Simultaneous anterior and posterior screw fixations confined to the axis for stabilization of a 3-part fracture of the axis (odontoid, dens, and hangman fractures)

Report of 2 cases

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Fractures of the axis are considered to be one of the most common injuries to the cervical spine, accounting for more than 20% of all cervical spine fractures. Multiple fractures of the axis are much rarer, accounting for 1% of all cervical fractures. Management of such complex fractures is still challenging, and there is no strong consensus for the treatment. The authors describe the cases of 2 patients who presented with 3-part fractures of the axis consisting of an odontoid Type II fracture and a Levine-Edwards Type IA fracture, which were treated with concurrent insertion of an anterior odontoid screw and bilateral posterior pedicle screws.

The cases presented were characterized by 1) a Type II odontoid fracture; 2) a Type IA traumatic spondylolisthesis with no or a little translation and angulation of C-2 on C-3 in a ring fracture of the axis; and 3) no disorders at the C2–3 disc on MR images. Therefore, the authors performed surgery confined to the axis by concurrently inserting an anterior odontoid screw and posterior bilateral pedicle screws without arthrodesis of C2–3. This was followed with cervical soft collar fixation for only 1–2 weeks. The outcomes were favorable, including good osteosynthesis, high primary stability, early patient mobilization, and preserved range of motion of the cervical spine at C2–3 as well as at C1–2.

Case Reports

Case 1

History and Examination. A 58-year-old man arrived at our hospital in an ambulance suffering from neck pain after a 1.5-m fall at a construction site. Although he had a wound on his forehead, which suggested a possible hyperextension injury of the neck, he had no neurological deficits. Plain radiographs and a CT scan showed a complex fracture of the axis consisting of an odontoid Type II fracture associated with a bilateral superior articular process fracture categorized as a Levine-Edwards Type II fracture.
IA fracture (anterior translation 2 mm, angular deformity 4°) (Fig. 1A–F). No evidence of disc disorders was seen on MR images (Fig. 1G and H).

**Operation.** Under fluoroscopic guidance, we positioned the patient supine and inserted an odontoid screw through the dens. We then moved the patient to a prone position and inserted bilateral pedicle screws.

**Postoperative Course.** After removal of the drains on Day 2, we allowed the patient to be mobilized. We removed the soft cervical collar on Day 14 after surgery. At the final follow-up 18 months after the operation, the patient had a normal cervical range of motion with no residual pain and was performing hard labor at a construction site. Plain radiographs and CT scans showed good bone union (Fig. 2), and MRI showed no sign of any C2–3 disc disorder.

**Case 2**

**History and Examination.** An 80-year-old man presented with neck pain after a fall while walking. He initially rode to another hospital by bicycle, but after complaining of unbearable neck pain, he was transferred to our hospital by ambulance. He also had a wound on his forehead but no neurological deficits. Plain radiographs and a CT scan demonstrated a complex fracture of the axis consisting of an odontoid Type II fracture associated with a bilateral superior articular process fracture categorized as a Levine-Edwards Type IA fracture (no translation, angular deformity 3°) (Fig. 3A–F). The disc remained intact at the C2–3 level (Fig. 3G and H).

**Operation.** Under fluoroscopic guidance, we placed an odontoid screw through the dens with the patient in a supine position, followed by insertion of bilateral pedicle screws with the patient in a prone position.

**Postoperative Course.** After removing the drainage tube on Day 2, the patient was allowed to walk. We removed the soft cervical collar on Day 7 after surgery because he refused to wear the collar for a 2nd week. Eighteen months after the operation, the patient felt no pain in his neck, had no limitation in neck range of motion, and was enjoying walking and bicycling. Plain radiographs and a CT scan showed that complete bone union had taken place (Fig. 4).

**Discussion**

In these 2 cases, we described the operative treatment of 3-part fractures of the axis consisting of an odontoid Type II fracture associated with a ring fracture of the axis, which we managed by concurrently inserting an anterior odontoid screw and bilateral posterior pedicle screws confined to the axis.

Daum and Archer first reported multiple fractures to the axis consisting of an odontoid fracture with traumatic spondylolisthesis, where a halo vest was used for the treatment. Korres et al. also reported multiple fractures of the axis, which consisted of a combination of traumatic spondylolisthesis and an odontoid process fracture; the patient was treated successfully with skeletal or Glisson-type traction, followed by immobilization with a Minerva or halo vest. However, the drawback of the conservative therapy is its longer duration, ranging from about 6 to 12 weeks.

On the other hand, due to the improvement of surgical techniques with more accurate imaging and surgical devices, treatment of isolated traumatic spondylolisthesis has become more aggressive but safer. In line with this trend, operative treatment has been proposed more often for multiple fractures of the axis as well.

Koller et al. reported a case of an atypical traumatic spondylolisthesis of C2–3 with a Type IIA fracture of the odontoid, a burst fracture of the left lateral mass of the...
Anterior and posterior screw fixation for fractures at C-2

Figure 2. Case 1. Postoperative images. A and B: Plain radiographs showing an odontoid screw and 2 pedicle screws in the axis. C–H: Sagittal (C–E) and axial (F–H) CT reconstructions obtained 18 months after the operation, demonstrating good positioning of the screws and excellent osteosynthesis.

Figure 3. Case 2. Preoperative images. A–F: Sagittal (A–C) and axial (D–F) CT reconstructions demonstrating a combined fracture with both a Type II odontoid fracture and a bilateral superior articular process fracture categorized as a Levine-Edwards Type IA fracture. G and H: Magnetic resonance images showing no disruption of the disc at C2–3.
axis, rupture of the disc at C2–3, and a stable posterior ring fracture of the atlas. Since the disc rupture at C2–3 was indicated on MRI, the authors performed surgery using a combination of anterior odontoid screw fixation and anterior fusion of C2–3 simultaneously with cervical collar fixation for only 10 days.

Blondel et al. also reported a Levine-Edwards Type IA fracture involving spondylolisthesis of C2–3 in association with an unstable odontoid Type IIA fracture. A Levine-Edwards Type IA fracture, first reported by Starr and Eismont, was defined as atypical and asymmetrical traumatic spondylolisthesis associated with the posterior cortex of the C-2 vertebral body; 3 months of immobilization in a Halo vest was the recommended treatment. Because of the achievement of early mobilization, Blondel et al. successfully performed the operation using a combination of an odontoid screw and C2–3 iliac bone fusion and plating with a semirigid cervical collar worn for only 3 weeks. Whether the disc disorder at C2–3 existed was not described.

If we had followed the traditional treatment, using a Halo vest or odontoid screw fixation followed by a neck collar would have been appropriate. Furthermore, if rupture of the disc at C2–3 existed, we would have performed anterior fusion at C2–3. However, our cases were characterized by 1) a Type II odontoid fracture; 2) a Type IA traumatic spondylolisthesis with no or a little translation and angulation of C-2 on C-3 in a ring fracture of the axis; and 3) no disorders at the C2–3 disc space on MR images, which is different from the cases reported by Koller et al. and Blondel et al. Therefore, we undertook an operative method confined to the axis by concurrently inserting an anterior odontoid screw and posterior bilateral pedicle screws without C2–3 arthrodesis. This was followed by cervical soft collar fixation for only 1–2 weeks. Our patients had favorable outcomes; enough stability of the fracture sites was achieved to allow for early mobilization, which led to preserving range of motion of the cervical spine at C2–3 as well as at C1–2, and good osteosynthesis was acquired.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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