injury, the patient is asymptomatic. The range of motion of the cervical spine is within the normal limits, with only mild restriction of the left flexion-rotation.

**Case 2.** A 66-year-old male was involved in a road traffic accident. The patient was the driver of the car and had a head-on collision into a roadside wall. The patient was not wearing his seatbelt. He was alert after the accident, and he was transferred to the local hospital. A week later, with the diagnosis of a C2 fracture (Figure 4), he was referred to the authors' institution for further evaluation and definite treatment.

At admission, the patient had painful and restricted neck motion, without any neurologic deficit. Computerized tomography (Figure 5) showed a transverse fracture of the body of the axis, with the fracture line extending from the anterior surface of the body to just below the pedicles. The patient was treated conservatively with skull traction for 6 weeks, followed by skeletal immobilization in a halo vest for another 6 weeks. At the latest follow-up, 3 years

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Figure 1. Lateral radiograph of the cervical spine shows the horizontal fracture of the body of C2.

after the initial injury, the patient had full range of motion of the cervical spine and no neurologic deficits. Radiographic evaluation showed solid union, with no instability or residual deformity of the axis (Figure 6).

#### ■ Discussion

The initial approach to understanding the mechanisms and biomechanics of axis fractures lies in the study of the external characteristics and anatomy of the axis. The external bony anatomy and dimensions of the axis have been the subject of several studies.<sup>1,9-12</sup> The internal anatomy of human bones is known to be related to their mechanical behavior and fracture mechanisms.<sup>13-14</sup> The architecture of the axis, distribution and strength of the

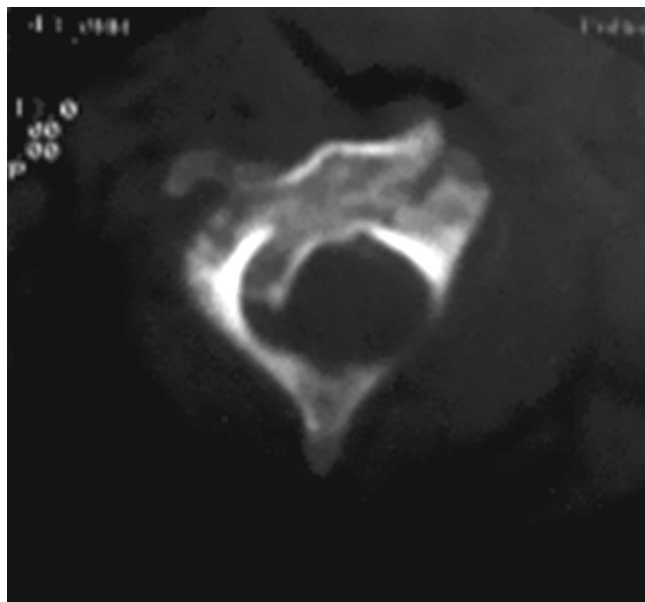


Figure 2. Computerized tomography shows extension of the fracture to the left pedicle.

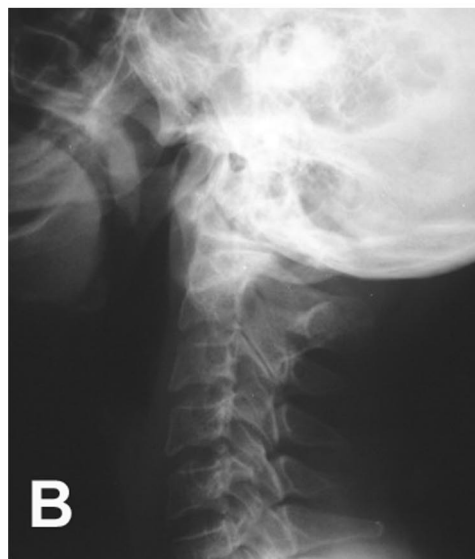


Figure 3. Six months after the injury, flexion (A) and extension (B) lateral radiographs of the cervical spine show fracture healing without any signs of instability.

bone trabeculae, and proportion and location of cortical bone, in addition to the magnitude of the applied forces and position of the axis at injury, lead to unique mechanical properties responsible for the specific patterns of axis fractures.<sup>15</sup> Investigation currently is focused on internal structural and architectural properties, especially on the qualitative bone characteristics of the axis.<sup>12-14,16</sup> In a recent study,<sup>16</sup> the age-related internal structural (quantitative and qualitative) properties of the axis were assessed to identify mechanically weak areas that relate to fracture patterns. A small area of trabecular bone with decreased density was found close to the anteroinferior edge of the body of the axis in the specimens from younger subjects. In contrast, a large area of trabecular bone with decreased density extending anteroinferiorly to superoposteriorly to the base of the dens was found in the specimens from older subjects.<sup>16</sup>



Figure 4. Lateral radiograph of the cervical spine shows the horizontal fracture of the body of the axis.

Benzel *et al*<sup>4</sup> classified the fractures of the body of the axis into 3 types: coronal, sagittal, and horizontal. The horizontal fracture is the previously described type III odontoid process fracture.<sup>4</sup> Based on standard radiographs, Fujimura *et al*<sup>5</sup> classified these fractures into 4 types: avulsion, sagittal, burst, and transverse.



Figure 6. Three years after the initial injury, lateral radiograph of the cervical spine shows union of the fracture with no residual deformity of the axis.

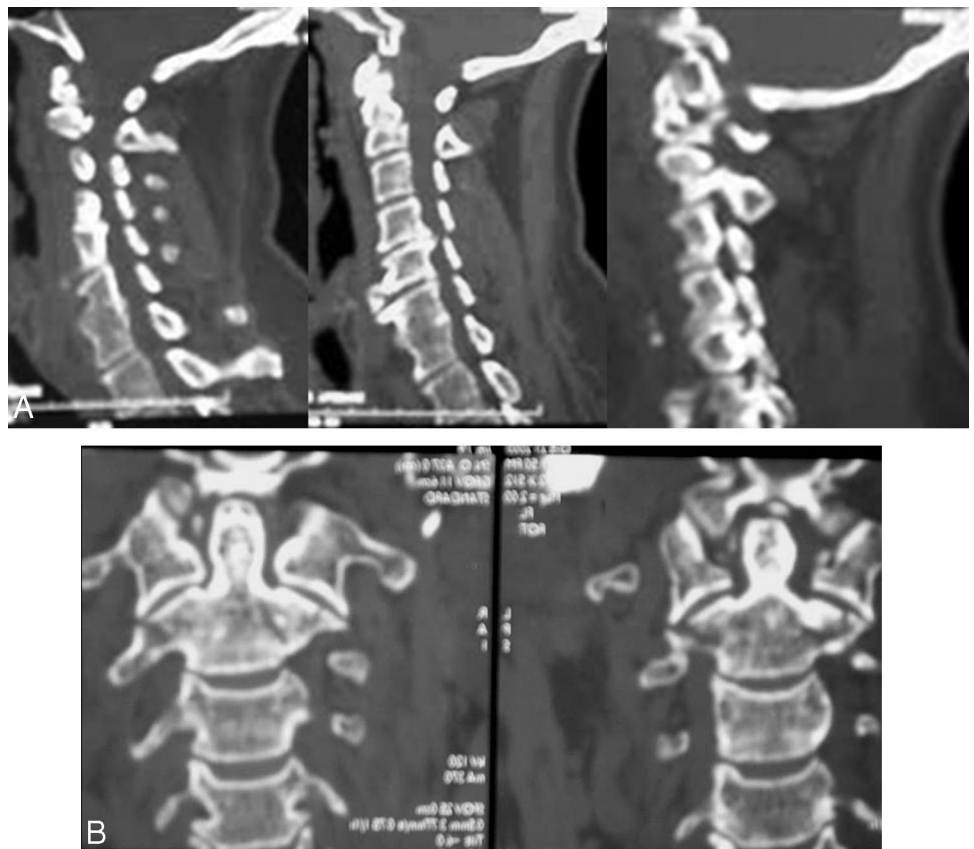


Figure 5. **A** and **B**, Computerized tomography shows the horizontal axis body fracture.

Horizontal axis body fractures are produced by hyperflexion and distraction<sup>7</sup> or hyperextension forces,<sup>6</sup> as in the current cases. In cases of hyperflexion and distraction, the fracture line extends horizontally from anteriorly to posteriorly, perpendicular to the lower surface of the body of the axis. In cases of hyperextension, the fracture line extends below the pedicles. Rarely, the fracture may extend even distally, to the neck of the posterior arch, in such a way that the posterior spinal elements will remain in continuity with the cephalic half of the body of the axis. In all cases, the ring of the axis remains intact. Therefore, the occurrence of neurologic deficits secondary to spinal cord injury is very rare.

Fujimura *et al*,<sup>5</sup> Jakin and Sweet,<sup>6</sup> and Maki<sup>7</sup> have reported satisfactory results using conservative measures in the treatment of patients with this type of injury. Union is usually uncomplicated, regarding that the fracture involves noncortical bone with uneven fragments. Skull traction for 6 weeks followed by the application of a cervical hard collar or a halo vest provides pain relief, rapid union, and long-term stability. In the present series, only 2 of the 674 patients (0.3%) with fractures of the cervical spine had a horizontal Chance-type fracture of the body of the axis. In both patients, nonoperative treatment led to union and a satisfactory functional result.

## ■ Conclusions

Horizontal fracture of the body of the axis is a rare, unstable injury. The direction of the applied injury force and the internal structure of the axis in relation to the age of the patient play an important role in the creation of this rare fracture pattern. Neurologic deficits are uncommon, and conservative treatment results in fracture healing and long-term stability.

## ■ Key Points

- A retrospective study was performed to identify horizontal, Chance-type fractures of the body of the axis.

- Two patients with a horizontal, Chance-type fracture of the body of the axis vertebra are presented. This accounts for 0.31% of the cervical spine fractures in the authors' institution.
- Conservative treatment proved effective in both patients.

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