Percutaneous Posterior Fixation: A Unique Entity to minimize Further Damage to Patient with Traumatic Spine

Kaushal R Patel, Jayprakash V Modi, Kirtan V Tankshali

ABSTRACT

Introduction: Percutaneous posterior fixation is a novel and unique modality to fix traumatic spine injury. Conventionally, traumatic spine injury severe enough to consider for fixation is approached by open method. However, this method is disadvantageous as there occurs further trauma to the surrounding soft tissue while approaching spine for fixation. Percutaneous technique, on the contrary, offers stable fixation as conventional method and also offers added advantage of minimal soft tissue damage.

Study design: This is an original prospective cohort study of 35 patients having traumatic spine injury operated by percutaneous posterior fixation.

Aims and objectives: To compare the midterm results of percutaneous posterior fixation vs conventional (open) posterior fixation and to evaluate the role of percutaneous posterior fixation as damage control surgery (DCS).

Materials and methods: This is a prospective cohort study of 35 patients operated at a single center from January 2012 to January 2014 with 2 years of follow-up.

- Inclusion criteria:
  - Patients having traumatic thoracic or lumbar spine injury between level T10 and L3
  - Age >18 years
  - Polytrauma patients having associated spine injury
  - Patients having normal neurology
  - Patients having A1, A2, or A3 type of injury according to AO classification

- Exclusion criteria:
  - Patients having neurological deficit
  - A4 type of injury

Results: As observed in our study, traumatic spine injury is more common in middle-aged male patients. Percutaneous fixation provides definitive advantage over conventional method of posterior fixation in terms of decreased intraoperative blood loss, decreased postoperative pain, earlier mobilization of the patients, reduced duration of hospital stay, less complications, and better functional outcome as measured by visual analog scale (VAS) score, Oswestry disability index (ODI) score, and SF-36 score, modified MacNab’s criteria.

Postoperatively, all the patients had either excellent or good outcome as measured by MacNab’s criteria.

Conclusion: Midterm results of percutaneous fixation are equivalent to conventional method with added advantage of reduced risk of infection as observed in our study. Percutaneous fixation has more to it rather than only DCS, however, its role in replacing conventional method requires proper surgeon training, steep learning curve, long-term studies and critical evaluation.

Keywords: Normal neurology, Percutaneous posterior fixation, Traumatic spine.

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Conflict of interest: None

INTRODUCTION

Minimally invasive spine surgeries are one of the most recent advances in spine surgeries. It has already established its role in surgeries like discectomy and has shown potential benefits in the surgeries like MIS-TLIF. Though in use for almost a decade now, its role in management of traumatic spine injuries remains to be established yet. Percutaneous posterior pedicle screw fixation is a novel and unique modality to fix traumatic spine injury. Conventionally, traumatic spine injury severe enough to consider for fixation is approached by open method. However, this method is disadvantageous as there occurs further trauma to the surrounding soft tissue while approaching spine for fixation. Percutaneous technique, on the other hand, offers as stable fixation as conventional method and also offers added advantage of minimal soft tissue damage. With improvements in imaging modalities along with better understanding of spinal anatomy, it is now possible to place the pedicle screws by percutaneous approach without damaging nerve roots. A promising novel technique of navigation guided percutaneous pedicle screw insertion has also emerged, however, it is difficult to study in detail the results of this technique due to limited outreach and cost.

MATERIALS AND METHODS

This is a prospective cohort study of 35 patients of traumatic spine injury operated at a single center by percutaneous pedicle screw insertion from January 2012
to January 2014. All the patients were followed up to 2 years postoperatively.

**Inclusion criteria**

- Patients having traumatic thoracic or lumbar spine injury between level T10 and L3
- Age >18 years
- Polytrauma patients having spinal injury as an associated component
- Patients having normal neurology
- Thoracolumbar injury classification and severity score (TLICS) ≤ 4

**Exclusion criteria**

- Patients having neurological deficit
- TLICS > 4

All the patients were followed postoperatively for 2 years and functional outcome measured in terms of VAS, Oswestry disability index (ODI), SF-36 scoring and modified MacNab’s criteria.

**TECHNICAL ASPECTS**

The technique described here uses intraoperative radiography [image intensifier (II)]. The sequence of percutaneous placement of pedicle screw insertion is described below (Figs 1 and 2). We have used sextant system of medtronics for percutaneous pedicle screw insertion (Fig. 3).

Place the IITV-C arm in AP direction with centring of the spinous process. Mark the position of the lateral border of the pedicle on the skin. The skin incision should be made laterally, so that the Jamshidi needle can be
angled appropriately. Place the needle through the incision and “dock” onto the lateral aspect of the pedicle, i.e., “3 o’clock” position. Advance the needle for 20 mm into the pedicle, make sure that the needle remains lateral to the medial pedicle wall. Position the IITV in the lateral plane. The Jamshidi needle should be in the vertebral body, and “safe” with no risk of medial pedicle breach. Place a K-wire down the Jamshidi needle and place a pedicle tap down the trajectory of the K-wire (Fig. 4). Engage the final pedicle screw down the K-wire, make sure not to advance the K-wire beyond the anterior wall of the vertebral body. After insertion of required screws, the rod trocar is used to help make a path through the fascia and muscle down to the saddle of the first screw (Fig. 5). A small skin incision is required and then the trocar is advanced through the muscle until it hits the first screw saddle. Then the rod of measured length is advanced in the same direction.\textsuperscript{1-3}

RESULTS

In our study, out of 35 patients, 25 were males and 10 were females. Age of the patients ranged from 18 to 55 years with an average age 35 years. Distribution of patients according to the level of operated spinal injury is shown in the Table 1.

Duration of surgery, blood loss during surgery, day of postoperative mobilization and duration of hospital stay was noted for all the patients. Average of these values is described in the Table 2.

Average preoperative VAS score was 6 whereas postoperative VAS score was 1 at the end of 2 years. Average preoperative ODI score was 42 whereas postoperative score was 3.8, at the end of 2 years. Average preoperative SF 12 score was 24.14 and postoperative average SF 12 score

**Table 1:** Distribution of patients according to level

<table>
<thead>
<tr>
<th>Level</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>T11</td>
<td>5</td>
</tr>
<tr>
<td>T12</td>
<td>11</td>
</tr>
<tr>
<td>L1</td>
<td>11</td>
</tr>
<tr>
<td>L2</td>
<td>8</td>
</tr>
</tbody>
</table>

Fig. 4: The IITV images depicting Jamshidi needle, K-wire insertion and tapping

Fig. 5: Technique of rod insertion
was 31.2 in those operated by percutaneous method (Table 3 and Graph 1).

Table 4 shows MacNab’s score at the end of 2 years:

- There was not a single case of infection at the end of 2 years of follow-up in our study (Table 5).

DISCUSSION

As observed in our study, traumatic spine injury is more common in middle-aged male patients. Patients of polytrauma with normal neurology were selected, specifically for percutaneous fixation so as to prevent iatrogenic trauma to already traumatized patient and to allow vocational rehabilitation as early as possible. As observed in our study, percutaneous pedicle screw insertion offers advantages in terms of decreased duration of surgery, decreased intraoperative blood loss, earlier postoperative mobilization, reduced duration of hospital stay and reduced rate of complications.

Study by Palmisani et al. showed improvements in VAS score in patients operated by percutaneous pedicle screw insertion. At follow-up, average VAS score was 1.9 points which is consistent with the finding of our study. Wild et al observed average blood loss of 194 mL (vs open - 380 mL), average operative time - 87 minutes (vs open - 81 minutes) and no postoperative infection which is consistent with findings of our study.5

Merom et al. observed average blood loss of 50 mL (open - 200-250 mL), operative time ranging from 73 to 85 minutes (open - 78-102 minutes), length of hospital stay - 1 to 2 days (open - 3-4 days) and no infection (open - 1 case of infection) which further supports finding of our study.7

Average preoperative VAS score was 6 whereas postoperative VAS score was 1 at the 2 years follow-up. Average preoperative ODI score was 42 whereas postoperative score was 3.8 at 2 years. Average preoperative SF-36 score was 24.14 and postoperative average SF-36 score was 31.2 in those operated by percutaneous method. MacNab’s scoring showed either excellent or good outcome at the end of 2 years in all the patients.

Though having various advantages, percutaneous posterior fixation has limitations of the steep learning curve, radiation exposure, and implant and system associated complications, rod insertion difficulties. Also, procedures, such as fusion and decompression cannot be performed by percutaneous approach where role of mini-open surgeries is being emphasized, thus limiting the role of percutaneous fixation to type A1, A2, and A3 fractures. Most of the patients needed implant removal at 9 to 12 months postoperatively due to implant impingement. Still, the correction achieved in kyphotic angle was well maintained at the end of 2 years.

Advantage of percutaneous fixation seems to be more so in the short-term as it enables patient to resume daily activities earlier as compared to conventional method. When compared to results at 2 years follow-up, functional outcome of percutaneous posterior fixation is similar to conventional posterior fixation. Malpositioning of screw may cause neural injury and pedicle fractures. In percutaneous method, surgeons lack the ability to visualize or palpate bony landmarks, so they must, therefore, rely heavily on fluoroscopic assistance.8 Percutaneous non-fusion fixation techniques do not allow for bone graft placement. Purely percutaneous posterior screw/rod

Table 2: Average parameters of the study

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average duration of surgery</td>
<td>90 minutes</td>
</tr>
<tr>
<td>Average blood loss during surgery</td>
<td>80 mL</td>
</tr>
<tr>
<td>Average day of postoperative mobilization</td>
<td>Day 1</td>
</tr>
<tr>
<td>Average duration of hospital stay</td>
<td>4 days</td>
</tr>
</tbody>
</table>

Table 3: Pre- and postoperative VAS, ODI and SF-36

<table>
<thead>
<tr>
<th>Score</th>
<th>Visual analog scale</th>
<th>Oswestry disability index</th>
<th>SF-36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>6</td>
<td>42</td>
<td>24.1</td>
</tr>
<tr>
<td>Postoperative (at 2 years)</td>
<td>1</td>
<td>3.8</td>
<td>31.2</td>
</tr>
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</table>

Table 4: Two year follow-up of MacNab’s score

<table>
<thead>
<tr>
<th>MacNab scoring</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two years follow-up results</td>
<td>17</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5: Improvement according to fracture type

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>Number of patients</th>
<th>Average preoperative kyphotic angle</th>
<th>Average postoperative kyphotic angle at 2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>3</td>
<td>20°</td>
<td>10°</td>
</tr>
<tr>
<td>A2</td>
<td>10</td>
<td>25°</td>
<td>13°</td>
</tr>
<tr>
<td>A3</td>
<td>22</td>
<td>35°</td>
<td>20°</td>
</tr>
</tbody>
</table>
fixation for trauma has unclear long-term efficacy as the screw-bone interface may loosen in the absence of fusion. Apart from posterior fixation, percutaneous technique has role in diskectomy, vertebroplasty or kyphoplasty, TLIF. Future scope of percutaneous pedicle screw insertion may showcase routine use of navigation guidance as this technology minimizes chances of neural injury by accurately mapping the screw trajectory in all the planes.

CONCLUSION

Percutaneous posterior fixation offers a minimally invasive approach to fix the traumatic spine injury, avoiding further trauma (iatrogenic) to already traumatized spine and its surrounding structures. Percutaneous fixation has more to it rather than only damage control surgery, however, its role in replacing conventional method requires proper surgeon training, steep learning curve, long-term studies, and critical evaluation as current studies have shown its advantage over conventional methods only in the short-term. Stability of fixation and capacity to fix multiple levels further expands horizons of this technique to fix multiple level osteoporotic wedging in old and debilitated patients. But at the same time, inability to perform fusion and decompression limits its use for certain pathologies.

REFERENCES