Odontoid fractures anterior screw fixation: A continuous series of 36 cases

C. Eap, L. Barresi, X. Ohl*, R. Saddiki, C. Mensa, K. Madi, E. Dehoux

Introduction: Fracture of the odontoid process represents 5 to 15% of cervical spine fractures. Anterior screw fixation is the reference technique in unstable posterior oblique or horizontal odontoid fracture.

Objective: We describe results with an original anterior screw fixation technique using a curved thoraco-lumbar pedicle awl to facilitate intra-operative reduction.

Patients and methods: This is a retrospective study of 36 consecutive patients who underwent anterior screw fixation for odontoid process fracture. Mean age was 70.3 years. Twenty-six patients had type II and 10 type III fracture on the Anderson-D’Alonzo classification. On the Roy-Camille classification, there were 34 posterior oblique fractures and two horizontal fractures. There were no anterior oblique fractures. Bony union was assessed on CT-scan at 3 months. We describe the surgical technique, which used a 4.5 mm cannulated cancellous lag screw in all cases.

Results: Mean follow-up was 3 years (range, 4 months to 8 years). No intra-operative complications were observed. Union rate was 95% and the average time to union was 5 months (3 to 6 months).

Discussion: Anterior screw fixation is a common surgical treatment for posterior oblique and horizontal odontoid process fractures. We detail a reliable and reproducible intra-operative reduction maneuver to obtain a good union rate without complications.

Level of evidence: Level IV. Retrospective therapeutic study.

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possibly with associated posterior C1–C2 arthrodesis was the only surgical option in case of displaced fracture [2]. Bohler, in 1982, performed the first anterior screw fixation [3], providing an alternative attitude better adapted to posterior displacement. Indications and surgical techniques have since evolved, and anterior screwing is now, where feasible, the most widely used osteosynthesis technique. It conserves the mobility of the C1–C2 joint, which provides 50% of cervical spine rotation. It also obviates the need for a posterior approach, which is much more damaging to the muscles, often inducing chronic cervicalgia. There are variants on the technique, some teams using two screws and others crossing the superior odontoid cortical.

The present retrospective study presents our results and the development of our surgical technique, which uses a curved thoraco-lumbar pedicle awl to facilitate intra-operative reduction of the fracture site.

**Patients and methods**

**The series**

Between 1999 and 2006, 67 patients were operated on for odontoid fracture in our department; 40 were managed by anterior screwing. Comorbidity based on the American Society of Anesthesiologists (ASA) classification was ASA-1 in four patients, ASA-2 in 11 and ASA-3 in 25. Four patients died at a mean 2.5 months postoperatively, too early for union to be assessed. These deaths, at a mean age of 75 years, were unrelated to the spinal fracture; one patient was classified as ASA-2 and 3 as ASA-3.

Thirty-six patients (21 female, 15 male; mean age: 70.3 years, range 16.8–94.9) had clinical and radiological follow-up. Etiologies comprised nine road accidents and 27 falls. The mean age of road-accident victims was 31.6 years (16.8–80.1) and of fall victims 82.5 years (65.2–94.9). On the 1974 Anderson-d’Alonzo classification [4], 18 patients were type II and 8 type III. On the 1973 Roy-Camille classification [5], 34 patients presented with an oblique posterior fracture and two with a horizontal fracture. There were no cases of anterior oblique fracture.

Five patients presented with neurologic disorder at diagnosis. Four cases involved cognitive disorder (confusion and disorientation); one patient had tetrarapsis with brachial predominance. Cases involving associated fracture (bipedicle C2, Jefferson, C2 lamina and spine, or double C1 posterior arch fractures) were excluded from this study. Two cases of late-diagnosed severe inferior cervical spine sprain underwent secondary anterior arthrodesis.

**Surgical technique**

All patients were operated on using the same technique. Surgery was performed under general anesthesia, in dorsal decubitus, with the head held in neutral position by a Gardner clamp. A single-plane image intensifier was swung through 90° so as to give AP and lateral views of the odontoid process. We used a right unilateral anterior approach at C4–C5 [6], incision extending down to the superior edge of the sternum to allow instruments to be held as horizontally as possible with respect to the spinal axis. The right middle thyroid pedicle was conserved whenever possible. The C2–C3 joint space was located on fluoroscopy and partial corpectomy of the antero-superior C3 angle was performed, conserving the C2–C3 disk as well as possible. This technique exposed the anterior extremity of the inferior C2 body plate, where the entry point was marked using a pick. A tunnel was then created in the C2 body up to the cranial odontoid fragment, using a 2 mm-diameter thoraco-lumbar pedicle awl (Fig. 1a and b). Rotation of the curved awl optimized reduction of the distal odontoid fragment under AP and lateral fluoroscopy.

A guide K-wire was positioned in the tunnel to guide drilling, unless the tunnel was already well-formed by the pedicle probe. A 4.5 mm-diameter stainless steel cannulated cancellous lag screw was then positioned under fluoroscopy (Fig. 2). Our experience has always involved using a single screw.

Postoperative immobilization in a rigid neck brace was for 3 months; in bedridden patients, a simple flexible brace was sometimes used, to avoid pressure scarring.

**Clinical and X-ray assessment**

Local and general peri-operative complications were examined. Postoperative neurological assessment was systematic.


Union was assessed on clinical and X-ray follow-up at 6 weeks, 3 months, 6 months and 1 year and then annually. Immediate post-operative CT scan with sagittal reconstruction was systematic (Fig. 3), and repeated at 3 months and then every 3 months until union was achieved.

**Results**

Mean follow-up was 3 years (range, 4 months–8 years). No post-operative complications were observed.

All cases with pre-operative confusion or disorientation showed favorable immediate postoperative evolution.
Figure 2  Introduction of a 4.5 mm cannulated cancellous lag screw under lateral (2A) and AP (2B) fluoroscopic views.

Figure 3  Postoperative sagittal CT reconstruction.

At last FU, the patient with tetraparesis with brachial predominance showed slight paresthesia of the extremities; late MRI found a syringomyelic cavity.

On CT scan, odontoid fracture union was obtained in 35 cases out of 36 (2 horizontal and 33 posterior oblique fractures), at a mean 5 months (range, 3–6 months). One 77 year-old patient with posterior oblique fracture treated by osteosynthesis on day 6, showed subsequent non-union and underwent posterior C1–C2 arthrodesis.

The rate of union was 95%. At last FU, no cases of screw mobilization were observed.

Discussion

Depending on the author, anterior screwing is used in horizontal, anterior oblique or posterior oblique fractures. Apfelbaum, (2000), in a follow-up of 129 patients with recent odontoid fracture, found significantly higher non-union rates in case of anterior oblique fracture compared to the other forms [7]. Likewise, Dantas, (2002) reported 94% union in posterior oblique and horizontal fracture and advised against anterior screwing in anterior oblique fractures [8].

Postoperative immobilization attitudes vary greatly between literature series. Some authors prescribe no immobilization [7], others use flexible braces [1] and others again, like ourselves, recommend rigid braces [1,9,10]. Ivancic, in a recent biomechanical study, found improved fracture-site stabilization with an association of anterior screwing and strict immobilization by thoracic halo [11]. Koller et al. reported no significant difference in atlo-axoid immobilization as obtained by thoracic halo or by Philadelphia occipito-cervico-mandibular collar [12].

The rate of union in the present series was 95% for those patients with clinical and X-ray follow-up. Table 1 compares this rate with those of the most recent literature series [7–10,13–15]. Several parameters may account for such good results. Firstly, strict selection: anterior screwing was indicated only for posterior oblique or horizontal fractures on the Roy-Camille classification. Secondly, the reduction technique using a curved pedicle awl enabled reduction without peroperative maneuver, by adjusting the traction on the Gardner clamp in case of persistent reduction defect in the sagittal plane; this usually enables excellent reduction with optimal bone-bone contact, facilitating bone union [16]. Finally, 3 months’ immobilization by occipito-cervico-

Table 1  Comparison of literature series.

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>Union rate (%)</th>
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<tbody>
<tr>
<td>Borm et al., 2003 [9]</td>
<td>26</td>
<td>74</td>
</tr>
<tr>
<td>Alfieri, 2001 [15]</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>Subach et al., 1999 [14]</td>
<td>26</td>
<td>96</td>
</tr>
<tr>
<td>Dantas et al., 2002 [8]</td>
<td>15</td>
<td>94</td>
</tr>
<tr>
<td>Lee and Sung, 2006 [10]</td>
<td>20</td>
<td>85</td>
</tr>
<tr>
<td>Present series, 2009</td>
<td>36</td>
<td>95</td>
</tr>
</tbody>
</table>
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thoracic brace provided excellent atlo-axoid neutralization, further facilitating union.

According to the literature, age seems to be a major factor in the efficacy of anterior screwing. Platz et al., (2007), comparing results of anterior screwing in 110 patients with either horizontal or posterior oblique odontoid fracture, found significantly more non-union in the over-65 year-old age group, whereas cervical spine mobility did not differ between the two groups [17]. The present series, however, did not disclose any correlation between patient age and bony union.

Arand, (2001), in a series of 58 patients, reported many potential peroperative complications [18], whereas there were no particular such complications in the present series. A minimally invasive endoscopic technique was reported by Hashizume et al. [19], but with a risk of esophageal wound that we consider serious enough to exclude such an attitude in these indications.

The technique usually described in the literature involves bicortical fixation to compress the fracture site, but this can entail complications, especially neurological, due to guidewire migration beyond the apex. We recommend unicortical fixation by a cannulated cancellous lag screw, which ensures good stability of assembly. As the peri-odontoid ligaments were generally conserved despite fracture, we observed no malunion in rotation. Biomechanical studies, however, have shown assembly resistance to be greater using a fully threaded cortical screw or headless fully threaded variable-pitch screw compared to a partially threaded cancellous compression screw [20]. The various series show no significant difference between the use of one or two screws [7,21]. Biomechanical studies have previously shown that using two screws does not improve stability and resistance, whereas, by reducing the bone-bone contact area, it may hinder union [7,22,23].

The limitations of the present study lie in its retrospective design and the lack of clinical data on cervical spine mobility. On the other hand, bone union was systematically and satisfactorily assessed on CT: Koller et al. recently demonstrated that simple X-ray assessment of odontoid fracture bony union is unreliable [24].

Conclusion

Odontoid fractures make up 5 to 15% of cervical spine fractures. Anterior screwing is a satisfactory technique in case of horizontal or posterior oblique fractures, conserving C1—C2 joint mobility.

We describe a technique of peroperative reduction of odontoid fracture using a curved thoraco-lumbar pedicle awl which, combined with the use of a single 4.5 mm-diameter cannulated cancellous compression screw, provided a CT union rate of 95%, with no peroperative complications. This technique thus appears to be reliable and reproducible.

Conflict of interest statement

None.

References

[22] McBride AD, Mukherjee DP, Kruse RN, Albright JA. Anterior screw fixation of type II odontoid fractures. A biomechani-