CASE REPORT

Anterior Transpedicular Screw Technique for Failed Anterior Cervical Internal Fixation in Revision Surgery: a Case Report

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Introduction

Anterior cervical corpectomy and fusion (ACDF) is a widely used surgical approach for cervical diseases such as cervical trauma, spondylosis, tumor, deformity and degenerative spondylolisthesis^{1,2}. Although successful in achieving good outcomes, drawbacks to the anterior approach include screw and plate loosening, development of pseudarthrosis and lack of bioabsorbability^{3,4}. Zdeblick *et al.* reported excellent results can be achieved with repeat anterior decompression and autogenous bone-grafting. Wang *et al.* perform laminoplasty for failed anterior cervical spine surgery⁵. To our knowledge, a cervical anterior transpedicular screw (ATPS) technique has not been used for revision surgery for failed anterior cervical internal fixation.

Case Report

A 58-year-old man was re-admitted to our department, because X-ray films showed loosening of internal fixation 20 days after he had undergone surgery. The patient had previously been admitted to the Emergency Department of our hospital with numbness and motor weakness in all four extremities after being injured in a traffic accident. On neurological examination, he had 1/5 motor strength in the upper extremities and 2/5 in the lower extremities. Clinically, his American Spine Injury Association (ASIA) score was B at the C₅₋₆ level. Plain X-ray films of the cervical spine showed burst fractures of the C₅ and C₆ vertebrae. Magnetic resonance imaging (MRI) showed injury of the spinal cord at the C₅₋₆ level. After sufficient preoperative preparation, the patient underwent surgery from an anterior approach. The C₅ and C₆ vertebrae were partially resected and the spinal canal decompressed, after which a titanium plate and autogenous bone were implanted.

One day after surgery, the patient's motor function had dramatically improved to 3/5 motor strength in the upper extremities and 4/5 in the lower extremities. A hard cervical collar was fitted and he was discharged. Radiographs taken 1 week postoperatively demonstrated acceptable alignment of the plate and graft. Twenty days post-surgery, he presented to the emergency room with severe neck pain, progressive numbness and motor weakness in all extremities, urinary incontinence and encopresis after suddenly experiencing strong emotions and vigorously moving his neck (the patient has schizophrenia). He was accordingly re-admitted to our department. Neurological examination showed 1/5 motor strength in the arms, 0/5 in the hands and 0/5 in the lower extremities. Clinically, his ASIA score was A at the C₅₋₆ level. Plain X-ray films (Fig. 1A) and reconstructed computed tomographic (CT) sagittal scan (Fig. 1B) showed loosening of the internal fixation and kyphosis. An MRI (Fig. 1C) indicated spinal cord compression at the C₅₋₆ levels.

Revision surgery was subsequently performed via an anterior approach. The implant was removed, after which instrumented fusion with new titanium was implanted. Next, a fluoroscope was set on the left side of the patient to obtain an accurate lateral view of the cervical spine. The fluoroscope was rotated until the right pedicle cortex appeared approximately circular in the transverse plane of the vertebral body, setting the axis of rotation to a cervical longitudinal axis. A screw trajectory angle of 45° from the sagittal plane was used for C₄ and 40° for C₇. There is typically about 2 mm of surface area below the upper end, central to the transverse plane; an entry hole was created through this with a straight awl. Next, a drill was used to insert 1.5 mm Kirschner wires into the pedicle cavities at a 45° inclination from the sagittal plane. This trajectory angle conformed to the C-arm beam angle of the

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Fig. 1 Before revision surgery, (A) plain lateral X-ray film and (B) a reconstructed CT sagittal scan showed internal fixation loosening and kyphosis. (C) MRI indicated spinal cord compression between C₅ and C₆. After revision surgery, (D, E) plain X-ray films showed acceptable alignment of the plate, titanium and anterior cervical pedicle screws. (F, G) Axial CT scan showed very good position and length of the cervical ATPS. (H) Six months after revision surgery, a reconstructed CT sagittal scan showed solid graft fusion. (I) Axis plate was well implanted. (J) UCSS hollow screw was used as cervical anterior transpedicular screw.

fluoroscope. The placement of guidewires was confirmed repeatedly on anteroposterior, lateral and pedicle axis views by fluoroscopy. If a guidewire migrated outside the pedicle, insertion was reattempted to create the correct pathway. After inserting guidewires at each level, tapping was performed. Plates (axis plates) of precisely the required length were selected and bent to match the contour of physiological lordosis. The diameters of the cannulated (pedicle) screws were 4 mm and their lengths ranged from 30 to 35 mm. Finally, cervical ATPS was performed and an axis plate (Medtronic Sofamor Danek, Memphis) implanted.

Early after this revision surgery, the patient's severe neck pain was alleviated. Two weeks later, the patient had varying improvement in sensation, movement, defecation and urination. Motor examination showed dramatic improvement with 4/5 motor strength in the arms, 3/5 in the hands and 2/5 in the lower extremities. However, he was still incontinent of feces and urine. His ASIA score was C at the C₅₋₆ level. He was again discharged with a hard cervical collar. Radiographs taken 2 weeks post-revision demonstrated acceptable alignment of the plate and titanium (Fig. 1D and E). An axial CT scan (Fig. 1F and G) showed the position and length of the cervical ATPS were very good. Sixth months after revision surgery, a reconstructed CT sagittal scan (Fig. 1H) showed solid graft fusion and, after undergoing rehabilitation, there was good partial recovery of neural function with 4/5 motor strength in the arms, 4/5 in the hands and 3/5 in the lower extremities and continence of feces and urine.

Discussion

Anterior cervical corpectomy and fusion, a widely used surgical approach to treating cervical disease, produces adequate immediate stabilization in single-level surgery^{6,7}. However, it is of limited use in multiple-level cervical discectomy and fusion and patients with osteoporosis because it does not provide enough biomechanical stabilization⁸. It also has a high rate of failure and nonunion^{9,10}. Previous clinical studies have shown that the rate of non-union after multilevel ACDF is as high as 20%–50% and the failure rates for long-length anterior cervical decompressions or corpectomies with multilevel fusion range from 30%–100%¹¹. Therefore, most patients need multilevel revision surgeries that utilize additional posterior stabilization or external fixation (e.g. halo vests) to improve early and long-term stability. The need for multilevel procedures unquestionably increases the risks complication rates of revision surgeries. Moreover, although use of halo vests decreases the chances of instrumentation failure, they are extremely uncomfortable for patients¹².

In recent years, a new concept—ATPS—that combines the advantages of an anterior approach and the superior biomechanical characteristics of cervical pedicle screw fixation was devised^{12–14}. Clinical research showed that a significant increase in axial pull-out strength can be achieved by incorporating the following characteristics: wide external diameter, large insertion depth, flat angle of tooth profile and small thread pitch¹⁵. In the present case, the vertebral body screw

could not be re-used because collapse of the titanium and loosening of the internal fixation had resulted in destruction of the anterior edge of the patient's C₇ vertebral body. However, a 30–35 mm cervical anterior transpedicular screw could provide strong biomechanical fixation. Koller *et al.* have demonstrated in cadaver experiments that the pull-out strength of an ATPS (mean, 467.8 N) is about 2.5 times that of a vertebral body screw (mean, 181.6 N)¹⁶. Results of testing the ATPS prototype were encouraging regarding primary stability compared to that achieved by its posterior counterparts. In addition, these researchers showed that unilateral end-level pedicle screw fixation for stabilization of two-level corpectomy constructs is free of the potential risks of bilateral pedicle screw placements¹⁷. This completely new technique of ATPS was first reported by Koller *et al.* in 2008¹⁴. So far, no large studies or large scale clinical application of ATPS in cervical disease have been reported; this technique has mainly been used for one stage treatment of cervical degenerative disease and cervical spine fractures. We tried ATPS out and achieved good results in this case, which is the first reported instance of using this technique for revision surgery (Fig. 1I and J).

Choosing the correct cases in which to use the ATPS technique is very important. Indications include (i) cervical vertebral tumor or tuberculosis with pathological destruction; (ii) multi-segment anterior cervical decompression and reconstruction; (iii) elderly patients with osteoporosis and ankylosing spondylitis, rheumatoid arthritis and other patients with poor quality vertebral bone who need anterior cervical decompression and reconstruction; and (iv) failure of conventional anterior internal fixation requiring revision surgery because secondary surgery cannot provide rigid internal fixation. In addition, because of the morphology of vertebral pedicles, ATPS fixation can be used with vertebral body screws in each cervical vertebra along with the newly developed anterior plates¹⁶. Another advantage over regular anterior plate fixation is that segmental pedicle screw fixation can be performed at each level even when using grafted bone for reconstruction after long segmental corpectomy¹³. Although the pull-out strength of ATPS is reportedly higher than that of vertebral body screws, its resistance to rotation or bending is inferior to that of vertebral body screws¹⁷. Accordingly, we plan to investigate this aspect of instrumentation and study further improvement in design in the next stage of our research.

The main limitation of this study is that it is based on a single case report. This technique demands a high level of surgical skill and has relatively high risks. Dedicated instrumentation for ATPS is currently under construction and is expected to be developed soon. The ATPS technique demands great understanding of and familiarity with cervical anatomy, as well as experience with posterior pedicle screw and special imaging techniques. Development of surgical techniques and imaging instruments should improve the accuracy of screw placement. ATPS should not be considered a routine surgical procedure; rather it should be seen as the surgical option

that offers the strongest fixation in anterior cervical reconstruction. The ATPS technique may be as well accepted as

posterior pedicle screw in future and widely applied in cervical surgeries.

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