# Intermediate Screws in Short Segment Pedicular Fixation for Thoracolumbar and Lumbar Burst Fractures

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***Purpose:*** *To evaluate the clinical relevance of short segment pedicular fixation with intermediate screws.*
***Methods:*** *Retro- and prospective studies were done of 29 patients with thoracolumbar or lumbar burst fractures who were treated with posterior short segment pedicular fixation. Anterior vertebral body height compression percentage (AVBCP) and local kyphosis were measured and analyzed pre-operatively, post-operatively, and at last follow-up period. All patients were followed up for a minimum of 6 months.*
***Results:*** *The mean immediate post-operative corrections of AVBCP and kyphosis were 24±15% and 14±8° respectively. The mean losses of correction at the last follow-up period were 0% and 2.2° for AVBCP and kyphosis respectively. At last follow-up, there was significant loss of correction of kyphosis (p<.001), whereas lost of correction of AVBCP was not significant (p=0.135). The final kyphotic angle at the latest follow-up period compared to the preoperative value was significantly improved (p<.001). There was no evidence of instrument failure or neurological deterioration in this study.*
***Conclusions:*** *Short segment pedicular fixation with intermediate screws is safe and effective in the surgical treatment of thoracolumbar and lumbar burst fractures. It provides significant correction of vertebral body height and local kyphosis, and maintains the correction.*

***Keywords:*** *fracture, spine, pedicular screw, intermediate screws*

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Unstable thoracolumbar and lumbar burst fractures may be treated with anterior, posterior or combined approach. Regardless of approach, the goal of internal fixation is to minimize the number of vertebral levels to be fused by using short segment fixation. For this purpose, the anterior approach is ideally effective, but it can also cause high morbidity[1]. The posterior approach, using transpedicular short segment fixation, became popular after its introduction by Roycamille and Dick[2]. This approach included pedicular screw placement in one vertebra above and one vertebra below the fracture site. It has several advantages[3,4] but may suffer from loss of reduction and failure of instrumentation. Achievement of a stiffer construction can be performed by several methods. These include cross linking[5-7], supplemental hook fixation[8,9], vertebroplasty, kyphoplasty[10-13], and screw fixation at the fracture site[14-15]. The purposes of this study are to evaluate the clinical efficacy of short segment pedicular screw fixation with intermediate screws and the procedure's effectiveness in maintaining the initial correction of deformity.

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## Material and Method

Twenty-nine consecutive cases of unstable thoracolumbar and lumbar burst fractures between 2002 and 2007 were studied. Data were drawn from medical records and phone interviews. The inclusion criteria were unstable burst fracture according to McAfee[16] (defined as anterior compression exceeding 50%, kyphosis exceeding 20°, associated posterior element injury, and associated neurological deficit) treated with short segment pedicular fixation plus intermediate screws and followed up for at least 6 months. Short segment pedicular screw placement with intermediate screws fixation is defined as pedicular screw fixation at one level above and one level below the fracture site, as well as fixation at the level of fracture. The instruments used in these cases were either a pedicular screw & rod system or a pedicular screw & plate system. All spinal fixations were done by the author. After the operation, all patients had 2-3 days of bed rest and then wore a hyperextension brace for 3 months.

Pre-operative, post-operative and follow-up plain radiographs were evaluated. Analysis included measurement of local kyphotic angle and anterior vertebral body compression percentage (AVBCP).

The local kyphotic angle was the intersection between a line along the superior endplate of the vertebra just above the fractured vertebra and a line along the inferior endplate of the vertebra just below the fractured vertebra. AVBCP was the percentage of anterior vertebral body compression with respect to the average intact vertebrae above and below the fractured vertebra[17]. Failure was defined as an increase of 10° or more in local kyphotic angle in the latest follow-up radiograph compared to the initial postoperative radiograph and/or implant failure adopted by Alanay[18]. Clinical assessment of pain was determined by using Denis's pain scale[19], with the grading system as:

$P_1$ No pain
$P_2$ Occasional minimal pain with no need for medication
$P_3$ Moderate pain with occasional medication but no interruption of work
$P_4$ Moderate to severe pain with frequent medication and occasional absence from work or significant change in ADL
$P_5$ Constant severe pain, chronic medication

Neurological assessment was determined by using Frankel's neurological level[20].

**Statistical Analysis**

Statistical testing was done using paired t-test by SPSS.

## Results

The study included 19 males and 10 females. Mean age at time of injury was 39±16 years. Fifteen patients underwent surgery using pedicular screw & rod. Fourteen patients underwent surgery using pedicular screw & Rama plate. Distribution of fracture level is shown in Table l. All patients had complete clinical follow-up but only 21 patients had complete clinical and radiographic follow-up. The mean follow-up period was 23±19 months.

**Table 1.** Distribution of fracture level

| Fracture level | Number of patients |
|---|---|
| $T_9$ | 1 |
| $T_{10}$ | 0 |
| $T_{11}$ | 0 |
| $T_{12}$ | 8 |
| $L_1$ | 11 |
| $L_2$ | 3 |
| $L_3$ | 5 |
| $L_4$ | 1 |

**Table 2.** Pain scale at latest follow-up

| Level of pain | Number of patients (%) |
|---|---|
| P1 | 13 (45%) |
| P2 | 13 (45%) |
| P3 | 3 (10%) |
| P4 | 0 |
| P5 | 0 |

**Table 3.** Frankel neurological level

| Level | Pre-op | Post-op |
|---|---|---|
| A | 3 | 3 |
| B | 4 | 0 |
| C | 2 | 0 |
| D | 2 | 2 |
| E | 18 | 24 |

**Clinical Results**

At the latest follow-up, 45% of patients had no pain, and 45% had mild pain as shown in Table 2. Recovery of neurological impairment is shown in Table 3. No patients had infection or instrumental failure.

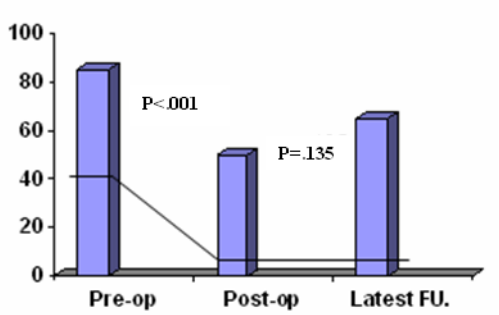



**Fig. 1** Anterior vertebral body height compression percentage (AVBCP) preoperatively, early posto-peratively, and at last follow-up

**Radiographic results**

AVBCP and local kyphotic angle before surgery, after surgery, and at last visit are shown in **Table 1** Distribution of fracture level Figure 1 and Figure 2. Preoperative AVBCP and local kyphotic angle were 40±19% and 16±12° respectively. Early postoperative mean corrections of AVBCP and local kyphotic angle were 24±15% and 14±8° respectively. These changes were statistically significant. Mean losses of correction of AVBCP and local kyphotic angle were 0±3.2% and 2.2±2.7° respectively. Loss of correction was significant for local kyphotic angle ($p<.001$), but not for AVBCP ($p=.135$). Despite the significant loss of correction for the local kyphotic angle at the latest follow-up, it remained less than the preoperative value ($p<.001$). No patient had instrument failure or loss of local kyphotic angle of 10° or more. There was no significant difference in loss of kyphotic

correction among the pedicular screw & rod group and the pedicular screw & Rama plate group. One typical case undergoing posterior short segment pedicular fixation with intermediate screws for unstable burst fracture ($L_1$) is shown in Figure 3.

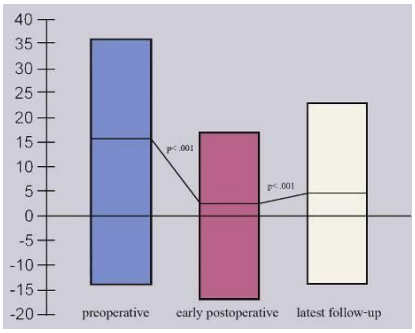
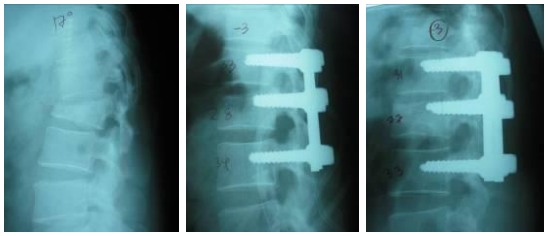



**Fig. 2** Local kyphotic angle preoperatively, early postoperatively, and at last follow-up



**A** **B** **C**

**Fig. 3** Radiography of unstable burst fracture $L_1$ undergoing posterior short segment pedicle fixation and intermediate screws

(A) Preoperative AVBCP and local kyphotic angle were 64% and 17° respectively

(B) Immediate postoperative AVBCP and local kyphotic angle were 16% and -3° respectively

(C) At 1-year follow-up AVBCP and local kyphotic angle were well maintained

## Discussion

Surgical treatment of thoracolumbar and lumbar burst fractures should correct vertebral body height loss and sagittal kyphosis, and also maintain these corrections until bony healing. Short segment pedicular fixation with fusion one level above and one level below the fractured vertebra using a posterior approach usually preserves the most spinal motion. However, only slight screw misplacement can lead to loss of correction and subsequent instability[19]. Deformity of fractured vertebra can be indirectly reduced, but the procedure for augmenting and strengthening the anterior column of the vertebral body is usually limited. This may result in a higher risk of instrumental failure and loss of correction[4,18]. Screw insertion at the fractured vertebra is essential to overcome potential problems with posterior short segment pedicular fixation.

Anekstein[14] et al. evaluated the mechanical effect of adding screws at the intermediate level on the stiffness of short segment constructs. In this study, an unstable burst fracture of pig's spine was created by dropped mass technique plus multiple drilling. Mechanical testing showed a significant decrease in the flexibility of the spinal segment in all axes of rotation when intermediate screws were added to the short segment construct.

Mahar[15]et al. performed a biomechanical study on cadaveric lumbar burst fractures of segmental constructs using screws at fracture sites versus nonsegmental constructs. Axial torsion was significantly higher for segmental constructs than for nonsegmental constructs, but there were no significant differences in flexion, extension, or lateral bending. Intervertebral disc pressure fluctuation during flexion-extension was significantly higher with segmental constructs than non-segmental constructs, reflecting the counteracting force of fractured vertebra which was fixed by the pedicular screw. The study showed the clinical results of 9 patients with lumbar burst fractures treated with segmental constructs and a mean follow-up time of 4.4 months. The mean kyphotic deformity was 9° and the mean kyphotic correction was 15° after surgery. Follow-up radiography showed 5° kyphotic angle loss. Mean anterior vertebral body height was 58% of normal before surgery. After surgery this height became 89% of normal and 78% at final follow-up.

This study confirmed the findings of Mahar et al. and Anekstein et al. concerning the clinical relevance of adding an intermediate screw to short segment pedicular fixation. There was no instrumentation failure in this study, short segment pedicular fixation with intermediate screw construction provided significant correction of spinal deformity, and it maintained its correction throughout the follow-up period. The patients had no neurological deterioration after the operation. The advantages of adding intermediate screws were stiffer construction by method of three-point fixation and stronger pull-out resistive fixation. This procedure is also less invasive than anterior approach reconstruction. The disadvantages include a slightly longer operation time and higher expense.

## Conclusions

Short segment pedicular fixation with intermediate screws is safe and effective in the surgical treatment of thoracolumbar and lumbar burst fractures**.** It provides significant correction of vertebral body height and local kyphosis, and maintains the correction**.**

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## *การผ่าตัดแก้ไขกระดูกสันหลังหักยุบที่ระดับช่วงอกและเอวโดยใช้สกรูยึดทางด้านหลังร่วมกับสกรูในตำแหน่งที่กระดูกหัก*

***สุวิทย์ เอกอภิชน, พบ.***

การศึกษาแบบย้อนหลังและไปข้างหน้านี้ได้ศึกษาประโยชน์ของ short segment pedicular fixation with intermediate screw ในผู้ป่วย 29 ราย ซึ่งได้ติดตามเป็นเวลาอย่างน้อย 6 เดือน (ค่าเฉลี่ย 23 เดือน) ค่าเฉลี่ยก่อนผ่าตัดของ anterior vertebral body height compression percentage (AVBCP) และมุม kyphosis คือร้อยละ 40 และ 16 องศา ตามลำดับ หลังผ่าตัดทันทีค่าเฉลี่ยของการแก้ไข AVBCP และมุม kyphosis คือร้อยละ 24 และ 14 องศา การติดตามผลการรักษาผู้ป่วยครั้งสุดท้ายพบว่า ค่าเฉลี่ยการสูญเสียการแก้ไข AVBCP และมุม kyphosis คือร้อยละ 0 และ 2.2 องศา ตามลำดับ short segment pedicular fixation with intermediate screw สามารถแก้ไขและรักษามุม kyphosis และ AVBCP หลังผ่าตัดได้ดี โดยไม่มีภาวะแทรกซ้อนที่ร้ายแรงจากการผ่าตัด