

Cervical Spondyloptosis Successfully Treated with Only Posterior Short Segment Fusion Using Cervical Pedicle Screw Fixation

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Abstract

This paper describes two patients with cervical spondyloptosis with severe spinal cord injury treated with cervical pedicle screw (CPS) through a single-stage operation, posterior approach. A 60-year-old male patient with quadriplegia due to trauma 1 day before visited the emergency room. Cervical spine computed tomography (CT) and magnetic resonance imaging showed complete dislocation of the C7 and T1 vertebrae with severe spinal cord compression, disc injury, and disc herniation at the C7–T1 level. Cervical pedicle screw with freehand technique was done on C6 and T1 vertebrae, and bilateral distraction for a reduction was performed with a screw distractor. After reduction of the C7 vertebra on the surgical field, CPS placement on C7 body was done. After surgery, follow-up X-rays showed near complete reduction. The patient completed a rehabilitation program, and his condition improved. From the third month postoperatively, the patient could ambulate without assistance and perform nearly normal daily activities. A postoperative CT scan 1 year later showed accurate screw position and complete fusion bridges on the C6–C7–T1 vertebrae. The other patient, a 39-year-old male, also showed C7–T1 spondyloptosis with quadriplegia (grade IV). C6–T1–T2 fusion surgery was performed only through a posterior approach. The patient showed nearly normal neurology and reduction. Considering early surgery time followed by open reduction and biomechanical superiority of CPS, single posterior approach and short segment fusion appear to be a great surgical method.

Key words: cervical pedicle screw, cervical spondyloptosis, fusion, posterior surgery, reduction

Introduction

Cervical spondyloptosis, a rarely reported traumatic fracture, is generally associated with high-energy trauma and severe spinal cord injury (SCI). Although it is highly unstable and surgical treatment is mandatory, controversy still surrounds the fixation technique and the role and effectiveness of closed reduction.^{1–3)}

In previous studies, the efficacy and safety of cervical pedicle screw (CPS) placement has been shown, even with a freehand technique.^{4–7)} The authors have also shown the effectiveness of CPS placement in traumatic conditions, especially subaxial cervical spine facet dislocation.^{8,9)} In this study, two challenging but successfully treated cases of cervical spondyloptosis, C7–T1 level, were

described in which the dislocation was completely reduced and the short segment was fused using CPS placement and interbody grafting through a posterior approach.

Technical Note

A 60-year-old male patient with quadriplegia due to trauma 1 day before visited the emergency room. The patient had fallen on a pile of logs and been rescued. The mechanism of trauma was estimated to be compression and distraction, which resulted in subaxial cervical spine translation with pedicle fracture. He was otherwise healthy with no abnormal past medical history. Preoperative neurological examination of the patient's muscle strength showed grade 2 in the upper extremities and grade 0 in the lower extremities. In addition, there was no anal tone, and no sensory function was preserved in the anal area. Thus, the patient was classified with American Spinal Injury Association (ASIA) grade A injury.

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Preoperative sagittal computed tomography (CT) showed complete dislocation of the C7 and T1 vertebrae, indicating traumatic subaxial cervical spondyloptosis on the C7–T1 level and bilateral pedicle fracture of the C7 vertebrae. Also, T2-weighted sagittal magnetic resonance imaging (MRI) showed severe spinal cord compression, disc injury, and disc herniation on the C7–T1 level (Fig. 1).

It was nearly 7 h from the patient's arrival to the initiation of emergency surgery, which was completed in approximately 4 h. The patient was kept in prone position, and surgery was done under general anesthesia. CPS with freehand technique was done on C6 and T1 vertebrae using 4.5×32 mm² screws (Vertex system, Medtronic-Sofamor Danek, Memphis, TN, USA). After insertion of CPS on C6 and T1 vertebrae and rod connection, bilateral distraction for a reduction was performed with screw distractor (Medtronic-Sofamor Danek). Because the C7 vertebral body was lying entirely in front of the body of T1 and disconnected from its posterior elements because of bilateral pedicle fracture, the separated lamina, including spinous process and facet, were removed in an en bloc fashion. Post the identification of the reduction of the C7 vertebra on surgical field, CPS placement on directly C7 body without passing through the pedicle was

done using 4.0×32 mm² screws (Vertex system, Medtronic-Sofamor Danek).

After laminectomy and facetectomy, the disc was removed through the wide space of C7–T1 foramen under the C7 root using pituitary forceps. Because of the highly unstable nature of spondyloptosis even after successful reduction of completely torn disc, discectomy and insertion of local bone graft chips was accomplished with a small distraction through the posterolateral direction.

After discectomy on the C7–T1 level, local bone graft chips were inserted, followed by the insertion of the fractured pedicle and fibular allograft bone, both with a 7 mm height, for the transforaminal interbody fusion (Figs. 2 and 3).

The follow-up period lasted for 1 year, and from the 3rd month postoperatively, the patient could ambulate without assistance and perform nearly normal daily activities, indicating ASIA grade D. Postoperative cervical MRI 2 weeks later and radiography 6 months later showed completely corrected alignment of C6–C7–T1 vertebrae and accurately inserted screw position. A postoperative CT scan 1 year later showed accurate screw position and complete fusion bridges on the C6–C7–T1 vertebrae (Fig. 1).

The second case was another 39-year-old male patient who had undergone C7–T1 pedicle screw

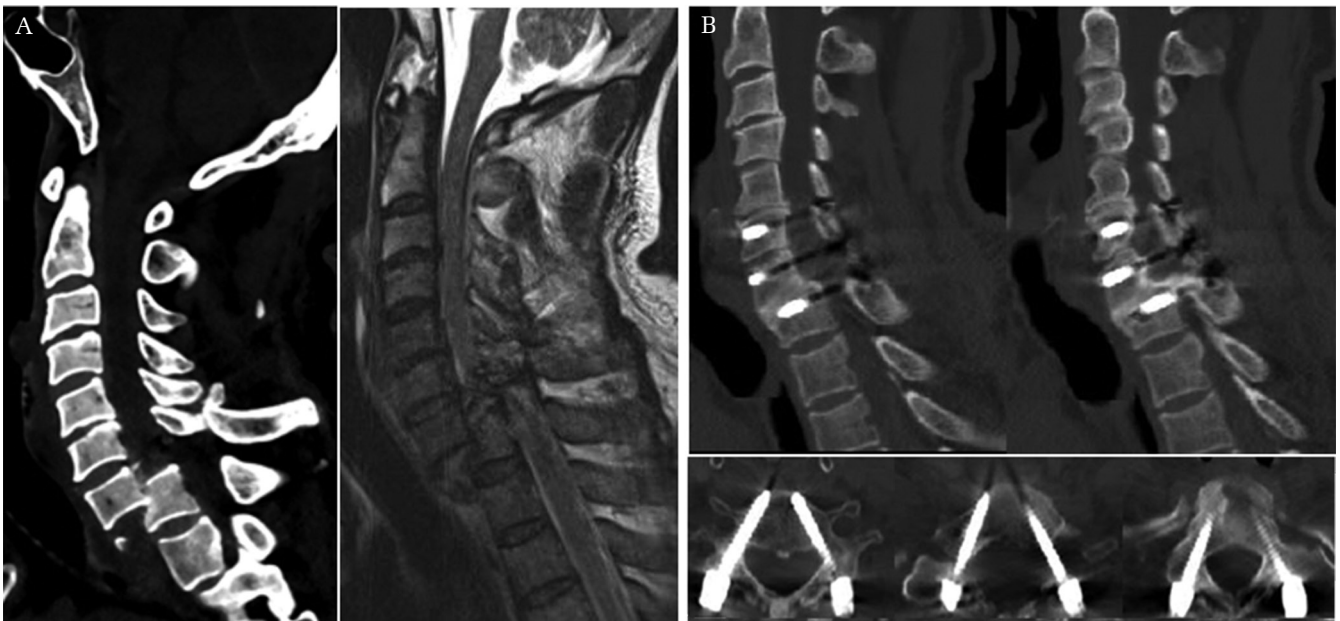


Fig. 1 (A) Preoperative computed tomography (CT) sagittal and axial images showing complete dislocation of C7 vertebra from the T1 vertebra and indicating spondyloptosis on the C7–T1 level. T2-weighted sagittal MRI showing severe spinal cord compression, disc injury, and disc herniation on the C7–T1 level. (B) Postoperative CT images 1 year after the operation. In the sagittal image, the presence of bridging bone between C6 and C7, and C7 and T1 is seen. The axial view shows accurate screw position on the C6–C7–T1 vertebrae.

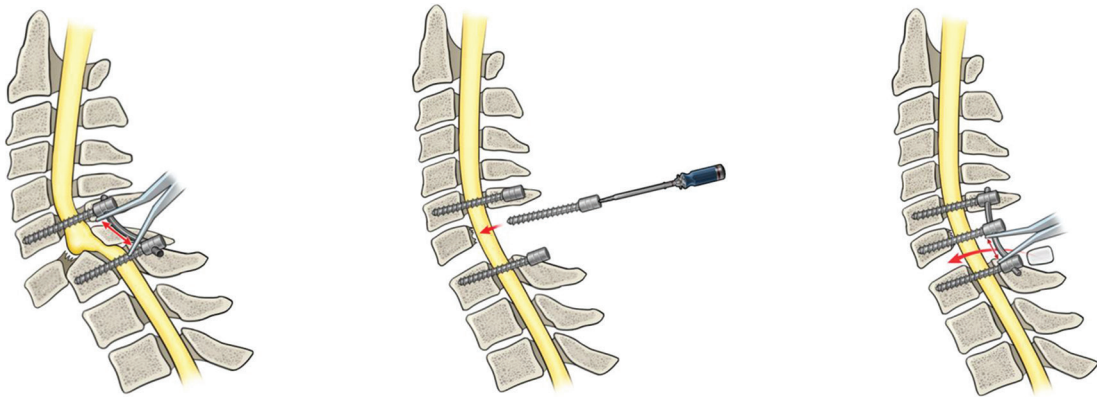


Fig. 2 Schematic diagram for reduction and transforaminal interbody fusion procedure. *Left:* Traumatic subaxial cervical spondyloptosis on the C7-T1 level. Distraction for reduction was performed after CPS placement on C6, T1, and rod connection. *Middle:* After the identification of the reduction of the C7 vertebra on the surgical field, CPS was placed directly on the C7 body after removing posterior column structure, including both C7 pedicles and lamina. *Right:* After discectomy on the C7-T1 level, local bone graft chips were inserted, followed by the insertion of fractured pedicle and fibular allograft bone, both with a 7 mm height, through the C7-T1 foramen.

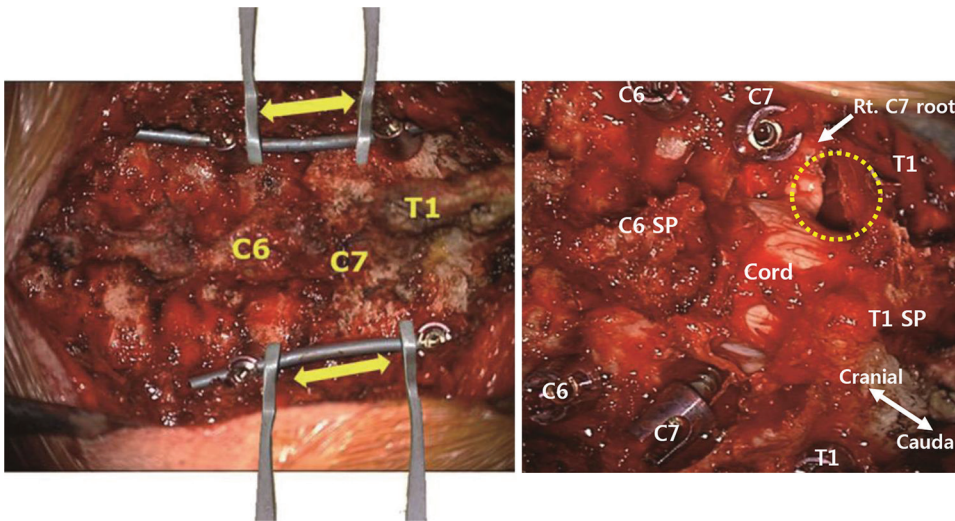


Fig. 3 Intraoperative images showing CPS with freehand technique at C6 and T1 vertebrae. After insertion of CPS and rod connection, bilateral distraction for a reduction was done. An additional CPS was placed on the C7 body. Transforaminal interbody fusion was completed (see *dotted line circle*) with the fractured pedicle fragment (7 mm height) and fibular allograft bone (7 mm height) serving as bilateral interbody cages.

fixation surgery 1 month before due to bilateral facet locking (C7-T1 after diving). He was presented with sudden neck pain during rehabilitation. The patient showed quadriparesis (grade IV) and voiding difficulty after neck pain occurred, indicating ASIA grade D injury. On the CT scan and lateral radiographs, both C7 screws had been pulled out and displaced in both pedicle fractures. MRI showed cord compression and disc injury. The mechanism of trauma was thought to be flexion and distraction during rehabilitation exercise, resulting in C7-T1 spondyloptosis.

About 14 h after the neck pain and weakness occurred, short segment PSF was done. Procedure was C6-T1-T2 using $4.5 \times 30 \text{ mm}^2$ on C6 and $6.5 \times 35 \text{ mm}^2$ on T1-2 screws (Legacy system, Medtronic-Sofamor Danek) with the same reduction

method, distracting between C6 and T1 pedicle screws. Both C7 pedicles were already broken, so screws were not inserted at the C7 level. Because of the desire to preserve a more mobile cervical segment, the surgeon stopped at C6 rather than C5 level. Instead, thicker C6 pedicle screws and rod were used that were usually for thoracic spinal fixation ($4.5 \times 30 \text{ mm}^2$ screws and 5.5 mm diameter rod, Legacy system, Medtronic-Sofamor Danek). To achieve biomechanical stability for this highly unstable pathology, additional T2 segment fixation was deemed mandatory.

The patient's neurologic symptoms improved, and function was nearly normal when he was discharged. The excellent prognosis was most likely due to a rapid reduction and strong biomechanical stability (Fig. 4).

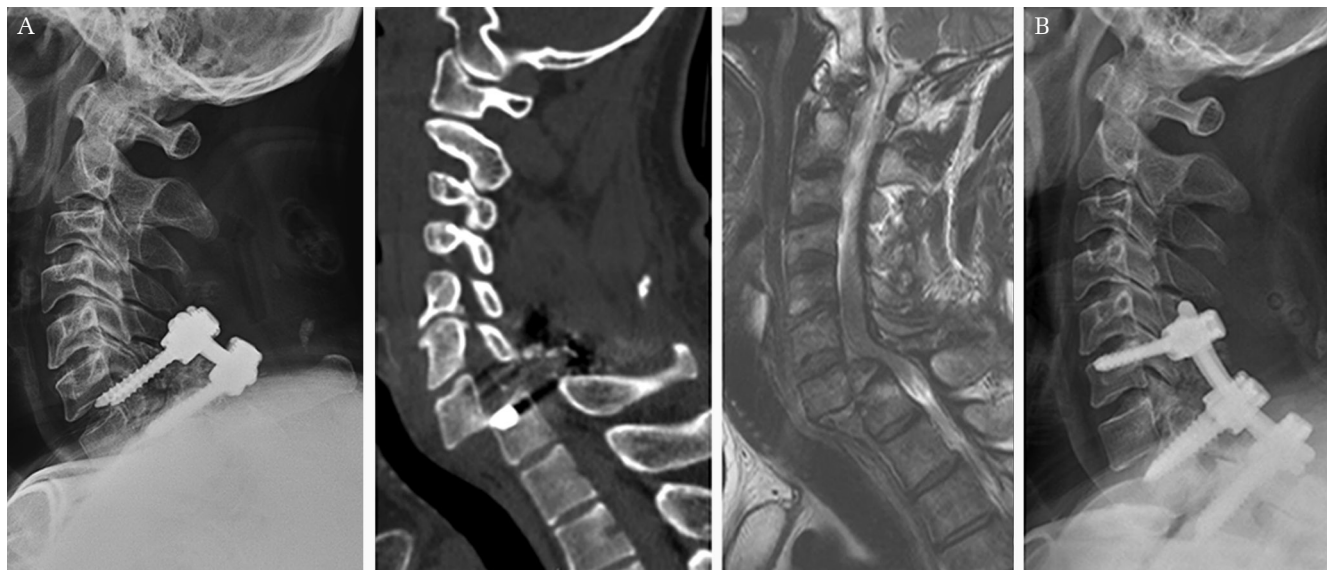


Fig. 4 (A) Preoperative X-ray image, CT scan, and MRI showing spondyloptosis with the C7-T1 screw displacement that was previously inserted. (B) Postoperative X-ray showing good alignment.

Discussion

Despite a relatively low success rate ranging from 42% to 57%, closed reduction was recommended to treat severe traumatic cervical spondyloptosis.^{3,10} However, previous studies by the authors have shown that cervical dislocation can be successfully treated with initial open reduction followed by CPS placement through the posterior approach.⁹ Therefore, the authors believed that these patients could also be treated similarly and could show instrument durability, because of the biomechanically strong fixation power of CPS placement.

The approach of early surgery followed by open reduction (with or without closed reduction) is believed to result in better clinical outcomes for patients with SCI, especially considering the low success rate and/or the possibility of the failure of closed reduction in the case of severe cervical facet dislocation.^{9,11–19} In the current study, the first patient began to perform nearly normal daily activities at 3 months postoperatively and transitioned from ASIA grade A to D. Compared with previously reported neurological outcomes,^{3,10,20} this improvement seems quite unusual and is probably related to ultra-early surgical reduction and decompression.

As previously reported, the accuracy rate of CPS placement in the current study was more than 96% even with the freehand technique, because five safety steps were followed to avoid neurovascular complications. The five safety steps of freehand

CPS placement consist of the following sequence: (1) Preoperative planning using CT angiography (CTA); (2) adequate medial angle using a curved pedicle probe; (3) ability to detect pedicle breach with a ball tip probe; (4) a lateral mass screw conversion when a breach was felt; and (5) ability to interpret the intraoperative AP radiographic images after screw insertion.^{4,6}

Because of the relatively poor supporting environment in an emergent situation for the traumatic patient, high-cost equipment such as navigation, a guide template, or even a fluoroscope may not be useful. Considering the cost–benefit ratio, it is suggested that such cumbersome, high-cost equipment cannot easily substitute for surgical technique.

The American Association of Neurological Surgeons and the Congress of Neurological Surgeons Joint Section evidence-based Guidelines on the Management of Acute Cervical Spine and Spinal Cord Injuries do not recommend the use of steroid for SCI.²¹ Therefore, in compliance with these guidelines, steroids were not administered to the patients in this study.

According to previous reports on this severely unstable, traumatic condition, a combined approach using the anterior and posterior surgical route has been most commonly seen in a small number of cases using only the anterior approach and a few cases using only the posterior approach. In addition, most of the previously reported cases using the posterior approach needed at least four levels of segment fusion. In one case using the anterior-only

approach, there was early instrumentation failure, indicating that the anterior approach should be followed by additional posterior-instrumented fusion.^{3,10,20} Until now, there has been no report of a short segment and single posterior-only approach to fuse two or three vertebral segments for cervical spondyloptosis. This report finally shows complete radiological fusion in our patients.

Because C7 body had slipped down in front of the T1 vertebra body in this spondyloptosis, C7–T1 level differently a low-grade spondylolisthesis, the screw could not be inserted on C7 level without reduction. Thus, the screws were inserted into the upper (C6) and lower (T1) vertebrae, and the reduction was performed through distraction. After that, the last screws on the reduced C7 vertebra body could be inserted directly without passing through the pedicle due to their absence. During the reduction maneuver, careful consideration should be given to the risk of herniated disc and hematoma, which can cause cord damage on the ventral side.

Pedicle screw placement has a long history for treatment of thoracic or lumbar spine trauma, including fracture and dislocation. In cases of cervical spine trauma, the authors believe that the same fusion level and surgical approach considerations can be used if CPS is used instead of lateral mass screws.

We previously showed the accuracy and safety of our subaxial CPS technique from C3 to C7 cervical spine, several times.^{4–6,8,9} If the spondyloptosis level is higher than the C6 vertebra, it is most likely fatal because of vertebral artery injury. However, if the patient is alive and available for general anesthesia, surgery at the C6 level or the upper level can be accomplished in the same way as presented in this technical report. Previous studies have shown the safety and efficacy of subaxial CPS placement by freehand technique.

Short segment fusion for thoracic or lumbar spine trauma is a good surgical treatment option, which was easily adopted for the patients in this study.^{22,23} Interbody fusion on the cervicothoracic junction seems unfamiliar because of the narrow surgical corridor. Because our patients had highly unstable spines, discectomy was performed followed by the cage and fractured pedicle implantation to obtain more fixation points and an enhanced and extended fusion bed.

Conclusion

In this study, successful treatment was reported for a patient with cervical spondyloptosis (C7–T1 level) using a single posterior-only approach with short segment fusion using CPS. The biomechanically strong

fixation power of CPS can lead to better preservation of mobile cervical segments, combined with good clinical outcomes for patients with SCI, even those with highly unstable cervical spine fractures.

Conflicts of Interest Disclosure

None.

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