Anterior Odontoid Screw Fixation for the Treatment of Type 2 Odontoid Fracture with a Kyphotic Angulation or an Anterior Down-slope: A Technical Note

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Abstract

Anterior odontoid screw fixation (AOSF) is difficult and challenging to perform in patients with type 2 odontoid fracture with a kyphotic angulation or an anterior down-slope. To demonstrate two surgical techniques to resolve kyphotic angulation or difficult fracture direction issues. Anterior odontoid screw fixation was performed in two patients with type 2 odontoid fracture with a kyphotic angulation or an anterior down-slope. This technique can avoid sternal blocking using a percutaneous vertebroplasty puncture needle, and can reduce the kyphotic angle using a Cobb elevator in patients with type 2 odontoid fractures with a kyphotic angulation or an anterior down-sloped fracture. In both the patients, AOSF was successfully performed and a successful clinical outcome was achieved. The screws were well-maintained with reduced fracture segment and well-preserved, corrected kyphotic angles were achieved, as observed on cervical X-ray 6 months postoperatively. Our technique is a safe and effective method for the treatment of type 2 odontoid fracture with a kyphotic angulation or an anterior down-slope.

Key words: anterior odontoid screw fixation, type 2 odontoid fracture, kyphotic angulation, anterior down-slope

Introduction

Immobilization using a rigid brace or halo vest is associated with high morbidity and significant failure rates in the treatment of type 2 odontoid fractures. Although several surgical stabilization options are currently available, direct anterior odontoid screw fixation (AOSF) provides immediate stability, high fusion rate, and cervical rotation preservation.1–7 However, AOSF should be avoided in patients with severe osteoporosis, comminution, severe angulation, or displacement.1,4,8 In addition, AOSF is difficult and challenging to perform in patients with type 2 odontoid fractures with a kyphotic angulation or an anterior down-slope.9–11 Here, we have described two challenging cases wherein the kyphotic angulation and difficult fracture direction were resolved.

Methods and Surgical Techniques

Anterior odontoid screw fixation was performed in two patients with type 2 odontoid fracture with a kyphotic angulation or an anterior down-slope.

Patient 1 had an anterior down-sloped fracture

A 49-year-old male presented to our emergency center after experiencing trauma related to neck pain since the past 1 day. Sagittal reconstructed computed tomography (CT) revealed type 2 odontoid fracture in an anterior down-sloped direction. The odontoid tip had anteriorly slipped by 3 mm and was distracted by 3 mm. As previously described, when using the anterior–inferior corner of the C2 body as the starting point, simultaneous firm fixation of the anterior wall of the C2 body and odontoid tip is difficult to achieve (Fig. 1a).5,11 In this case, the only way to achieve these two goals was to use the deeper inferior endplate as the starting point. However, it is considered to be more difficult to insert the probe without disturbing the sternal wall (Fig. 1b). Thus, we decided to use a percutaneous vertebroplasty puncture (PVP) needle instead of a...
straight pedicle probe, which has been previously used,\textsuperscript{11} to avoid disrupting the sternal blocking. In addition, we used the deeper inferior endplate of the C2 body as the starting point (Fig. 1c). The PVP needle is shorter than the pedicle probe, and its handle portion is relatively flat, which enabled us to lay it flat on the body surface. Using the PVP needle, the starting point was positioned as deeply as possible in the inferior endplate, thereby allowing an increase in the needle insertion angle at the starting point. The screw could then be inserted without sternal blocking (Fig. 1d). We performed a bicortical fixation and obtained reduction of the displacement of the odontoid tip with a 4.0 × 40-mm lag screw and avoided disturbing the sternal blocking using a 64° angle (Fig. 1e).\textsuperscript{3,11} The day following the surgery, the patient could move without any brace and without any complaint of neck pain, with a Numeric Rating Scale (NRS) pain score of 3. The NRS neck pain score at 6 months postoperatively was 1. Moreover, the patient’s neck moved freely, and he was highly satisfied with the outcome.

**Patient 2 had a kyphotic angulated fracture**

The second patient was a 41-year-old male who presented to our emergency center with neck pain that had developed on the same day. His X-ray and CT examination revealed a shallow type 3 odontoid fracture with a kyphotic angulation of 9° (Fig. 2a). Under general anesthesia during surgery, positional reduction through a neck extension allowed 5° angle reduction, but 4° angle of kyphosis remained (Fig. 2b). Thus, we pushed the Cobb elevator to the anterior wall of the odontoid body and struck at it with a hammer to obtain better reduction (Fig. 2c). After achieving a further reduction of 3°, a 40-mm bicortical lag screw was inserted. The patient’s neck pain improved, and his NRS pain score was graded to be <3 on the day following the surgery. At the 6-month follow-up, he showed no neck pain and his neck moved freely. X-ray imaging revealed a remaining kyphosis of 1° (Fig. 2d).

**Discussion**

There are various techniques for the treatment of type 2 odontoid fractures. Some authors have suggested conservative treatments for type 2 or shallow type 3 odontoid fractures. However, these treatments result in a high rate of nonunion, with the potential danger of developing myelopathy or loss of neck motion. Thus, early surgical treatment...
is recommended for patients with type 2 or shallow type 3 odontoid fractures.12)

Anterior odontoid screw fixation and posterior cervical instrumented fusion (PCIF) are both well-accepted techniques for surgical treatment. However, several absolute and relative contraindications have been reported regarding them.12) For example, PCIF results in the loss of atlantoaxial rotation, requiring prone positioning and warranting a longer duration of surgery compared to AOSF. Obtaining postoperative neck motion preservation is significantly beneficial. We believe that posterior C1–2 arthrodesis can be possible even if we fail in the anterior motion preserving surgery. Thus, we suggest that anterior surgery should always be considered priority.

However, the utility of AOSF is limited by nonreducible fractures, fragment geometry, or body habitus, such as a barrel-shaped chest, short neck, and cervical or thoracic kyphosis, which may inhibit the proper trajectory for screw placement.1,9) In addition, some authors have reported that fracture line orientation also affects the procedural success. Subach et al.13) concluded that sagittal oblique (anterior down-slope) fractures should be considered as a contraindication for AOSF. In fact, they suggested that posterior atlantoaxial stabilization could yield good long-term results.8,14) However, it remains debatable whether an anterior down-sloped fracture orientation is a contraindication to AOSF, as considered by different authors and applicable for patient 1 in our study.8)

Anterior odontoid screw fixation has several advantages over posterior C1–2 arthrodesis, such as less surgically induced soft-tissue trauma, no requirement for bone grafting, lower risk of injury to the vertebral arteries, and the preservation of C1–2

![Fig. 2 (a) CT and X-ray examination showing a shallow type 3 odontoid fracture and kyphotic angulation of 9°. (b) C-arm lateral view; positional reduction through neck extension reduced the kyphosis by 5° with 4° of kyphosis remaining. (c) Using a Cobb elevator to reduce kyphosis by another 3° angle. (d) Three months after surgery, C-spine X-ray (lateral view) showing 1° of remaining kyphosis.](image)
rotational motion.\textsuperscript{1–7} The reason for not performing AOSF include inconvenience in obtaining sufficient bony engagement due to the anatomical sternal blocking in the anterior down-sloped fracture and proper reduction in the kyphotic angulated fracture. However, we could avoid sternal blocking using a PVP needle and by reducing the kyphotic angle using a Cobb elevator in patients with type 2 odontoid fractures with a kyphotic angulation or an anterior down-sloped fracture. Therefore, we attempted to develop tips to overcome the abovementioned limitations while maximizing the advantages of AOSF.

In this paper, we have reported a technique to overcome kyphotic angulation or anterior down-sloped fracture using AOSF. We used a PVP needle to avoid sternal blocking (patient 1) and a Cobb elevator to further correct the kyphotic angulation after positional reduction through neck extension (patient 2). In patient 1, the short length and flat handle of the PVP needle was used to avoid sternal blocking, allowing the starting point to be as deep as possible in the inferior endplate with a greater insertion angle, particularly in the velvet direction, which allowed the needle to move ventrally as it went up. Thus, we demonstrated the possibility of proceeding in a vertical direction engaging as many odontoid tips as possible. In patient 2, the angle was reduced by a position change, but a greater reduction angle was necessary to insert the screw easily and effectively. Accordingly, we pushed the Cobb elevator to the anterior wall of the odontoid body and struck it with a hammer to obtain better reduction. PCIF is usually performed in type 2 odontoid fractures with a kyphotic angulation or an anterior down-slope. However, we believe that our AOSF technique is advantageous in preserving the motion between C1 and C2 vertebra.

**Conclusion**

Our proposed technique using a PVP needle and a Cobb elevator was confirmed to be safe and effective for the treatment of type 2 odontoid fractures with a kyphotic angulation or an anterior down-sloped fracture direction issues.

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**Conflicts of Interest Disclosure**

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

**References**

1) Andersson S, Rodrigues M, Olerud C: Odontoid fractures: high complication rate associated with anterior screw fixation in the elderly. Eur Spine J 9: 56–59, 2000
2) Denaro V, Papalia R, Di Martino A, Denaro L, Maffulli N: The best surgical treatment for type II fractures of the dens is still controversial. Clin Orthop Relat Res 469: 742–750, 2011
3) Koivikko MP, Kiuru MJ, Koskinen SK, Myllynen P, Santavirta S, Kivisaari L: Factors associated with nonunion in conservatively-treated type-II fractures of the odontoid process. J Bone Joint Surg Br 86: 1146–1151, 2004
4) Montesano PX, Anderson PA, Schlehr F, Thalgott JS, Lowrey G: Odontoid fractures treated by anterior odontoid screw fixation. Spine (Phila Pa 1976) 16: S33–S37, 1991
5) Polin RS, Szabo T, Bogaev CA, Replogle RE, Jane JA: Nonoperative management of types II and III odontoid fractures: the Philadelphia collar versus the halo vest. Neurosurgery 38: 450–456; discussion 456–457, 1996
6) Tashjian RZ, Majercik S, Biffi WL, Palumbo MA, Cioffi WG: Halo-vest immobilization increases early morbidity and mortality in elderly odontoid fractures. J Trauma 60: 199–203, 2006
7) White AP, Hashimoto R, Norvell DC, Vaccaro AR: Morbidity and mortality related to odontoid fracture surgery in the elderly population. Spine (Phila Pa 1976) 35: S146–S157, 2010
8) Apfelbaum RI, Lonser RR, Veres R, Casey A: Direct anterior screw fixation for recent and remote odontoid fractures. J Neurosurg 93: 227–236, 2000
9) Cho DC, Sung JK: Is all anterior oblique fracture orientation really a contraindication to anterior screw fixation of type II and rostral shallow type III odontoid fractures? J Korean Neurosurg Soc 49: 345–350, 2011
10) Subach BR, Morone MA, Haid RW Jr, McLaughlin MR, Rodts GR, Comey CH: Management of acute odontoid fractures with single-screw anterior fixation. Neurosurgery 45: 812–819; discussion 819–820, 1999

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11) Park JH, Kang DH, Lee MK, et al.: Advantages of direct insertion of a straight probe without a guide tube during anterior odontoid screw fixation of odontoid fractures. *Spine (Phila Pa 1976)* 41: E541–E547, 2016

12) Joaquim AF, Patel AA: Surgical treatment of type II odontoid fractures: anterior odontoid screw fixation or posterior cervical instrumented fusion? *Neurosurg Focus* 38: E11, 2015

13) Agrillo U, Mastronardi L, Puzzilli F: Management of acute odontoid fractures with single-screw anterior fixation. *Neurosurgery* 47: 794, 2000

14) Dailey AT, Hart D, Finn MA, Schmidt MH, Apfelbaum RI: Anterior fixation of odontoid fractures in an elderly population. *J Neurosurg Spine* 12: 1–8, 2010

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