Case Report

Posterior transodontoid fixation: A new fixation (Kotil) technique

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Abstract

Anterior odontoid screw fixation or posterior C1-2 fusion techniques are routinely used in the treatment of Type II odontoid fractures, but these techniques may be inadequate in some types of odontoid fractures. In this new technique (Kotil technique), through a posterior bilateral approach, transarticular screw fixation was performed at the non-dominant vertebral artery (VA) side and posterior transodontoid fixation technique was performed at the dominant VA side. C1-2 complex fusion was aimed with unilateral transarticular fixation and odontoid fixation with posterior transodontoid screw fixation. Cervical spinal computed tomography (CT) of a 40-year-old male patient involved in a motor vehicle accident revealed an anteriorly dislocated Type II oblique dens fracture, not reducible by closed traction. Before the operation, the patient was found to have a dominant right VA with Doppler ultrasound. He was operated through a posterior approach. At first, transarticular screw fixation was performed at the non-dominant (left) side, and then fixation of the odontoid fracture was achieved by directing the contralateral screw (supplemental screw) medially and toward the apex. Cancellous autograft was scattered for fusion without the need for structural bone graft or wiring. Postoperative cervical spinal CT of the patient revealed that stabilization was maintained with transarticular screw fixation and reduction and fixation of the odontoid process was achieved completely by posterior transodontoid screw fixation. The patient is at the sixth month of follow-up and complete fusion has developed. With this new surgical technique, C1-2 fusion is maintained with transarticular screw fixation and odontoid process is fixed by concomitant contralateral posterior transodontoid screw (supplemental screw) fixation; thus, this technique both stabilizes the C1-2 complex and fixes the odontoid process and the corpus in atypical odontoid fractures, appearing as an alternative new technique among the previously defined C1-C2 fixation techniques in eligible cases.

Key words: Odontoid fracture, posterior transodontoid, screw fixation kotil technique

INTRODUCTION

Since Mixter and Osgood have performed the first surgical procedure for atlantoaxial instability, numerous new techniques were described. Anterior odontoid screw fixation may be adequate for nondisplaced uniform fractures with no transverse ligament rupture, but some cases necessarily require the fusion of C1-2 complex. The most serious complication of the posterior techniques, especially of transarticular screw fixation, is vertebral artery (VA) injury. After Grob and Magerl had announced better outcomes with transarticular screw fixation compared with wiring techniques, Goel and Laheri have defined the C1-C2 plate and screw fixation technique avoiding the VA in the last decade to reduce the VA injury risk this technique harbors. But still, the dominant VA may be injured during the surgical procedure or dissection itself rather than the screw...
posterior transodontoid fixation. Moreover, this technique has its own possible complications. Thus, the surgical techniques for C1-2 fusion are still challenging because of VA injury.

Bilateral transarticular screw placement technique may be problematic in some complex C2 fractures, atypical odontoid fractures, and high-riding VA. In such cases, some authors recommend unilateral transarticular screw placement and fusion at the non-dominant VA side. It was reported previously that fixation and fusion of the C1-2 complex is maintained after safe transarticular screw placement at the non-dominant VA side. But with this technique, resorption of the broken odontoid or reduction of the dislocation is not possible. Thus, we report our technique with the proposition of the fixation of the C1-2 complex by transarticular screw placement and reduction of the broken odontoid by contralateral posterior transodontoid screw fixation providing stabilization at the same time.

**CASE REPORT**

A 40-year-old male patient involved in a motor vehicle accident had only neck pain in his neuromuscular examination. Odontoid fracture from the neck extending to the superior part of the corpus was seen in the cervical roentgenogram. Three-dimensional (3D) cervical spinal computed tomography revealed that the oblique odontoid fracture extending to the apex of the corpus was comminuted sagittal image and axial image. Magnetic resonance imaging arose the suspicion of posterior longitudinal ligament rupture, and showed that the atlantoaxial interval was about 6 mm. Dislocation was not reduced by closed traction. Doppler ultrasonography demonstrated the VA was dominant at the right side where the fracture was more prominent and displaced. The dominant VA being on the right side with a fracture at the corpus extending medially, posterior longitudinal ligament rupture and anterior dislocation of the odontoid necessitated a left C1-2 transarticular screw placement followed by contralateral odontoid fixation by posterior transodontoid screw placement with a supplementary screw directed medially [Figure 3a] and toward the apex [Figure 3b]. The entry point of the supplementary screw is 2 mm lateral compared with the other side. Cancellous autograft was scattered for fusion without the need for structural bone graft or wiring. The patient is at the sixth month of follow-up, he is pain-free, and complete fusion has developed. Direct flexion and extension graphs were normally at this period. The follow-up time is 26th month.

**The surgical technique**

Detailed 3D anatomical evaluation of the VA and the transverse foramina is necessary to determine VA and bony anatomy. The patient is placed in prone position, head neutral at the midline. After the lateral masses of C1 and C2 are exposed, first C2 entry point is determined and transarticular screw is placed as in the routine procedure. Generally, 45 ± 3 x 4 mm screw is suitable. In our opinion, this technique may provide better outcome in anteriorly displaced oblique fractures. If the fracture is displaced, it must be reduced with an manual reduction maneuver of intraoperative manipulation. Then, contralateral entry point is drilled at a point 2-mm lateral and 1-mm inferior compared with the first one [Figure 3]. This change in the entry point provides the screw to be more medially directed to the odontoid process. If necessary, a minilaminotomy can be performed to control any penetration into the spinal canal. Especially in fractures extending to the corpus (Type III), one can reach a point between the displaced bone fragments or a soft tissue gap; if this happens, the screw must be controlled in order not to be on the VA; but anyway, the screw is directed medially toward the spinal canal to avoid the VA. While the screw is placed from the pedicle entry point to the apex of the odontoid, it may perforate the medial side of the pedicle but this is unimportant; in fact, in complicated fractures, this is a necessary maneuver to avoid the VA. Dural contact or bleeding due to pedicle perforation can be controlled easily by controlling the canal with a dissector. All these are shown tomographically and as drawings in Figure 4 (a-h). According to Steel ratio, medulla spinalis comprises only 1/3 of the spinal canal at this level. Intraoperative scopy control must be performed bplaranly. Both illustration and cadaver studies are presented in Figures 5 a and b. Then, cancellous autograft is scattered after decortication of the posterior elements and the operation is ended after the placement of a drain. The patients do not need to use collar after the operation. Thus, with both screw placement techniques, the VA is avoided and a strong fixation and fusion is provided. Fusion can be seen at the follow-up time in 6 months [Figure 6].

**DISCUSSION**

Odontoid fractures comprise 10 to 15% of all cervical spinal fractures and because of the very complex anatomy of the upper cervical region and the possible complications of the treatment procedures, there are sometimes hesitations. There is no single universally accepted method of management of type II fracture. Odontoid fractures have been divided into three types by Anderson and D’Alonzo and about 60% are Type II fractures. Type II fractures are unstable and about 6% carry morbidity and mortality risk. Type II fractures are important surgically and Apfelbaum et al. have described three different Type II fractures based on the direction of the fracture line: type IIa, where the line is anterior oblique; type IIb, where the line is posterior oblique; and type IIc, where the line is horizontal. When unstable odontoid fractures are treated nonsurgically, they harbor non-union risk and may become chronic odontoid fractures after 6 weeks. Oblique anterior odontoid fractures are prone to displacement and are not suitable for anterior approach, posterior approach should be preferred. Neugebauer has performed endoscopic odontoid fracture surgery in 1991. In 1995, Dickman et al. and in 1996, Apfelbaum et al. have used tube systems in odontoid fixation during open surgery. Kazan et al. have been the first to define minimal invasive anterior transodontoid fixation in cadavers. Recent approaches to acute unstable odontoid fractures are C1-2
is placing the screw in compression; this is difficult in anterior approach, but in posterior approach, the displacement can be reduced even manually and screws are placed. VA injury is the most important complication of transarticular screw fixation, so techniques avoiding VA are searched. The most important biomechanical study to avoid VA injury is posterior transarticular screw fixation and fusion with only one screw.\[8,9\] Although Goel’s technique\[2\] is a VA avoiding technique, it could not eliminate the complications.

The most important issue to be questioned in this new technique is how much perforation would be caused while directing the supplemental screw medially. This can easily be controlled intracanalically while the screw is placed through the C2 pedicle (C2P). The control is easy and possible at the opening at the posterior face of the isthmus-lamina arc of the C2 vertebra. Besides, in this region, as it is the largest anatomical region in the spinal canal, unless the screw is too medially directed, spinal cord compression does not occur. Because the VA has a lot of variations, preoperative evaluation is very important in C2 screw placement. The rates of VA anomalies are reported to be up to 5% in some series.\[21\] Thus, VA should be avoided to the most during C1-2 complex screw placement. Likewise, the importance of directing the screw medially to avoid VA injury in patients with high-riding VA is reported.\[22\]

Recently, Goel and Laheri have first described a method of C1-2 fixation using a plate-screw system for the C1 lateral mass (C1LM) and C2P as an alternative to transarticular screw fixation in 1994.\[2,23\] Goel’s technique is a posterior approach\[2,23\] and it was very popular in these fractures both pediatric and
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Figure 4: Both entry points on the axis are seen in the axial (a) and coronally reconstructed (b) cervical spinal computed tomography images. 2 mm anterior to the first coronally reconstructed image, the screws are seen entering the pedicle (c). At this level, the screw can be seen in the coronal reconstructed images, too (d). The position of the screws after passing through the pedicles is seen (e). The axial (f) and sagittally (g) and coronally (h) reconstructed cervical spinal computed tomography images show the screws passing from the corpus to the broken odontoid.

Figure 5: Note the direction of the right supplementary screw from the base of the odontoid to the apex in the illustrated image (a). Lastly, left transarticular screw is seen penetrating or fixating the lateral mass and the right supplementary screw is seen into the pedicle, (opened the roof) fixating the odontoid process in compression (b), the tip of the screw is in the apex of the odontoid process (cadaveric study).

adult patients. C1LM-C2P fixation has advantages over the transarticular screw fixation technique. First of all, individual placement of screws in C1 and C2 allows intraoperative reduction of C1-C2 subluxation.[23,24]

Compared with other posterior fusion techniques, it has the advantage of increased stability and allows effective reduction and fusion as well as immediate ambulation with minimal head support. Goels technique has biomechanically superior or at least equivalent stability in comparison with transarticular screw fixation on the all dimensions of motion. Our experience of acute odontoid type 2 fractures, managed by this technique, is presented. Two screws are used, one of them in non-dominant side which is fixed with both C1 and C2, and one of the screws is in dominant side which is reducted of fracture. For thus, VA injury is not observed. This is the aim of this technique. The pedicle may be perforated minimally medially with medial direction, but this heals spontaneously because fusion will develop soon while the
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Kotil K, Köksal Ns, Kayaci S. Posterior transodontoid fixation at the non-dominant side, the possibility of determining VA during the placement of the contralateral supplementary transodontoid screw placement after transarticular screw fixation at the non-dominant side, the possibility of determining the odontoid fracture, good fusion and stabilization placing posterior transodontoid screw and transarticular screw at the same operation. We expect this preliminary new technique to be used in numerous complicated cases in the future and to be accepted with the support of the results of large series.

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