Percutaneous pedicle screw fixation through the pedicle of fractured vertebra in the treatment of type A thoracolumbar fractures using Sextant system: an analysis of 38 cases

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【Abstract】 Objective: To prospectively evaluate the feasibility, safety and efficacy of the percutaneous pedicle screw fixation through the pedicle of fractured vertebra in the treatment of type A thoracolumbar fractures using Sextant system in the retrospective non-randomized case-control study.

Methods: A total of 38 consecutive non-randomized patients with type A thoracolumbar fractures, which had been stabilized posteriorly from December 2006 to March 2009, were examined retrospectively more than 9 months after surgery. Twenty-one patients had been treated conventionally with open pedicle screw fixation (OPSF) and 17 patients received minimally invasive treatment with Sextant percutaneous pedicle screw fixation (SPPSF). As a method of evaluation, the incision size, the intraoperation and postoperative volume of blood loss, operation time, postoperative hospital stay, blood transfusion, the radiological assessment of the sagittal Cobb’s angle, vertebral body angle and vertebral body height were recorded and compared.

Results: All patients were followed up for 8-24 months (average 11.6 months). There were significant differences in the incision size, surgical blood loss, surgical draining loss, operation time, hospital stay after operation, blood transfusion, the proportion of antalgic supplement and postoperative incisional VAS between the two groups (P<0.05). Mean preoperative kyphotic deformity was 16.0° and improved by 9.3° after surgery in OPSF group, but 15.2° and 10.3° respectively in SPPSF group. Mean anterior vertebral body height (% of normal) was 67.3% before surgery and 95.8% after surgery, but 69.1% and 90.1% respectively in SPPSF group. Mean posterior vertebral body height (% of normal) was 93.3% before surgery and 99.5% after surgery, but 88.9% and 93.3% respectively in SPPSF group. Among the patients whose 9-month follow-up films were available, 3.0° of kyphosis correction was lost in OPSF group, but 3.2° in SPPSF group. And 1.0° of the angle of the fractured vertebral body correction was lost in OPSF group, but 1.5° in SPPSF group. Then 3.0% of the anterior vertebral body height correction was lost in OPSF group, but 2.2% in SPPSF group. And 3.0% of the posterior vertebral body height correction was lost in OPSF group, but 2.5% in SPPSF group. The sagittal Cobb’s angle, vertebral body angle and anterior height of the fractured vertebra were all significantly different in each group before and after operation (P<0.05). There were no significant differences in the postoperative sagittal Cobb’s angle, vertebral body angle and the improvement of the vertebral body height and the kyphotic deformity correction between OPSF and SPPSF groups (P>0.05), but there was significant difference in the postoperative anterior height of the fractured vertebra between the two groups (P<0.05).

Conclusion: The percutaneous pedicle screw fixation through the pedicle of fractured vertebra using Sextant system is a good minimally-invasive surgical therapeutic choice for patients with type A thoracolumbar fracture except for that the SPPSF has a little insufficiency in resuming the anterior height of the fractured vertebra compared with OPSF.

Key words: Fractures, bone; Thoracic vertebrae; Lumbar vertebrae; Bone screws
In most burst fractures, the posterior column of the fractured vertebral body remains intact and provides additional points of fixation. Insertion of pedicle screws at the level of the fracture would result in a segmental construct and a protective effect on the fractured vertebral body by indirectly supporting the anterior column. The placement of pedicle screws at the level of the fracture can make the fixation more stable and therefore decrease the risk of reduction loss.\(^1\)\(^-\)\(^3\) The standard open posterior approach to thoracolumbar spine has distinct hypothetical disadvantages, i.e. the extensive dissection of the paraspinal muscles may be associated with massive blood loss and may lead to persisting sequelae, such as muscular denervation, atrophy and pain.\(^4\)\(^-\)\(^6\) To minimize these negative consequences of screwrod instrumentation, some surgeons have been working for a percutaneous means of spinal fixation.\(^7\)\(^-\)\(^9\) The purpose of this study was to evaluate the feasibility, safety and efficacy of the percutaneous pedicle screw fixation through the pedicle of fractured vertebra in the treatment of thoracolumbar fractures. Perioperative data, radiographic data and clinic outcomes for 17 patients treated with percutaneous pedicle screw fixation and 21 patients treated with traditional open technique were retrospectively reviewed.

METHODS

Patients

From December 2006 to March 2009, 38 patients with thoracolumbar fracture were analyzed in this study. Among them, 17 patients (13 men and 4 women), aged 28-54 years (average 41.6 years), were enrolled into the Sextant percutaneous pedicle screw fixation (SPPSF) group. The interval between the injury and operation ranged from 3 days to 15 days (average 8.3 days). The injury segments were T\(_{12}\) in 3 patients, L\(_1\) in 10 and L\(_2\) in 4. Mechanisms of injury included falling from a height (7 patients), traffic accidents (7 patients) and tumble (3 patients). According to the AO fracture classification, A1 fracture occurred in 6 patients, A2 fracture in 4, and A3 fracture in 7. According to the scale of Americal Spinal Injury Association (ASIA), 5 patients had an incomplete injury (grade D), and 12 patients were neurologically intact (grade E). Twenty-one patients, (18 men and 3 women) aged 37-61 years (average 45.0 years), were enrolled into the open pedicle screw fixation (OPSF) group. The interval between the injury and operation ranged from 3 days to 21 days (average 7.9 days). The injury segments were T\(_{12}\) in 7 patients, L\(_1\) in 6 and L\(_2\) in 8. Mechanisms of injury included falling from a height (15 patients), traffic accidents (2 patients), tumble (3 patients) and strike by dropping heavy objects (1 patient). According to the AO fracture classification, type A1 fracture occurred in 11 cases, A2 in 9 and A3 in 1. Twelve patients had an incomplete injury (ASIA grade D), and 9 patients were neurologically intact (ASIA grade E). All patients had a type A fracture without any rupture of the posterior ligaments or fractures of the vertebral joint or the vertebral arch. The vertebral canal blocked area of all the patients was less than 1/3 in sagittal diameter. There were no patients needing posterior decompression of the vertebral canal.

Surgical procedures

Preoperative preparation

The advantages and disadvantages of this procedure were carefully explained to the patients. All patients consented to undergo this procedure. The operating room should be large enough to accommodate the fluoroscopic instruments and Sextant percutaneous or traditional open pedicle screw fixation system appropriately. A C-arm fluoroscopy device was used for guidance of percutaneous screw placement. It was important to determine whether adequate anteroposterior (AP) and lateral fluoroscopic images of the thoracic or lumbar spine can be obtained before preparing and draping the patient.

Postural reduction

When the patients came into the hospital, they were positioned supine with cushions under the thoracolumbar segments. In the surgery, following the induction of general anesthesia, the patients were in the prone position with cushions under the iliac crests and the thorax to prevent pressure on the abdominal region so that the spine was in a hyper-extension position and postural reduction was performed. In order to achieve a better postural reduction, we could properly press the vertex of the kyphosis when the kyphosis was severe.

Both OPSF and SPPSF were accomplished by the doctors with more than ten-year clinical experience of spinal surgery in our department.

OPSF

All patients had the surgery under general anesthesia. After the lateral C-arm fluoroscopic images were obtained, the location of the incision could be
determined. Make a posterior median incision with the fractured vertebra as the center to expose vertebral plate and articular process. After opening the skin and fascia, the paravertebral musculature was shaved aside and then the pedicle screws (TTL-USS system, TENOR-CD HORIZON M8 system, SINO-UPASS system) were inserted into fractured vertebra and two successive vertebrae upwards and downwards with the guidance of C-arm fluoroscopic image. Reduction was performed with all pedicle screws in place. The over-contoured rods were then inserted using rod persuaders and connected with the remaining pedicle screws, providing certain pressure on the spine. Significant reduction and restoration of height were obtained with these maneuvers (Figure 1). A silica gel drainage tube was used and the skin was closed with more than 10 sutures.

**SPPSF** Fluoroscopic images were obtained in the AP and lateral planes to ensure that the pedicles could be adequately visualized. The entry points were chosen for the pedicle screws that were to be fitted with instrumentation. An approximate 15-mm incision was made at the skin entry point and extended into the underlying subcutaneous tissue. A guide wire was used to perforate the fascia, and a series of sequential dilators were then used to dilate the fascia and to bluntly separate the underlying paraspinal muscles until the spine was exposed. The dilators were removed, and both a tracked awl and a pedicle probe were used to create a pedicle pilot hole under C-arm fluoroscopic guidance. Then the chosen pedicles were tapped and screws were placed. These angles were judged using preoperative computerized tomography or magnetic resonance imaging of the thoracolumbar region. The axial angulation of the instrument was adjusted until the PAK needle was visualized within the boundaries of the pedicle on the AP view but lateral to the medial pedicle wall. After three pedicle screws, together with their attached extenders, had been inserted, a Sextant rod was placed by the Sextant rod placement system (Figure 2). In this manner, bilateral pedicle screws were inserted into the pedicles above and below the fractured vertebra. All steps of pedicle fixation were performed under C-arm fluoroscopic image guidance. A postoperative plain film was obtained, which revealed satisfactory fixation in our study (Figure 3). Any bleeding in the wound was controlled with the bipolar forceps. A drainage rubber tissue was usually placed in the wound, the fascial incision and the skin incision were sutured.

**Postoperative care**
Keep the drainage well in order to avoid haematocele and infection. The antibiotic drug was used routinely for 5 to 7 days. The glucocorticoid, dehydrating and neurotrophy agents were used properly to relieve nerve edema and accelerate neurofunctional rehabilitation in neurodeficient patients in the first week postoperatively. Patients were encouraged to do some out-of-bed activities with brace 2 or 3 weeks after operation in the SPPSF group, 7 or 8 weeks in the OPSF group. The over-activity and weight loading should be forbidden in 6 months after operation. X-ray test should be taken regularly.

**Observation index and statistical analysis**
The contrast analysis was made on the incision size, the intraoperative and postoperative volume of blood loss, operation time, postoperative hospital stay, blood transfusion and the anterior and posterior vertebral body height (%), vertebral body angle and sagittal Cobb’s angle at preoperative and postoperative one week. The data were represented as mean ± standard deviation (SD) and analyzed by SPSS 13.0 software package. All tests were two-sided, and \( P<0.05 \) was considered as statistical significance.

**RESULTS**

**Surgical results (Table 1)**
The mean duration from operation to last available follow-up films was 11.6 months (range, 8-24 months). There were no statistical differences in the age, gender, the interval between the injury and operation, preoperative diagnosis, the injured segments between the two groups. SPPSF group showed significantly less intraoperative and postoperative volume of blood loss, operation time, postoperative hospital stay, blood transfusion and the anterior and posterior vertebral body height (%) than OPSF group (\( P<0.0001 \), \( P<0.0001 \)). SPPSF group needed significantly less transfusion and much smaller incision than OPSF group (\( P<0.05 \), \( P<0.05 \)). SPPSF group had a shorter hospital stay (\( P<0.0001 \)) and significantly longer operation time than OPSF group (\( P<0.0001 \)). All perioperative data are illustrated in Table 1.

**Radiological results (Table 2)**
The measurements of kyphotic deformity before and after operation are shown in Table 1. Mean preoperative kyphotic deformity in the OPSF group was 16.0° (1°-29°). An average of 9.3° of kyphosis correction was achieved, improving kyphotic angulation to 6.8° in the
immediate postoperative period in the OPSF group, but 15.2° (0-28°), 10.3°, 3.9° respectively in the SPPSF group. Among the patients whose 9-month follow-up films were available, (3.0°±1.5°) of kyphosis correction was lost in the OPSF group, but (3.2°±1.6°) in the SPPSF group. Mean preoperative angle of the fractured vertebral body in the OPSF group was 15.9° (4°-25°). Average 7.9° of kyphosis correction was achieved, improving kyphotic angulation to 8.0° in the immediate postoperative period in the OPSF group, but 14.9° (3°-25°), 6.6°, 8.2° respectively in the SPPSF group. Among the patients whose 9-month follow-up films were available, (3.0°±1.5°) of kyphosis correction was lost in the OPSF group, but (3.2°±1.6°) in the SPPSF group. Mean anterior vertebral body height (% of normal) was 67.3% (44.4%-92.3%) before surgery and 95.8% after surgery, yielding an average vertebral body height restoration of 28.6%, but 69.1% (51.5%-93.2%), 90.1%, 21.0% respectively in the SPPSF group. Among the patients whose 9-month follow-up films were available, (3.0°±1.7°) of the anterior vertebral body height correction was lost in the OPSF group, but (2.2±1.4%) in the SPPSF group. Mean posterior vertebral body height (% of normal) was 93.3% (83.5%-100%) before surgery and 99.5% after surgery, yielding an average vertebral body height restoration of 6.2%, but 88.9% (81.3%-98.0%), 93.3%, 4.4% respectively in the SPPSF group. Among the patients whose 9-month follow-up films were available, (3.0±1.3%) of the posterior vertebral body height correction was lost in the OPSF group, but (2.5±1.1) % in the SPPSF group.

There was significant difference in sagittal Cobb’s angle, fractured vertebra angle and anterior height of the vertebral body in each group between preoperation and postoperation (P<0.01). There were no significant differences in the improvement of sagittal Cobb’s angle, fractured vertebra angle, the improvement of the vertebral body height and the kyphotic deformity correction between the two groups (P>0.05), but the postoperative anterior height of the fractured vertebra was significantly different (P<0.05). There were no significant differences (P>0.05) in the correction loss of sagittal Cobb’s angle, the fractured vertebra angle and the anterior height and posterior height of the fractured vertebra in the two groups at 9-month follow-up.

Clinical results

Four patients in the OPSF group received blood transfusion and the total blood volume was 2 200 ml. None in the SPPSF group received transfusion. The proportion of patients receiving antalgic supplement is 61.9% (13/21) in the OPSF group, 11.8% (2/17) in the SPPSF group. There were significant differences in the blood transfusion and the proportion of patients receiving antalgic supplement between the two groups (P<0.05). The mean value of VAS for postoperative back pain was significantly different in SPPSF group at the first week after surgery compared with the OPSF group (P<0.05). As for outcome after spinal surgery in the Modified Macnab criteria, 15 (excellent in 9, good in 6, fair in 2)/17 in SPPSF group (88.2%) and 18 (excellent in 11, good in 7, fair in 2)/21 in OPSF group (85.7%) had good to excellent results (Table 3). There was no statistical difference between the two groups in clinical results at the 6-month follow-up (P>0.05). In the two groups, all the patients in ASIA grade D recovered completely and the patients in grade E remained the same during the observation period.

Complications

In the OPSF group, screw malpositions (3 pedicle screws, 2.1%) were seen in two patients without clinical symptoms and necessity for revision. Two patients had incision stagger, who were treated successfully with restitching, taking oral antibiotics in the OPSF group. One patient developed a deep venous thrombosis of the left lower extremity 3 months after the surgery, which was managed successfully with drug therapy. There were no complications in the SPPSF group.
Figure 1. A 41-year-old man with L₂ compression fracture caused by tumble. A: On lateral films, 14° of preoperative kyphotic deformity and 37% loss of anterior vertebral body height were noted. B: The intraoperative fixation showed that the patient underwent 3-segmental posterior pedicle screw fixation, which improved kyphosis correction to 4° and restored anterior vertebral body height to 98%. C: Lateral views of the spine in the immediate postoperative period. D: Lateral view of the spine at 1-year follow-up. There was no significant loss of the correction.

Figure 2. A: The lateral C-arm fluoroscopic image shows that PAK needle reaches the boundaries of the pedicle. B: the AP C-arm fluoroscopic images. The PAK needle reaches the medial pedicle wall. C: the rod is inserted and gets to the final position. D: Intraoperative fluoroscopic image confirming the correct placement of the percutaneous rod.

Figure 3. A 24-year-old man with the L₁ compression fracture caused by a traffic accident. A: On lateral films, 30° of preoperative kyphotic deformity and 53% loss of anterior vertebral body height were noted. B, C: Lateral and AP views of the spine and the view of the incision in the immediate postoperative period. The patient underwent 3-segmental posterior pedicle screw fixation with Sextant system, which improved kyphosis correction to 3° and restored anterior vertebral body height to 88%. D: Lateral view of the spine in one year postoperative period was shown. There was no significant loss of the correction.
DISCUSSION

Biomechanical and clinical studies of transpedicular fixation into the injured vertebra for thoracolumbar fractures

Traditional short-segment fixation involves pedicle screw placement only at the levels immediately adjacent to the fractured vertebra. Since this procedure is popular, several researchers have reported unacceptably high failure rates of this technique. In most burst fractures, the posterior column of the fractured vertebra remains intact and provides additional points of fixation. The use of intermediate screws can increase the stability of fixation so as to lower the probability for loss of reduction. There are so many researches indicating that the placement of pedicle screws into the fractured vertebra generates a segmental construct, which demonstrates improved biomechanical stability compared with a nonsegmental construct. Firstly, this additional point of fixation allows for a 3-point reduction maneuver of the fractured segment and a better pull-out strength as 2 more fixation points are provided, so the technique can increase the fixation stability and shield the fractured vertebra from anterior loads. Secondly, the supplemental screws may have protective effects on the fractured vertebra by indirectly supporting the anterior column. Thirdly, the technique can avoid pulling the normal intervertebral discs above and below the fractured vertebra and the over-contoured rods can connect the three screws and the fixed vertebra, so the rods can shove the fractured vertebra and promote the height recovery and reduction.

Comparison between the percutaneous pedicle screw fixation and traditional open fixation through the fractured vertebral body for treatment of thoracolumbar fractures

Open posterior instrumented lumbar fusion procedure is known to be a widely accepted method for the management of a variety of spinal disorders requiring spinal stabilization but it has additional surgical risks, such as a high infection rate, elevated blood loss, more damages to the paraspinal musculatures, prolonged operative time and hospital stay, risk of instrumentation failure. To minimize these negative consequences of screw rod instrumentation, some surgeons have been

<table>
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<tr>
<th>Variables</th>
<th>SPPSF group</th>
<th>OPSF group</th>
<th>t value</th>
<th>P value</th>
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<tr>
<td>Average incision size (mm)</td>
<td>9.4±0.9 (8.0-11.0)</td>
<td>11.8±2.8 (6-15)</td>
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<td>Average surgical blood loss (ml)</td>
<td>83.5±51.8 (30-200)</td>
<td>304.8±209.1 (50-750)</td>
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<td>Average postoperative drainage (ml)</td>
<td>14.4±4.3 (10-20)</td>
<td>350.1±204.5 (10-820)</td>
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<td>Average surgical time (min)</td>
<td>97.1±15.3 (80-130)</td>
<td>161.0±72.5 (75-385)</td>
<td>3.915</td>
<td>0.001</td>
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<td>Average postoperative hospital stay (days)</td>
<td>11.1±3.8 (5-18)</td>
<td>22.9±14.1 (9-52)</td>
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<td>Average VAS on postoperative pain of incision</td>
<td>1.5±0.9 (0-3)</td>
<td>2.2±0.8 (1-4)</td>
<td>2.526</td>
<td>0.016</td>
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**Table 2. Radiographic data on kyphotic deformity (mean±SD)**

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<tr>
<th>Groups</th>
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<th>Postoperative</th>
<th>Changes</th>
<th>Preoperative</th>
<th>Postoperative</th>
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<td>SPPSF</td>
<td>16.0±9.3</td>
<td>6.8±5.3</td>
<td>9.3±7.3</td>
<td>15.9±5.7</td>
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<td>OPSF</td>
<td>15.2±7.8</td>
<td>3.9±2.6</td>
<td>10.3±6.1</td>
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<td>8.2±4.7</td>
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<td>P value</td>
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<th>Preoperative</th>
<th>Postoperative</th>
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<td>SPPSF</td>
<td>67.3±16.1</td>
<td>95.8±9.3</td>
<td>28.6±18.7</td>
<td>93.3±5.5</td>
<td>99.5±4.4</td>
<td>6.2±4.8</td>
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<tr>
<td>OPSF</td>
<td>69.1±12.4</td>
<td>90.1±10.0</td>
<td>21.0±11.8</td>
<td>88.9±5.0</td>
<td>93.2±5.0</td>
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<td>P value</td>
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<td>1.453</td>
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working for a percutaneous means of spinal fixation.\textsuperscript{7,12,17-21} Percutaneous pedicle screw fixation permits a safe application while preserving soft tissues without relevant blood loss and persisting sequelae, such as muscular denervation, atrophy, and pain.\textsuperscript{3-6}

In our study, the operation time and blood loss can be drastically reduced compared with the open technique. There was a statistically significant difference in the posterior incisional VAS between two groups. The decreased postoperative pain could potentially yield benefits, such as earlier mobilization, shorter recovery time and hospital stay, and less hospital cost. The patients in SPPSF group were discharged at an average of 11.1 postoperative days, compared with the 23.6 days in OPSF group. No differences were found in terms of clinical outcomes assessed by Modified Macnab criteria between the two groups. This result suggests that the percutaneous pedicle screw fixation through the pedicle of fractured vertebra using Sextant system is a good minimally invasive surgical therapeutic choice for patients with type A thoracolumbar fractures except for the fact that the SPPSF has a little insufficiency in resuming the anterior height of the fractured vertebra compared with the OPSF.

**Insufficiency and managements of percutaneous pedicle screw fixation using Sextant system for thoracolumbar fracture**

**Malposition of pedicle screws** Placement of pedicle screws percutaneously limits the exposure and orientation. To compensate for this, the entry points and trajectory are localized with a series of C-arm fluoroscopic images. While inserting the pedicle screws, we must keep these trajectories in mind by multiple sequential fluoroscopic images of the pedicle probe in at least two planes to ensure the accuracy of the percutaneous screw placement. Fortunately, there was no malposition of pedicle screws in the percutaneous pedicle screw fixation group in our study.

**Higher expense on instrumentation using Sextant system** The application of implants and the Sextant system are more expensive but the percutaneous instrumentation permits a safe application while preserving soft tissues with relevant reduced blood loss and operation time compared with the open technique. So the technique can decrease the postoperative pain, which could potentially yield benefits, such as earlier mobilization, shorter recovery time and hospital stays and less hospital cost.

**Avoiding spinal canal decompression and spinal fusion** The Sextant system can not carry out the decompression of the vertebral canal and fusion of the spine, which can be achieved by some specific endoscopic systems such as METRx and Quadrant. Zhou \textit{et al}\textsuperscript{22} did the surgical treatment of percutaneous pedicle screw fixation, discectomy, spinal canal decompression and autograft implantation using METRx operation system in patients with lumbar disc herniation and segmental instability, then pointed out that the surgical procedure has some disadvantages, but it has shown predominant benefits, including small incision, less stripping of paraspinal muscles, less blood loss and rapid postoperative recovery.

**Insufficiency in the correction** Compared with the OPSF group, SPPSF group has a little insufficiency in resuming the anterior and posterior height of the fractured vertebral body. We can impute the insufficiency of the abnormality correction to the usage of multiaxial Sextant pedicle screws which can not keep the vertebral body height. So in our study, the patients were in supine position with cushions under the thoracolumbar segment after admission and in the prone position with cushions under the iliac crests and the thorax in the surgery so that the spine was in a hyperextension position and postural reduction was performed. At this time, both instrumental and postural reductions took effect on the vertebrae.

**High difficulty of the surgical technique** A thorough knowledge on the surgical anatomy, experience in open surgery and ability to master hand-eye coordination are critical for the success of percutaneous pedicle screw fixation surgery. Percutaneous fixation of pedicles carries a steep learning curve and mandates proper training before its routine usage. In order to maintain anatomic orientation during minimally invasive spinal surgery, the surgeon should be able to recreate this unseen anatomy in mind and assess the surrounding anatomy and repair it easily when a complication occurs intraoperatively. Some authors reported a safer insertion technique of percutaneous pedicle screw using computer-assisted fluoroscopic navigation, 3-dimentional fluorooscopy or a Bone Mounted Miniature Robotic System-based technique.\textsuperscript{8,23-25}
**Indications and contraindications for the percutaneous pedicle screw fixation**

As far as we know, the percutaneous pedicle screw fixation through the pedicle of fractured vertebra using Sextant system in the treatment of thoracolumbar fracture can be performed in all type A fractures, especially the A1, A2.1, A2.2 and A3.1 fractures according to the AO fracture classification. In A2.3, A3.2 and A3.3 fractures, there are so many segregative bone fragments in the fractured vertebral body, and the pedicle screws inserted into the fractured vertebral body can influence the restoration of the fragments.

Based on the results of this study, we suggest the following indications for minimally invasive percutaneous pedicle screw fixation: (1) single level spinal vertebral body fracture, the vertebral compression is less than 2/3 of its real height, and the anterior column is compressed; (2) the Cobb’s angle is less than 30°, with no neurodeficits; (3) the vertebral canal blocked area is less than 1/3 in sagittal diameter, with no neurodeficits; (4) Grade D and Grade E in ASIA scale, no need for posterior decompression of the vertebral canal; (5) all the type A fractures, especially the A1, A2.1, A2.2 and A3.1 fracture according to the AO fracture classification.

The surgery contraindications are listed as follows: (1) spinal vertebral body fractures at more than one level; (2) fracture in the pedicle of the fractured and/or the adjacent vertebrae; (3) rotation concomitant with instability or dislocation in the fracture; (4) severe neurodeficits, which require complete vertebral canal decompression.

**Conclusion**

In conclusion, percutaneous pedicle screw fixation through the pedicle of fractured vertebra using Sextant system is a good minimally-invasive surgical procedure for patients with type A thoracolumbar fracture. A thorough knowledge on the surgical anatomy, experience in open surgery and ability to mastering hand-eye coordination are critical for success of percutaneous pedicle screw fixation surgery. Therefore, the patient selection for this surgery should be more strict and cautious than the open procedure and consistent with the surgeon’s experience and surgical abilities.

**REFERENCES**


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ERRATUM

This is to notify that the first name and last name of some authors in the article “Spinal fractures resulting from traumatic injuries” published at the first issue of 2010 have been incorrectly listed. According to our journal guideline, some authors’ names should be rotated as below: Pedram (first name) Heidari (last name), Mohammad Reza Zarei, Mohammad Reza Rasouli, Vafa Rahimi-Movaghar. Similarly in the PubMed and footnote, the authors’ names should be changed as below: Heidari P, Zarei MR, Rasouli MR, Rahimi-Movaghar V. Among the authors, Alexander R Vaccaro is correctly listed.

Editorial Office