RETROSPECTIVE STUDY OF POSTERIOR DORSOLUMBAR FIXATION IN BAGHDAD: A CLINICAL STUDY OF 100 PATIENTS

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Abstract:

**Background:** Spondylolisthesis describes a condition of a forward slippage of one vertebra over another, which may or may not be associated with demonstrable instability. Spinal fixation is a neurosurgical procedure in which two or more vertebrae are anchored to each other through a synthetic "vertebral fixation device".

**Objective:** To determine the demographic distribution of different patient factors and the most commonly vertebrae undergo fixation in the thoracolumbar instrumentation.

**Patients and Methods:** One hundred patients were evaluated during the period of this study in a retrospective manner from January 2013 to January 2015 in four hospitals in Baghdad (Neurosurgical Teaching Hospital, Neuroscience hospital, Al-Kahdymia Teaching Hospital, Medical City\Ghazy AL-Hariri Hospital). The patients’ data regarding the etiology of instability, mechanism of injury for trauma patients, gender, age, segments undergoing instrumentation were identified.

**Results:** The study revealed female predominance over male: female ratio of 1:2.7, the age distribution was highest from 3rd to 7th decades of life, the etiology of instability was either degenerative or traumatic, the degenerative instability was 65% while traumatic cases was 35%. The neurological status of the patients was assessed by neurological examination and revealed 75% with incomplete deficit and 25% with complete neurological deficit, the most common pathologically involved vertebra was the L4, the most common vertebrae used in fixation were the L4 and L5 levels, the most common type of fixation used was the short segment fixation.

**Conclusion:** Posterior spinal fixation with pedicle screws and rods system is an effective and safe method in maintaining the stability of spine. The intraoperative imaging is important in maintaining safe trajectory of screws. Short segment fixation using the posterior approach with pedicle screw-rod fixation devices achieve good stabilization. The ideal candidates for undergoing posterior spinal fixation are patients with unstable fractures & incomplete neurological deficit.

**Recommendation:** The use of intraoperative neuro-monitoring, use of navigation system, use of fluoroscopy and the O-arm in spinal fixation surgery. Bone fusion is recommended for each patient.

**Keywords:** Thoracolumbar spine, spondylolisthesis, pedicle screw fixation
Introduction:

Spinal instrumentation basically means the implantation of more or less rigid metallic or non-metallic devices which are attached to the spine. These devices function to provide spinal stability and thus facilitate bone healing leading to spinal fusion. [1]

Types of instrumentation [2]
1. Metallic Pedicle Screw-Rod Systems
2. Polyetheretherketone (PEEK) Rods

Goals and indications of spinal instrumentation:
1. Trauma
2. Non trauma
   a. Tumor
   b. Infection
   c. Degenerative changes and spondylolisthesis [2]

Indications for fusion fall into two broad categories:
A. Preoperative structural problems that predispose to instability after decompression:
   1. Degenerative spondylolisthesis or lateral listhesis.
   2. Progressive scoliosis or kyphosis.
   3. Recurrent spinal stenosis requiring repeat decompression at the same level.
B. Intraoperative structural alterations that warrant consideration of a fusion:
   1. Excess facet joint removal 50%
   2. Pars interarticularis fracture or removal.
   3. Radical disc excision with resultant destabilization of the anterior spinal column.
C. Trauma that predispose to unstable spine

Measures for Correct Screw Placement
1. Navigation, CT, and fluroscope Guidance [3,4]
2. Electromyographic Monitoring [4]

Complications:
1. Pedicle Fracture [2]
2. Cerebrospinal Fluid Fistulae [5]
3. Infection [10]
4. Hardware Failure (Screw Breakage, Screw Pull-out, Screw Loosening or Plate or Rod Breakage, Loss of Correction, Wound Breakdown) [5,6,7,8]
5. Nerve root or cord injury.

**Free-hand technique**

Free-hand pedicle screw placement relies on an intricate appreciation of the relationship of various anatomical landmarks at each level of the thoracolumbar spine. Analogous entry sites guided by differential anatomy are utilized for both the thoracic and lumbar spine.\(^9,10\)

**Accuracy of pedicle screw placement**

Criteria of pedicle screw placement were: \(^{[11]}\)

1. Relation of pedicle screws to the pedicle.
2. Relation of pedicle screws to the vertebral body.

**Aim of the study:**

- To determine the demographic distribution of different patient factors
- To identify the most common vertebra levels to undergo fixation in the thoracolumbar spine.

**Patients and Methods:**

One hundred patients were evaluated during the period of this study in a retrospective manner from January 2013 to January 2015 in four hospitals in Baghdad (Neurosurgical Teaching Hospital, Neuroscience hospital, Al-Kahdimiya Teaching Hospital, Medical City/Ghazi AL-Hariri Hospital).

Demographic, Admission complaints and imaging were obtained for 100 patients through chart review. On Admission the following parameters independently reviewed: gender, age, chief complaint, etiology of instability, for the trauma patients the mechanism of injury was identified, the level of pathology, neurological examination, type of neurological deficit (whether complete or incomplete), level of fixation, number of screws used, outcome before discharge and a 6 months follow up.

The patients' data regarding the etiology of instability, mechanism of injury for trauma patients, segments undergoing instrumentation were identified.

All patients' undergone hematological investigations in the form of complete blood, ESR, C-reactive protein, renal function test, fasting blood sugar, blood group & Rh.

Only 16 patients have NCS and EMG prior to surgery, so the neuro-electro-physiological studies can't be analyzed in correlation to other clinical factors.

The findings of the patients' pre-operative imaging including thoracolumbar X-rays, CT-scan and MRI were reviewed.

The systems used were Medtronic and Aesculap.
Results:
The gender analysis revealed female predominance over male: female ratio of 1:2.7 and that 27% were males while 73% were females. (Fig. 1)

![Gender distribution](image)

**Fig. 1** Gender distribution

The age distribution of spine instability for both the traumatic and non-traumatic cases was highest from 3rd to 7th decades of life, it's very low in the first two decades of life and in the 7th decade of life.

**Table (1)** Age distribution

<table>
<thead>
<tr>
<th>AGE</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-19 years</td>
<td>2%</td>
</tr>
<tr>
<td>20-29 years</td>
<td>13%</td>
</tr>
<tr>
<td>30-39 years</td>
<td>23%</td>
</tr>
<tr>
<td>40-49 years</td>
<td>36%</td>
</tr>
<tr>
<td>50-59 years</td>
<td>21%</td>
</tr>
<tr>
<td>60-69 years</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

The etiology of instability was either non-traumatic or traumatic, the non-traumatic instability was 65% while traumatic cases was 35%. In the non-traumatic group the
Spondylolisthesis was predominant 89.2% while the pathological fractures were 11.8% of the pathological fractures 71.4% were due to infections while 28.6% were due to tumors. In the traumatic patients the FFH as a cause was 51.5% while the RTA as a cause to the instability was 48.5%.

**Table (2) Etiology of instability**

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Traumatic 35% (35 patient)</th>
<th>Non-Traumatic 65% (65 patient)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road traffic accident</td>
<td>51.5% (17 patient)</td>
<td>Fall from height 48.5% (18 patient)</td>
</tr>
<tr>
<td>Spondylolisthesis</td>
<td>89.2% (58 patient)</td>
<td>Pathological # 11.8% (7 patients)</td>
</tr>
<tr>
<td>Infection</td>
<td>71.4% (5 patients)</td>
<td>Tumor 28.6% (2 patients)</td>
</tr>
<tr>
<td>Tumor</td>
<td>28.6% (2 patients)</td>
<td></td>
</tr>
</tbody>
</table>

The neurological status of the patients was assessed by neurological examination and revealed 75% with incomplete deficit and 25% with complete neurological deficit, of the incomplete injury 20% were incomplete motor deficit, while 93.3% were incomplete sensory deficit and 12% sphincter disturbance. Such deficits (motor, sensory and sphincters) occurred either in isolation or together. (Fig. 2)
The Neurological deficit according to the etiology was reviewed and revealed a complete neurological deficit of 23 patients in traumatic spondylolisthesis while only 2 patients with complete neurological deficit in non-traumatic cases. The incomplete neurological deficit was predominant in non-traumatic spondylolisthesis of 63 patients while only 12 patients having incomplete neurological deficit in the traumatic cases.

**Table (3) Linking the Neurological Deficit to Etiology**

<table>
<thead>
<tr>
<th>Etiology of Instability</th>
<th>Complete Neurological Deficit</th>
<th>Incomplete Neurological Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traumatic</td>
<td>66% (23 patient)</td>
<td>34% (12 patient)</td>
</tr>
<tr>
<td>Non-Traumatic</td>
<td>3% (2 patient)</td>
<td>97% (63 patient)</td>
</tr>
</tbody>
</table>

The most common pathologically involved vertebra was the L4, followed by L5, L3 and L2. The least involved vertebrae were D10 and D11. Table (5) illustrates whether the pathological vertebra involved single or multiple levels (there were 2 cases with multiple fracture).
Table (4) Level of Pathology

<table>
<thead>
<tr>
<th>Level of Pathology</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D10</td>
<td>2</td>
</tr>
<tr>
<td>D11</td>
<td>2</td>
</tr>
<tr>
<td>D12</td>
<td>10</td>
</tr>
<tr>
<td>L1</td>
<td>5</td>
</tr>
<tr>
<td>L2</td>
<td>16</td>
</tr>
<tr>
<td>L3</td>
<td>15</td>
</tr>
<tr>
<td>L4</td>
<td>37</td>
</tr>
<tr>
<td>L5</td>
<td>15</td>
</tr>
</tbody>
</table>

The most common type of fixation used was the short segment fixation using 4 pedicle screws while the least common was the long segment fixation using 8 pedicle screws.

Table (5) No. of screws used in a single fixation

<table>
<thead>
<tr>
<th>Type of segment</th>
<th>No. of patients</th>
<th>No. of screws</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 screws (short segment fixation)</td>
<td>67</td>
<td>268</td>
</tr>
<tr>
<td>6 screws (intermediate segment fixation)</td>
<td>27</td>
<td>162</td>
</tr>
<tr>
<td>8 screws (long segment fixation)</td>
<td>6</td>
<td>48</td>
</tr>
<tr>
<td>Total No. of screws</td>
<td></td>
<td>478</td>
</tr>
</tbody>
</table>

The type of intraoperative guidance for screw placement was either by fluoroscopy (C-arm X-ray) 77 cases or by anatomical landmarks (free hand fixation) 23 cases.

Table (6) Type of Intraoperative Guidance for screw placement

<table>
<thead>
<tr>
<th>Type of Intraoperative Guidance for screw placement</th>
<th>Fluoroscopy Guided Fixation</th>
<th>Free Hand Fixation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>77</td>
<td>23</td>
</tr>
<tr>
<td>Accuracy</td>
<td>98%</td>
<td>91.3%</td>
</tr>
</tbody>
</table>

The complications occurred was either intraoperative or postoperative. The intraoperative complications include dural tear (3 patients), screw misplacement (4 patients). The postoperative complications include infection (7 patients), screw fracture (4 screw fractured in 3 patient as in Fig. 10), CSF leak (3 patients), and exposure of the system (1 patient).
Table (7) Intraoperative Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw misplacement</td>
<td>4</td>
</tr>
<tr>
<td>Dural Tear</td>
<td>3</td>
</tr>
</tbody>
</table>

Table (8) Postoperative Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>7</td>
</tr>
<tr>
<td>Screw fracture</td>
<td>3</td>
</tr>
<tr>
<td>CSF leak</td>
<td>3</td>
</tr>
<tr>
<td>Exposure of the system</td>
<td>1</td>
</tr>
</tbody>
</table>

Regarding follow up and outcome: 42 patients were followed for 6 months of which 39 patients show improvement of symptoms (1 patient with complete neurological deficit show improvement in motor function), 2 patients show worsening of symptoms and 1 patient died.

Table (9) Follow up and Outcome

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement of symptoms</td>
<td>39</td>
</tr>
<tr>
<td>Worsening of symptoms</td>
<td>2</td>
</tr>
<tr>
<td>Death</td>
<td>1</td>
</tr>
</tbody>
</table>

Discussion:

A significant number of patients suffer spinal diseases around the world, and a high percentage of them experience pathology in thoracolumbar region. Of those patients, a number of vertebral instability disorders need surgical stabilization.

Different surgical modalities are used in treating thoracolumbar spinal instability. Of these, the most common being used is posterior spinal fixation with different instruments.
The most modern and commonly used fixation is the pedicle screw and rod system. Other methods include anterior spinal fixation with cage, kyphoplasty, vertebroplasty, posterior interbody fusion and posterior intertransverse fusion. Of the posterior spinal fixation, the various instruments used are pedicle screws and rods system.

The neurological recovery is dependent on the degree of stability provided by fixation, and on initial instability and neurological loss. So, if stability is provided to spine then neurological status of some patients can improve.

Regarding the gender 73% of our study group was female and 27% was male with a male/female ratio of 1:2.7, while in Muralidhar B.M. et al Study [12] there was male predominance of 80% and female of 20%, Shailendra et al study [13] the male percentage was 76% and female was 24%. This difference is due to that 65% of our patient complaining of instability due to non-traumatic causes of which degenerative spondylolisthesis more commonly occurs in elderly females because of the postmenopausal osteoporosis.

About age group, in our study 36% of our patient are located in 50-59 age group which is the commonest age group while in Muralidhar B.M. et al study most of the patient are in 50-59 age group, in Shailendra et al study the commonest age group is 16-25 years followed by 26-35 years, this difference because the largest group of our patient had degenerative diseases other than trauma which prevalence increased with age. [12, 13]

Concerning etiology, 35% are due to traumatic injury (17 patient RTA, 18 patient FFH), 65% are due to non-traumatic causes (58 patient spondylolisthesis, 7 patient pathological fracture {pathological fracture 5 patient infection, 2 patient tumor}), while in study done by Alp Ozgun BOrcak et al [15] the non-traumatic cases was 63.9% while the traumatic cases was 36% which is close to our result.

The relation between etiology and neurological deficit in traumatic cases 66% had complete neurological deficit and 34% incomplete deficit while in non-traumatic cases 3% had complete deficit and 97% had incomplete deficit, this difference is due to two factors first is that traumatic injury which cause vertebral fracture and instability means sever trauma while in degenerative cases it is usually a chronic process and patient seek medical management before complete deficit occur, the other factor is that trauma mostly cause injury to thoracolumbar junction because the transition between the more rigid thoracic spine and the mobile lumbar spine concentrates bending and axial loads at the thoracolumbar junction where there is spinal cord in the spinal canal while in degenerative cases are mostly in L4 level where there is cauda equina and no cord.
Regarding the level of pathology: in 37% of cases, the pathology involving L4 followed by 15% for L3 and L5, in Muraldhiar B.M. et al study 70 % at L1 level and 20% at L2 level in our study the higher percentage of L4 are due to that most of our cases are degenerative which is more common in the lower lumbar region leading to L4 and L5 levels to be the most commonly instrumented level. \[12\]

Regarding type of pedicle screw fixation, the short segment was used 67 times, while the long segment fixation was used 6 times only because it is used in lesions involving the thoracolumbar junction vertebrae, while in a study done by Kashif Mahmood Khan et al\[16\] on 50 patient with thoracolumbar fixation, four screws with 2 rods were used in 38 patients (76%) and 8 screws were used in 12 patients (24%).

As regards the intraoperative guidance, 23% of operations done by free hand procedure without intraoperative fluoroscope, the accuracy was 91.3%, while in Parker et al study\[17\] on free hand fixation for degenerative cases (964 patients) the accuracy was 98.3%. In Gertzbein et al study\[21\] for traumatic patient (171 patients) the accuracy was 71.9%. The accuracy of free hand screw insertion is related to the experience of the surgeon, and possibly to change in anatomical landmark in traumatic cases.

The intraoperative complications, screw misplacement in 4 patients 4%, while in Faraj et al study\[38\] 3 patients 3.2% had screw misplacement, dural tear occurred in 3 patients 3% in our study, while is study done by Faraj et al 4 patients 4.4% had unintended dural tears.

The postoperative complications in our study included infection in 7 patients (7%) all of them had removal of the system, the patients with secondary neoplasia were receiving concurrent chemo- and radiotherapy for their malignant diseases which rendered their immunity low. In Sanford et al study\[19\] the infection rate was 3.2%. The CSF leak occurred in 3 patients 3% in our study, while in Faraj et al study\[38\] it was 2.1%. Screw fracture occurred in 4 screws in 3 patients out of 478 screws used in our study (1.2%), while 9 screw fractures out of 296 in Ohlin et al study.\[20\] Exposure of the system occurred in 1 patient only as a complication of being bed ridden in a complete neurological deficit, this patient died of septicemia and pneumonia.

Regarding six-month follow-up and outcome: 42 patients were followed (we couldn’t follow all the patients because of their residency in far provinces), 39 patients showed improvement in their neurological status (1 patient with complete neurological deficit show improvement within 3 weeks), 2 patient show worsening of symptoms (increased pain) and 1 patient died as mentioned above. While in a study done by Roop Singh et al\[21\] 41% of patients improved and 27% did not improve (all of them are paraplegic) with the difference possibly related to severity of injury and timing of surgery.
Patients who experience worsening of symptoms feel so due to misplacement of the screw with pressure on the nerve root or due to pathology in other levels.

**Conclusion:**

Posterior spinal fixation with pedicle screws and rods system is an effective and safe method in maintaining the stability of spine, by improvement in all the scores and parameters including the pain and mobility, range of motion of spine, and deformity.

1. The intraoperative imaging in coronal and sagittal planes is important in maintaining safe trajectory of screws, although free hand screw insertion is applicable with more experienced hands after thorough knowledge of anatomical landmarks.
2. Short segment fixation using the posterior approach with pedicle screw-rod fixation devices with or without bone grafting achieves good stabilization and fair enough neurological recovery in patients with unstable thoracolumbar fractures.
3. By applying the transpedicular screw fixation on the unstable fractures of the thoracolumbar spine, a stable fracture fixation can be achieved. So early ambulation, rapid return to work and less rehabilitation costs could be achieved. This kind of fixation prevents secondary spine deformities.
4. The ideal candidates for undergoing posterior spinal fixation are patients with unstable fractures & incomplete neurological deficit.
5. In patients with complete neurological deficit, spinal fixation done to aid to achieve stabilization and easy nursing care.
6. Non-Traumatic cause in 40-49 years old females represent the most common etiology.

**Recommendation:**

- Use of intraoperative neuro-monitoring in spinal fixation surgery.
- Use of a navigation system to guide the intraoperative manipulation.
- Use of fluoroscopy and the O-arm as an intraoperative guiding tool.
- Bone fusion is recommended for each patient with degenerative changes to improve stability of the spine and to prevent fixation failure.
- Use of short segment is better than long segment to decrease blood loss, timing of surgery, risk of vascular, neural and visceral injury, lost of motion, and cost.
Intraoperative & postoperative Imaging:

Fig. 3 Screw fracture indicated by the red arrows

Fig. 4 Free Hand Fixation lateral and AP views showing the 4 screws does not span 80% of the vertebral body AP diameter
**Fig. 5** Intraoperative C-arm AP view showing the upper right screw directed too medially

**Fig. 6** Postoperative lateral and AP views of lumbosacral vertebrae showing 4 screw system fixation the upper left screw in the AP view is directed too medially.
**Fig. 7** Intraoperative C-arm lat.view

**Fig. 8** Postoperative dorsolumbar lateral X-ray to the left and dorsal X-ray AP view showing 6 screw fixation system
References:


