Comparison of Percutaneous and Open Posterior Spinal Fixation in Thoracolumbar Fractures

Ahmed Elsawaf* and Mohamed Al-Qazaz
Department of Neurosurgery, Suez Canal University, Ismailia, Egypt

ABSTRACT

Background: Unstable thoracolumbar fractures are usually managed by posterior instrumentation. The standard open pedicle screw fixation or the newly introduced percutaneous technique can be used. Objectives: The purpose of this study was to provide safety and feasibility of both techniques and getting a more obvious plan for choosing either of them in such cases. Methods: This is a prospective study of a total of hundred and sixty-six patients with unstable thoracolumbar fractures with a mean follow-up of 14 months (range 10-21), they were classified randomly into two groups: Group I: Patients who underwent percutaneous spinal fixation and minimally invasive decompression if needed (72 patients). Group II: Patients who underwent standard open pedicle screw fixation with open decompression (94 patients). All patients had complete clinical assessments using Frankle grading scale and the visual analogue scale (VAS) for assessment of fracture site pain. We had also neuro-radiographic assessment (Antero-posterior X-ray, thin cuts CT scan and MRI imaging) at the first presentation and at 3, 6 and 12 months later. Results: Immediately after surgery, percutaneous approach had a significantly better results compared to open procedures in respect to operative time, hospital stay, and postoperative pain. At the final follow-up, there was significant clinical and radiological improvement according to Frankle grading scale in both groups. The Cobb angle and degree of canal encroachment also assessed respectively. Conclusion: Percutaneous technique in stabilizing the thoracolumbar fractures could be done regularly in all cases with percutaneous minimally invasive decompression if needed. Open spinal fixation can be reserved for significant canal compromise especially if multilevel decompression is required.

INTRODUCTION

Posterior spinal fixation is a common technique used for many purposes especially to spinal trauma. Open and percutaneous techniques are used nowadays in many centers.

Inserting screw inside the pedicle is an easy technique done by all neuro- and orthopedic surgeons. In spite of this, pedicle accuracy is not achieved by all surgeons; this could be for less experience, individual patient abnormality in anatomy, or over trust with no use of imaging techniques.

Open spinal fixation technique is more familiar to surgeons and may achieve more pedicle accuracy. It usually involves single long midline incision extending above and below the fixed levels, with opening of the ligaments and muscles and dissecting them laterally to expose the posterior part of the vertebra visualizing the site of entry of screw at the intersection of transverse process and facet joint.

On the other hand, the percutaneous technique depends on inserting the screw and rod from a small stab incision with fewer invasions to muscles, ligamentous structures, consequently less blood loss, shorter duration of recovery and hospital stay. The regular use of intraoperative imaging in percutaneous technique may get better results regarding pedicle accuracy.

Assessment of each procedure is discussed in the literature but long and large comparative studies are deficient. In our study we are comparing on long term a large number of patients operated by both techniques evaluating their clinical and radiological outcome in a trial to reach a definitive way for surgical treatment of patients with thoracolumbar fractures.

PATIENTS AND METHODS

This is a prospective randomized study done at the period between 2009 and 2015. The study includes one-hundred and sixty-six patients with unstable thoracolumbar fractures that underwent the full criteria for surgical fixation by posterior pedicle screw fixation. In this study some cases were operated as single level (one level above and one level below), or multi levels (two level above the fracture and one or two levels below)
The patients in this study were classified into two groups:

- **Group I**: Seventy-two patients had a percutaneous fixation, and percutaneous decompression if needed.
- **Group II**: Ninety-four patients were operated for open pedicle screw fixation with direct decompression.

For group I; Forty-six patients were operated for a single-level fixation, and twenty-six patients were operated for a two-level fixation. In group II, only thirteen patients were operated for a single level sixteen and eighty-one patients were operated for two level fixation.

### Table 1: Frankel grade scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>'Complete'</td>
</tr>
<tr>
<td>B</td>
<td>'Sensory only'</td>
</tr>
<tr>
<td>C</td>
<td>'Motor Useless'</td>
</tr>
<tr>
<td>D</td>
<td>'Motor Useful'</td>
</tr>
<tr>
<td>E</td>
<td>'Recovery'</td>
</tr>
</tbody>
</table>

1. 'Complete' (A). This means that the lesion was found to be complete both motor and sensory below the segmental level marked.
2. 'Sensory only' (B). This implies that there was some sensation present below the level of the lesion but that the motor paralysis was complete below that level.
3. 'Motor Useless' (C). This implies that there was some motor power present below the level but it was of no practical use to the patient.
4. 'Motor Useful' (D). This implies that there was useful motor power below the level of the lesion. Patients in this group could move the lower limbs and many could walk, with or without aids.
5. 'Recovery' (E). This implies that the patient was free of neurological symptoms, i.e. no weakness, no sensory loss, no sphincter disturbance. Abnormal reflexes may have been present.

### 2- Radiological assessment:

**Whole spine lateral and antero-posterior X-rays;**

Were done for all patients determining the level of spinal fracture, kyphotic angle and Sagittal deformity were measured by Cobb angle (The Cobb angle is the angle between the superior endplate of the upper and the inferior endplate of the lower adjacent vertebra by the Cobb method); it reflects the changes in the segmental curve.

**Computerized tomography Assessing:**

- The level of fracture,
- Transverse diameter of the spinal cord at the level of maximal compression,
- Three column assessment of stability according to Megrl Denis classification
- Measure of the target pedicles diameter to plan the screw size,

Postoperative screw position which is classified in our study into:

- **Satisfactory**: Intact intra-pedicular position,
- **Accepted**: Screw outside the pedicle but violating cortex of no more than 3 mm, and
- **Not accepted**: Violating cortex of more than 3 mm.

MRI was done for all patients to assess the neural compromise and to exclude underlying hematoma or accompanying disc herniation.

### Statistical Analysis

The Microsoft Excel-sum test was used to analyze differences in preoperative clinical and demographic characteristics (age, number of involved levels, duration of symptoms), and in variables affecting the outcome (Frankle grading scale, and motor and sensory deficit improvement). Data are presented as mean values ± standard deviation (SD). Statistical significance was set at P < 0.05.

### RESULTS

In our study, the mean age of the patients was 33 in group I, and 37 in group II. One hundred ninety-six levels were fixed in group I (forty-six patients; one level above and one level below, and in twenty-six patients; two levels above and two levels below), and three hundred- twenty-nine levels in group II (in 13 patients; one level above and one level below, in 60 patients; two levels above and two levels below, and in 21 patients; two levels above and one level below).

Clinical outcome:

**In group I (Percutaneous group):** Pain at the fracture site improved from a mean VAS of 7.8±3.7 preoperatively to a mean of 4.2±8.1 two weeks postoperatively. This was improved to a mean VAS of 1.9±5.4 at final follow-up. According to the neurological examination; preoperatively, thirty-two patients had Frankle grade E, all of them had the same grade postoperatively with no neurological deterioration of any of them. Twenty-two patients had Frankle grade D preoperatively, they underwent percutaneous transpedicular decompression with improvement of
twenty patients to Grade E but two patients had grade D at final follow-up after 1 year. Thirteen patients had preoperative Frankle grade C; eight of them had improved to grade E, one patient also improved to grade D, and four patients did not show any improvement at final follow (12 months after surgery). Five patients had pre-operative grade B, three of them remained in the same grade postoperatively and the other two showed partial improvement to grade C.

In group I, Forty patients had neurological deficit at presentation, thirty-one (77%) of them showed neurological improvement at the final follow-up. The patients without neurological deficit had no surgical decompression of the fracture except in four patients who had preoperative canal encroachment of more than 50% without neurological deficit for fear of the possible future stenotic symptoms.

The mean operative time was 115 minutes (range 60–220 minutes); this time was calculated from the start of first surgical incision till final closure of last incision. The operative time was longer at the first cases but started to decrease steadily with getting more experience in the approach. Intra-operative blood loss was calculated in the suction bag and in the tissues used for cleaning; it was always less than 100 ml. No-one case needed blood transfusions in the percutaneous fixation group.

Regarding hospital stay, it ranged from 33 to 87 hours postoperatively; this was calculated from start of recovery to final discharge of the patients with a mean of 44 hours. Only one patient had deep infection and collection of pus. This patient was admitted for about 10 days more for the management and follow-up of the wound.

In group II (open fixation): regarding pain at the fracture site; preoperatively, the degree of pain was 8.2 ±3.6 according to visual analogue scale. It changed to a mean of 5.7 ±3.5 two weeks postoperatively and to a mean of 4.4±7.4 at the final follow-up.

Regarding the neurological improvement assessed by Frankle scale at final follow visit, thirty-one patients had Grade E preoperatively; all of them had the same grade postoperatively. In eighteen patients, Grade D was taken, two of them remained in the same grade postoperatively but sixteen patients improved to grade E. Twenty-eight patients had grade C preoperatively; twenty of them improved to grade E, seven to grade D and only one patient showed no significant improvement. Seven patients had grade B preoperatively; six of them had improved to grade C, and one patient remained in grade B. Ten patients were found to be completely paraplegic after the trauma and were scored as grade A, seven of them still had the same grade at final follow-up, and three showed some improvement to grade C.

So, in a total of ninety-four patients in group II who was operated by open fixation, sixty-three patients had neurological deficits preoperatively. Fifty three of them (84%) showing clinical improvement at the final follow up visit.

The mean operative time was 189 minutes (range 110–310 minutes). The operative time was longer than percutaneous fixation because of time lost in soft tissues dissection and closure of all layers at the end of surgery. Intra-operative blood loss was calculated in the suction bag and in the tissues used for cleaning, with average blood loss of 880cc.

Regarding hospital stay, it ranged from 96 to 220 hours postoperatively; with a mean of 166 hours. This is not including the cases who had complications like deep infection who required longer duration extending up to two months.

Radiological outcome:

Postoperative screw position was evaluated immediately after surgery by thin cut bone window CT scan. In group I, 392 screws were inserted in the seventy-two patients of that group; 325 screws (83%) were classified as satisfactory, 67 screw as accepted and no screw was classified as non-accepted regarding our classification. In group II, however, 658 screws were inserted in the ninety-four patients of that group; 490 screws were satisfactory (75%), 154 screws were acceptable and 14 screws were classified as non-accepted and showed violation of the pedicle cortex more than 3 mm, but only 6 of them needed revision surgery.

Correction of kyphotic deformity produced by loss of anterior height of the fractured vertebra is an important goal in surgery. There was no significant difference in the correction of kyphotic deformity in both groups. In group I, Cobb angle was changed from a mean of 17.4°±7.1 preoperatively to a mean of 5°±8.6 postoperatively. In group II (open group), the Cobb angle showed also significant improvement from a mean of 20.8°±6.5 preoperatively to a mean of 3.1°±5.3 at the final follow-up visit postoperatively (Table 2).

Table 2: Frankle grade scale.

<table>
<thead>
<tr>
<th></th>
<th>VAS</th>
<th>Pedicle accuracy</th>
<th>Cobb angle</th>
<th>Canal diameter</th>
<th>Complications</th>
<th>Blood loss (ml)</th>
<th>Hospital stay (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>77%</td>
<td>7.8</td>
<td>1.9</td>
<td>83%</td>
<td>17.4</td>
<td>5</td>
<td>10.4</td>
</tr>
<tr>
<td>Group II</td>
<td>84%</td>
<td>8.2</td>
<td>4.4</td>
<td>75%</td>
<td>20.8</td>
<td>3.1</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Elsawaf and Al-Qazaz / Percutaneous Fixation in Thoracolumbar Fracture, Volume 31 / No. 2 / April - June 2016 125-130
The Improvement of the transverse diameter of the spinal cord at the level of maximal compression was shown in both groups but was more significant and obviously in group II than in group I. In percutaneous group (I), the canal sagittal diameter was 10.4±1.2 mm on the computer tomography scan; it was improved to 11±2.5 mm postoperatively. In group II, the canal diameter was of 9.44±3.2 mm preoperatively, it improved to 19.62±3.48 mm after surgery.

There were statistically significant correlation (P<0.001) between the improvement of canal diameter at the level of the maximal compression and the neurological improvement assessed by Frankle grading scale (Figure 1).

Complications:

In the percutaneous group, only one patient had deep infection and collection of pus. This patient needed exploration of the caudal incision and evacuation of the pus from this incision and inserting catheter in cephalic direction above the rod for 1 week with IV antibiotics according to culture and sensitivity. Five patients had superficial wound infection treated conservatively by simple dressings. One patient had retroperitoneal hematoma caused by slipping of the guide trocar anteriorly before pedicle penetration; this patient was followed conservatively.

In group II, thirteen patients had superficial infection treated by simple dressings. Five patients had deep infection, 3 of them needed operative debridement but none with hardware removal, (Figure 2). Two cases of unintended durotomy occurred beneath a laminar fracture.

Complications had happened in 9.7% of cases of group I, and in 21% of group II (blood loss, need for blood transfusion and long hospital stay were not included in the complications).

DISCUSSION

Posterior spinal fixation is the most common surgical procedure for treatment of thoracolumbar fractures. The traditional open pedicle screw fixation was used for many years and was described enormously in the literature. Percutaneous spinal fixation was introduced recently to improve the outcome of this procedure by a less invasive technique with lower morbidity.
In this study we compared the clinical and radiological outcome of both techniques to find out the actual benefits and hazards of these approaches.

Neurological improvement was shown in both groups operated either by open or by percutaneous approach. These results are matching with most of the studies done evaluating both approaches separately.

In our study, 87.5% of percutaneous group showed either completely normal or neurological improvement according to Frankle grade. On the other hand 89.5 % in group II showed similar results. Sakari had 84.6% good to excellent clinical outcome in his study, similar to that of 89.4% of Schwender and 91.1% of Foley. 

In this series the neurological improvement showed statistically significant correlation to the degree of improvement of sagittal canal diameter at the area of maximum compression, this was more obvious in group II.

This can be explained by the wide laminectomy done in most of those cases and the more familiarity of the surgeons by open decompressive procedures rather than the percutaneous decompressive techniques.

Also our results showed that pain was less in the percutaneous group either immediately post surgical or later at the last follow up. This can be explained by the small stab incision done, neither muscle, periosteal dissection, cauterization nor iatrogenic injury to the ligamentous and bony structures was.

This result matches with other results evaluating the pain in each technique separately.

In spite of the high price of the cannulated screw used for percutaneous technique, the less blood loss and hospital stay shown in the percutaneous group compared to open group has a direct impact on the total cost in favor to the percutaneous technique.

Pedicle accuracy showed some superiority in the percutaneous technique, this can be explained by the continuous radiological guidance during surgery rather than the open technique. Perfect lateral and AP images are needed to place screws safely. 83% of the screws inserted showed satisfactory position in the percutaneous technique, this percentage is somewhat worse than other studies; Sarkari in his series over 14 patients assessing the percutaneous technique found only 3.3% pedicle breach confirmed by CT scan. Wiesner also had near results of 6.6% pedicular encroachment; this can be explained by the larger number of patients in our series.

In our series, the open group had only 75 % satisfactory position. It is also less than most of the articles published regarding this topic; Kosmopoulos V in a meta-analysis found that 91.3% were identified as accurately placed for the combined in vivo and cadaveric populations after analysis of 130 studies. Van de Kelft the other hand had 97.5 % accuracy using the O-arm with the navigator.

The differences between percutaneous techniques and open techniques regarding blood loss and hospital stay are obvious and clear.

In our study, no patient needed blood transfusion for the percutaneous group with an average of less than 100 ml blood loss in all cases. On the other hand, twenty patients received 1 unit packed red blood cells in the open technique. In addition to the cost of the blood transfusion, the medical hazards of the transfusion process and the need to get donors in cases of unavailable rare blood groups increase the overall risk in the open technique. Schwender et al described their technique of mini-PLIF. The mean blood loss of 140 ml and mean hospital stay of 1.9 days in their series is comparable to that of 94 ml and 3.8 days respectively in Sakari’s study.

CONCLUSION

Percutaneous technique in stabilizing the thoracolumbar fractures could be done safely and effectively in all cases with minimal invasive intersegmental neural decompression if needed. It has many advantages over the standard open technique with similar clinical outcome and less complications. Open spinal fixation can be reserved to patients with significant canal compromise, especially if multilevel decompression is required. Personal experience in percutaneous technique is required to achieve good results. Hazards of exposure to continuous x-ray should be considered as a disadvantage to percutaneous technique.

Declaration

The author(s) declare no conflict of interest or any financial support and confirm the approval of the submitted article by the concerned ethical committee.

REFERENCES


