CASE REPORT

Traumatic atlantoaxial dislocation with odontoid fracture: A case report

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Summary We are reporting the one-year follow-up for a case of traumatic atlantoaxial dislocation associated with an odontoid fracture. This injury combination is rare and serious because of its resulting instability. After an unsuccessful attempt at closed reduction with traction, an open reduction with occipitocervical fixation was performed using a posterior approach. Based on our experience and a review of the published literature, the method for managing such an injury is discussed. If closed reduction with traction is successful, subsequent treatment is based on the algorithms for isolated odontoid fractures. If the closed reduction fails, surgical treatment consists of an open reduction using a posterior or lateral retropharyngeal approach, and then fixation of C1-C2, which is the key procedure.

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Introduction

The combination of atlantoaxial joint dislocation and odontoid process fracture is a rare spine injury: only seven clinical cases have been described in the scientific literature [1–6]. The estimated frequency is less than 2% among upper cervical spine injuries [7]. This injury combination is serious because of the resulting instability. We are reporting on the one-year follow-up for a case that occurred in the context of a high-energy head injury. The goal is to discuss the management of this condition based on our experience and data in the published literature.

Case report

A 65-year-old male, with no history, was treated at our unit following an accident at home. The patient had fallen from a ladder onto his head 7 days earlier. He subsequently saw the referring physician because of persistent neck pain. During the clinical examination, the patient had a stiff head posture, was rotated to the right, but had no neurological problems. On cervical spine X-rays (Fig. 1) and CT scans (Fig. 2), the axis (C2) was fractured at the odontoid process; this was a type II fracture based on the Anderson and D’Alonzo classification [8] and it had a horizontal fracture line (HTAL) according to the Roy-Camille classifica-
tion [9]; the atlas (C1) was displaced posteriorly relative to C2. This fracture was associated with a Type IV rotational atlantoaxial dislocation based on the Fielding classification [10], so a posterior displacement with bilateral dislocation of the lateral joints. The remainder of the X-rays showed that the seventh cervical (C7) vertebra was fractured, but stable.

Conservative treatment consisted of axial traction with a halo head brace to attempt to reduce the atlantoaxial dislocation. Despite a progressive increase in weight for 15 days up to 7 kg of traction (about 10% of body weight), the joint was only partially reduced.

Because traction failed and pressure sores were developing on the head, we decided to perform surgery to reduce the dislocation and fix the C1-C2 joint. The patient was placed in ventral decubitus and a middle posterior approach was performed. The reduction was completed through a posterior C1-C2 joint approach. Since it was not technically possible to place screws into C1-C2 (due to poor visibility of the joint line between the two vertebra when the fluoroscope was in front), we decided to do an occipitocervical fixation. Screws were used with the Roy-Camille plate that went from the occiput to the fourth cervical vertebra (screw fixation in the articular processes) to provide fixation; an iliac cancellous bone graft was added into the C1-C2 space. The screws had good purchase in the occiput, C2, C3 and C4. Postoperative X-rays were satisfactory (Fig. 3), and showed that the C1-C2 joint was reduced and that the odontoid process was well aligned with the C2 vertebral body. Postoperative immobilisation consisted of using a flexible Minerva brace to reduce pain for 6 weeks.

At the one-year follow-up, the clinical picture was stable and X-rays found no fixation failure or secondary displacement. Despite the fixation system being very stiff, the patient had no major functional problems and dynamic

Figure 1  A/P X-rays of the cervical spine: mouth open.

Figure 2  A. CT scan of the cervical spine-coronal reconstruction. B. CT scan of the cervical spine-sagittal reconstruction.

Figure 3  Lateral X-rays of the cervical spine after the surgery.
### Table 1  Literature review of cases.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Date</th>
<th>Age and Gender</th>
<th>Mechanism</th>
<th>Time before diagnosis</th>
<th>Fracture type (Anderson)/Dislocation type (Fielding)</th>
<th>Neurological status</th>
<th>Initial treatment</th>
<th>Time before reduction outcome</th>
<th>Secondary treatment</th>
<th>Sequela</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autricque et al. [2]</td>
<td>1986</td>
<td>Male 45 years</td>
<td>Head injury (HI)</td>
<td>1 month</td>
<td>Type II/Type IV</td>
<td>Spastic tetraparesis</td>
<td>Halo traction</td>
<td>8 days</td>
<td>Halo-vest for 6 months</td>
<td>Not specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male 63 years</td>
<td>MWA HI</td>
<td>2 months</td>
<td>Type II/Not specified</td>
<td>Sphincter dysfunction Normal</td>
<td>Reduced under GA then Minerva</td>
<td>Recurred at 1 month</td>
<td>Posterior occipito-C3 fusion with iliac graft Minerva 3 months</td>
<td>6 months none</td>
</tr>
<tr>
<td>Fuentes et al. [1]</td>
<td>2001</td>
<td>Male 24 years</td>
<td>Defenestration with HI</td>
<td>Initially non-displaced fracture. At 1 month, fracture, dislocation 2 hours</td>
<td>Type II/Type IV</td>
<td>Normal</td>
<td>Anterior screw fixation of odontoid</td>
<td>Reduction of dislocation failed</td>
<td>Posterior C1-C2 fusion Minerva 3 months</td>
<td>Not specified</td>
</tr>
<tr>
<td>Spoor et al. [6]</td>
<td>2008</td>
<td>Male 43 years</td>
<td>Cervical trauma, fell off bike</td>
<td>2 hours</td>
<td>Type II/Not specified</td>
<td>Hemiparesis, right side</td>
<td>Halo traction</td>
<td>3 days</td>
<td>Halo-vest for 4 months</td>
<td>Normal neurological status at 3 weeks</td>
</tr>
<tr>
<td>Lenehan et al. [4]</td>
<td>2009</td>
<td>Female 63 years</td>
<td>MWA</td>
<td></td>
<td>Type II/Not specified</td>
<td>Extrapyramidal syndrome</td>
<td>Halo traction Failure</td>
<td></td>
<td>Open reduction Posterior transarticular fusion</td>
<td>Asymptomatic at 12 weeks</td>
</tr>
<tr>
<td>Hopf et al. [3]</td>
<td>2009</td>
<td>Female 15 years</td>
<td>Fell off horse</td>
<td></td>
<td>Type II/Type IV</td>
<td>Normal</td>
<td>External manoeuvre</td>
<td>Failure</td>
<td>Posterior transarticular fusion Bicortical iliac crest graft between C1-C2</td>
<td>Not specified</td>
</tr>
<tr>
<td>Oh et al. [5]</td>
<td>2010</td>
<td>Male 37 years</td>
<td>Direct cervical trauma</td>
<td></td>
<td>Type III/Not specified</td>
<td>Normal</td>
<td>Halo traction</td>
<td>2 days</td>
<td>Halo-vest for 3 months</td>
<td>Asymptomatic Normal mobility</td>
</tr>
</tbody>
</table>
X-rays showed good range of motion in flexion and extension; however, rotation was limited to 45° in each direction. He had no discomfort related to the material.

Discussion

The combination of atlantoaxial joint dislocation and odontoid process fracture is a rare: an epidemiological study found two cases out of 784 cervical spine injuries (of which 116 were upper cervical spine injuries) [7]. A review of the published literature found seven similar cases [1–6] (Table 1). In the reported cases, the injury combination always involved a Type IV C1-C2 dislocation based on the Fielding classification [10] and a Type II odontoid fracture in five cases or a Type III fracture in two cases, based on the Anderson and D’Alonzo classification [8].

However, an isolated stage IV C1-C2 dislocation secondary to trauma is possible: 10 cases were found in the published literature [11]. The injury mechanism is probably different: cervical hyperextension rather than isolated posterior translation. In three cases, closed reduction of the dislocation was successful with traction by a halo head brace starting 2 to 8 days after the injury event [1,3,6]. Bone union was then obtained through the use of a halo-vest for 3 to 6 months. In the other cases, after the closed reduction had failed, a surgical procedure was required; a middle posterior approach was used for the reduction and fusion of C1-C2 [1,3,4] or the occipitocervical joint [2]. No specific procedure was performed for the odontoid fracture, except in the case reported by Fuentes et al. [2], where the odontoid fracture was stabilized anteriorly with screws. However, this did not reduce the Type IV C1-C2 dislocation, but converted it to a Type I based on the Fielding classification; a second procedure was needed to reduce and fuse the C1-C2 joint using a posterior approach.

A closed reduction must be attempted using a halo head brace to provide traction. The weight is progressively increased up to 10% of bodyweight; Fielding and Hawkins [10] suggested that no more than 9 kg be used in adults.

If the reduction is successful, the focus is now on the C2 fracture; the surgical approach now follows the algorithm for an isolated odontoid fracture (Fig. 4). If the odontoid fracture is not displaced, conservative treatment with a Minerva brace for 3 months is possible and consistent with the now reduced C1-C2 dislocation. This is enough time for the cervical spine ligaments to heal (ligament healing time assumption is based on work performed by Lucas et al. [11]). Conversely, if the odontoid fracture is displaced or unstable, surgical anterior screw fixation of the odontoid is needed (in French anagram for Oblique Below and backward [OBAR] or horizontal fracture [HTAL] type fractures) [12]. French anagram for Oblique Below and Forward (OBAV) type fractures have never been reported to occur in combination with C1-C2 dislocation.

If the closed reduction fails, attempting to reduce the joint with external manoeuvres while the patient is under general anaesthesia is dangerous in our opinion, because of the location of the injury. Botelho et al. [13] and Silbergeld et al. [14] reported that three deaths occurred because of these manoeuvres. This method requires the use of an image intensifier, which has been associated with the study of somatosensory evoked potentials. The most reliable reduction is performed surgically. Either a posterior or lateral approach can be used.

The posterior approach has multiple advantages: it allows access to the posterior joint when the dislocation is posterior and allows for screw fixation of C1-C2 [15]. If problems are encountered, occipitocervical fixation can still be performed. However, this approach does not provide good exposure of the articular processes, which are hard to access. Muscle layers must be detached and reflected laterally, which increases the risk of venous bleeding.

A unilateral or bilateral lateral retropharyngeal approach, described by De Andrade and Macnab [16], could allow an anterior transarticular fusion to be performed with the patient in dorsal decubitus. This surgical approach provides a direct approach to the C1-C2 joint and the possibility of C1-C2 reduction and transarticular fusion by Magerl transarticular screw fixation.
screw fixation. The C1-C2 joint space is freshened, and then oblique screw fixation is performed from caudal to cranial and outside to in, perpendicular to the joint line. It also avoids having to move the patient from dorsal decubitus (needed for the orotracheal intubation) to the ventral decubitus (indicated for the posterior approach) — a movement that puts the patient at risk neurologically.

Anterior transarticular fusion has not been commonly used or evaluated as a fixation method, despite promising results. It was first described by Barbour in 1971 [17], Du Toit [18], then Roy-Camille et al. in 1982 [19]. It is mostly used to perform C1-C2 fusion as a treatment for atlantoaxial instability [20].

Once the C1-C2 has been reduced and fixed surgically, screw fixation of the odontoid process is no longer indicated. Removal of the fixation material can be discussed after the surgical procedure once the odontoid has healed, and will depend on the patient’s tolerance for the implanted hardware.

Conclusion

The combination of atlantoaxial joint dislocation and odontoid process fracture is a rare injury. A closed reduction of the dislocation must be attempted. Once the dislocation is treated, treatment of the odontoid fracture is determined based on its reduction and stability (conservative treatment or direct screw fixation). If the reduction fails, an open reduction must be performed through a posterior approach with Magerl-type C1-C2 fixation; if this is not possible, occipitocervical fixation is performed. The rarely-used lateral approach has an advantage in this indication, because the atlantoaxial joint exposure is excellent and the option exists to perform anterior transarticular fusion.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References