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Abstract

A multilevel contiguous fracture of the subaxial cervical spine represents the severe trauma, and anterior plate fixation with anterior transpedicular screw fixation is a new and reliable fixation pattern for the treatment of acute spinal cord injury (ASCI). We present a case of multilevel contiguous fractures in the lower cervical spine without obvious posterior ligamentous complex injury, but with complete quadriplegia due to a falling accident. Computed tomography revealed multilevel contiguous fractures of the subaxial cervical spine including a posterior arch of atlas fracture with the sclerites of C5 vertebral body into the spinal canal with a major compression of the left anterior side of the cord. The patient was treated with a late surgery of C5, C6 corpectomies followed by an autologous bone graft with titanium mesh and surgical stabilization of anterior transpedicular screw-plate system (ATPS) through anterior approach only. At 1 year postoperative, the patient showed slight improvement except for urinary and fecal incontinence. The finger strength improved to grade 1 of 5 bilaterally, and muscular strength of lower extremities was grade 1 of 5 bilaterally. The latest follow-up showed the patient paralyzed without any further improvement at 2 years postoperative. Anterior cervical plate fixation with anterior transpedicular screw fixation provides a new route of how to treat multilevel fractures of the subaxial cervical spine, and it is feasible. Surgical intervention provides rigid fixation and facilitates early rehabilitation, but the functional recovery of traumatic cervical spinal cord injury remains a difficult problem.

ABBREVIATIONS

CT: Computed Tomography; MRI: Magnetic Resonance Imaging; APS: Anterior Pedicle Screw; ATPS: Anterior Transpedicular Screw; VBS: Vertebral Screw; ACCF: Anterior Corpectomy and Fusion

INTRODUCTION

High falling injury was the main cause of cervical trauma, which was frequently combined with the spinal cord injury [1]. Major reason of spinal cord injury is indirect violence injury and about 40 percent of patients suffering from cervical injury complicated with spinal neurological deficit in China. Clinical studies reported frequent failure with anterior instrumented multilevel cervical corpectomies. And the stabilization of anterior plate with vertebral screw may not be sufficient. In recent years, the new stabilization technique of anterior transpedicular screw fixation (ATPSF) has been recognized because of its good primary stability after implantation [2]. A review of the literature pertaining to this technique is also presented.

CASE PRESENTATION

In August 2014 a 25-year-old male was involved in a falling accident when working 5 meters high. He was transferred to our hospital for further treatment from an initial treatment facility. He was conscious and responded correctly to time and place queries. There were no signs or symptoms of thoracic or abdominal injury. The chief symptom was neck pain with upper and lower extremities weakness and anesthesia. Physical
examination showed the area over the cervical spine was tender to palpation. Bilateral upper and lower-extremity motor strength was graded as 0 of 5 according to the classification of the American Spinal Injury Association (ASIA). Sensation to light touch and pinprick was lost below the level of sternal angle, including the sella turcica region. The pathologic reflex has not drawn out. CT scanning of the cervical spine revealed a sagittal fracture of C4 vertebral lamina, and C5, C6 vertebral burst fracture with laminar fractures, and C7 vertebral body contusion (Figure 1a-f). Cervical and thoracic spinal MRI revealed C5 vertebral burst fracture with bony canal stenosis, C4-6 spinal cord contusion and compression injury, and C4, C7, T2, T3 vertebral body contusions, extensive contusion and swelling of soft tissue surrounding the cervical laminae(Fig. 1gh). Initial management at our institution included methylprednisolone sodium succinate (a 30mg/kg initial bolus followed by a twenty-three-hour infusion at 5.4 mg/kg/hr), 4.5kg of axial traction applied through Crutchfield (Pakistan) and other symptomatic relief and supportive treatment for six days. On the 7th day, the patient underwent an anterior arthodesis from C4 to C7 with a titanium mesh cage (Medtronic, Minnesota, America) and an ATPSP system (Sanyo, Shanghai, China) by one-stage operation (Figure 2). The patient was placed on surgical bed in the supine position with the head fixed with skull traction and shoulder back elevated by operating towels (Figure 3). The shoulder girdles were pulled caudally and immobilized by tape. The low anterior cervical approach (LACA) was adapted to expose the vertebral body of C4-C7 along the inner edge of sternocleidomastoid in his left neck. When determined the level of lesion by C-arm X-ray, C5 and C6 subtotal corpectomy were performed with continuous skull traction. The entry point and trajectory of ATPSSs were repeatedly confirmed with using a 2 mm diameter cutting kirschner wire, which was partially placed at the anterior cortex of the selected cervical vertebra under the guidance of C-arm X-ray machine. The ATPSs setting was completed using fluoroscope-assisted pedicle axis view imaging proposed by Yukawa et al., [3]. After placement of titanium mesh cage, the traction weight removed and an appropriate ATPS-plate in length was chose for following internal fixation. A 30mm ATPS in length with a diameter of 3.5mm was initially placed into the left pedicle of C4, and a 32mm ATPS in length with same diameter was inserted into the left pedicle of C7, while conventional VBS were placed unicortically on the right side in sequence (Figure 4). The operation was performed smoothly with no complications such as cerebrospinal fluid leak, vertebral artery or nerve injury. The neurological status didn’t improved, and level of sensation didn’t change right after surgery. CT scan revealed a stable construct with no misplacement of ATPSs, no shift in hardware or osseous position on the fifth day postoperatively (Figure 5). At 7 months postoperative, the patient showed slight improvement except for urinary and fecal incontinence. The finger strength improved to grade 1 of 5 bilaterally, and muscular strength of lower extremities was grade 1 of 5 bilaterally. CT scan revealed bone graft fusion with no loosening of plate and screw or spinal canal occupational (Figure 6). The classification of the American Spinal Injury Association (ASIA) was included in the following table:

<table>
<thead>
<tr>
<th>Level</th>
<th>Sensation</th>
<th>Motor</th>
<th>Autonomic</th>
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<tbody>
<tr>
<td>C4-C7</td>
<td>0-0</td>
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Figure 1 (a)-(h): Preoperative imaging examinations of CT and MRI.
Spinal Injury Association (ASIA) remained grade A. The latest follow-up showed the patient paralyzed without any further improvement at 2 years postoperative.

**DISCUSSION**

Multiple-level fracture of the cervical spine tended to be the lower cervical spine injury, the most common of which occurred in the site of vertebral body. Therefore, anterior and middle column is involved frequently. Our patient presented with C4-C7 multilevel contiguous fractures, in which a burst fracture was at C5. This pattern of injury is consistent with high-grade vertical compression mechanism, according to history of trauma and the image manifestations. A vertical compression injury characterized by axial stress concentration on a certain monosegment, which presented with a burst fracture and vertical splitting of both endplates. When the vertebral body ruptured, axial stress was absorbed immediately. If the stress was so strong to be absorbed incompletely, the remainder will continue to transfer up and down along the cervical spine and lead to multiple-level fracture eventually. Another special characteristic of this pattern of injury is the structural integrity of cervical posterior ligament complex without facet dislocation. Preoperative imaging examinations revealed distances between spinous processes without abnormal widening. Our patient presented with C5 burst fracture and migration of the sclerites into spinal canal with resultant compression. The classification of the American Spinal Injury Association (ASIA) was grade A preoperatively. Methylprednisolone (MP) combined with decompression of spinal canal is the main method for treatment of acute spinal cord injury (ASCI) [4]. Although the operation does not make sense for the recovery of spinal function, the aims of the surgery were to remove the persistent oppression and prevent the level of injury arising, and while stabilize the cervical spine. The range of spinal canal decompression was determined by the level of lesions and the corresponding regions of changes of spinal signal on MRI and the injury classification [5]. For the patient, C5, C6 were unstable,
Figure 4 (a), the pedicle axis view at the surgical level was confirmed by oblique cervical plain film by C-arm X-ray machine preoperatively; (b) The trajectory of C4 ATPS was ready with using a cutting kirschner wire under the guidance of C-arm X-ray machine; (c), the trajectory of C4, C7 ATPS was satisfied in lateral projection. (d), Titanium mesh bone fusion and anterior plate fixation with anterior transpedicular screw fixation.

Figure 5 (a-d), CT scans revealed the ATPS in good position without space-occupying lesion in cervical spinal canal or transverse foramen, and cervical alignment recovered on the fifth day postoperatively. (e), complete anterior decompression; (f), no migration of titanum mesh cage.
and the damage of bony canal stenosis at level of C5 combined with spinal contusion and compression, mainly occurred on the anterior border of spinal canal without the compressive factors of posterior column. Therefore, an anterior only approach is enough to ensure full decompression. Choices for anterior fixation include a conventional plate-and-screw construct and a novel ATPS-plate fixation. The biomechanical stability of current anterior cervical spine screw-and-plate systems is limited in anterior cervical spine surgery after multilevel discectomy/corpectomies [6]. Patients after this operation easily suffer from serious early complications associated with bone grafting and internal fixation [7-10]. Hence, a second posterior surgical approach is needed for multilevel cervical stability reconstruction [9,11]. In recent years, with the advent of anterior transpedicular screw fixation (ATPSF) [2,10,12,13], a new reconstruction mode of anterior locking plate fixation with anterior transpedicular screw fixation has become familiar to academics and specialists [14,15]. ATPS fixation inherits the merits of rigid internal fixation of posterior transpedicular screw system, and biomechanical study suggest that instant pull-out force and fatigue resistance capability of an ATPS fixation were significantly better than vertebral screw [16]. Biomechanical study performed by Koller has confirmed that anterior cervical plate fixation with anterior transpedicular screws is superior to vertebral screw fixation after a 2-level cervical corpectomy in flexion-extension and axial rotation. With this two segmental decompression following bone grafting, we believe that rigid fixation is desirable for this patient.

The earliest anterior cervical plate was developed by Orozco Delclos and Llovet Tapies in 1970. Anterior plate fixation provides immediate stabilization, prevents graft extrusion, and helps maintain the restored sagittal alignment. Aramomi M et al., [12] reported a surgical technique of anterior pedicle screw (APS) fixation for multilevel cervical corpectomy and spinal fusion in 2008, but without combination with anterior plate fixation. Due to lack of restriction of anterior cervical plate, the movement of flexion-extension and axial rotation of cervical spine may result in micromotion in the bone-implant interface before solid arthrodesis. Only APS fixation would be a risk of anterior graft nonunion. Furthermore, by combining with anterior cervical locking plate, ATPS-plate system decreases the need for supplemental posterior procedures, and provides stronger anti-rotary force to facilitate early rehabilitation nursing. However, the key point and difficult of the technique is accurate insertion of ATPS, which associated with adverse outcomes (such as pedicle or vertebral artery perforation) compared with vertebral screw fixation [17]. In order to improve the accuracy, attempts have been made to create individual navigation templates for ATPS placement by using three-dimensional reconstruction and rapid prototyping technology, though, there also comes a series of problems such as positioning deviation, surgical field overexposure and the unfitting of the surface between individual navigation template and the anterior cortex of cervical vertebra. In our experience, the pedicle axis view was confirmed by oblique cervical plain film and the Kirschener wire tip matched to the pedicle center with the assistance of fluoroscopic guidance (Note: the Kirschener wire should not be too long), and ATPS placement was performed after tapping along the same direction. Intraoperatively, the projecting direction of X-ray fluoroscopy was determined by patients’ position and corresponding transverse pedicle angle (tPA) and sagittal pedicle angle (sPA).
CT scans were performed in patients and multiplanar reformation was used to measure the related parameters such as tPA, sPA and distance between the intersection point and the vertebral body edge on pedicle axis view at planning operative segment preoperatively, which could help to rapidly locate the entry point and reduce the exposure number of times and the operation time. In addition, ATPS-plate for this case combines VBS and ATPS to create cross-over design, which equips with blocked locking screw design and simultaneously address the requirement of a big angle of tPA [15].

REFERENCES