Radiological Outcomes of Short Segment Pedicle Screw Fixation with Intermediate Screws at Fracture Level for Treating Thoracolumbar Fractures

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ABSTRACT

Objective: To report radiological outcomes of short segment posterior fixation with screws in intermediate vertebra.

Methods: This descriptive retrospective study was conducted in Nishtar Hospital Multan from January 2020 to July 2021. Patients with thoraco-lumbar spine (T10-L2 vertebra) burst fractures who underwent short segment posterior fixation with screws in fractured vertebra were included. Radiological outcomes in terms of Cobb angle and anterior vertebral height on pre-operative, immediate post-operative and 1-year follow-up x-rays were calculated and compared using paired sample t-test.

Results: This study included 40 patients (32 males and 8 females) with a mean age of 33.47±13.33 years. Majority of cases involved fracture of D12 vertebra (45%). The mean preoperative kyphotic angle according to Cobb's method was 24.58° ± 3.4° which showed significant improvement to 6.6° ± 1.33° following instrumentation ($p<0.0001$). The average preoperative vertebral height was 59.48% which improved significantly to 88.7% ($p<0.0001$). However, at final follow-up, there was loss of correction which was evident in terms of increased Cobb angle to 9.7° and loss of anterior vertebral height to 79%. The difference between pre-operative and follow-up measurements for both Cobb angle and anterior vertebral height was significant ($p<0.0001$). There were no incidence of implant failure or screw pull-out.

Conclusion: The results of this study demonstrate short segment posterior spinal instrumentation with screws in fractured vertebra provide excellent correction of kyphotic deformity.

Keywords: Thoraco-lumbar spine, spinal fractures, vertebral fractures, pedicle screws, short segment, posterior spinal instrumentation, Pakistan.

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INTRODUCTION

Spinal fractures most commonly occur in thoracolumbar region of vertebral column[(1)]. Burst type fractures constitute about half of all thoracolumbar spinal fractures[(2)] and have profound effects on patient's lives causing neurological deficit, permanent disabilities and kyphotic deformities[(3)].

The optimal treatment for thoracolumbar fractures remains a subject of debate, with surgical interventions being a contentious yet promising option[(2)]. Surgical interventions, which include fracture fixation and decompression of neural elements, offer better prospects for nursing care, earlier mobilization, shorter hospital stay, improved correction of kyphotic deformity and an optimal environment for neurological recovery[(4,5)]. For achievement of such goals, fractured vertebra may be stabilized by various anterior or posterior surgical approaches including pedicle screw instrumentation or corpectomy and reconstruction with cage[(2,6)].

Despite the ongoing controversy surrounding the choice of surgical approach, posterior approach remains most commonly used surgical technique[2,4]. Long segment posterior fixation stabilizes two vertebrae above and below the fracture level but increases load on lower level discs by engaging additional motion segments[6]. Alternatively, short segment posterior fixation (one level above and below fracture level) involves fewer motion segments but is linked to higher rates of hardware failure and loss of correction on long term follow-up[4,7,8].

To tackle these challenges, an innovative solution proposes the use of intermediate screws in fractured vertebrae combined with posterior short-segment fixation resulting in 6 screw construct[4]. Biomechanical studies on such constructs demonstrate improved stability and reduced likelihood of implant failure[4,9]. Numerus studies have compared clinical and radiological efficacy of posterior short segment fixation versus posterior long segment fixation[10-12]. This study focuses on presenting radiological outcomes of short segment posterior fixation with screws in intermediate vertebra. By exploring this approach, the aim is to contribute valuable insights into effectiveness and stability of this surgical technique for thoracolumbar spinal fractures.

PATIENTS AND METHODS

After ethical review committee approval, a retrospective analysis of 40 patients with thoraco-lumbar spine (T10-L2 vertebra) burst fractures who underwent short segment posterior fixation at Nishtar Hospital between Jan 2020 to July 2021 was performed. Surgery was indicated for cases involving a loss of 50% of anterior vertebral height, kyphotic angle exceeding 30 degrees, spinal canal compromise of 50% or more, posterior ligamentous complex injury and neurological involvement. Patients with polytrauma, previous spinal surgery and pathological fractures were excluded from the study.

As per our institutional protocol, initial management of all trauma patients was based on principles of Advanced Trauma Life Support protocols. Medical records and radiological studies of patients were analyzed to collect information on clinico-demographic profile of patients, preoperative neurological status according to ASIA classification, fracture level and AO classification of fracture. Pre-operative, immediate post-operative and follow up x-rays at 1 year were used to calculate anterior vertebral height and kyphotic angle according to Cobb's method (13). Anterior vertebral height of fractured vertebra was expressed as percentage of average vertebral heights of adjacent vertebrae.

Data analysis

SPSS version 21 was used for data analysis. Anterior vertebral height and Cobb angle were reported as mean and standard deviation. Paired t-test was applied to compare preoperative, immediate postoperative and one year follow up anterior vertebral height and kyphotic angle with a level of significance set at $p < 0.05$.

RESULTS

This study included 40 patients (32 males and 8 females) with a mean age of 33.47± 13.33 years. The most common mechanism of injury was fall from height. Majority of cases involved fracture of D12 vertebra (45%). D11, L1 and L2 vertebrae were involved in 10%, 30% and 15% cases respectively. According to ASIA classification of neurological deficit, 25, 3, 3, 4 and 5 patients belonged to ASIA class A, B, C, D and E respectively. Mean period of hospital stay was 5.2 ± 1.9 days.

The mean preoperative kyphotic angle according to Cobb's method was 24.58° ± 3.4° which showed significant improvement to 6.6° ± 1.33° following instrumentation ($p<0.0001$). The average preoperative vertebral height was 59.48% which improved significantly to 88.7% ($p<0.0001$). However, at final follow-up, there was loss of correction which was evident in terms of increased Cobb angle to 9.7° and loss of anterior vertebral

Table 1: Radiological parameters at different time intervals

	Mean	Standard Deviation	Minimum	Maximum
Pre-operative Cobb angle	24.58	3.419	18	30
Post-operative Cobb angle	6.60	1.336	5	9
Follow up Cobb angle	9.70	2.103	7	15
Pre-operative AVH	59.58	6.96	47.83	75
Post-operative AVH	88.72	3.80	78.95	95.83
Follow-up AVH	78.98	5.12	68.42	89.13

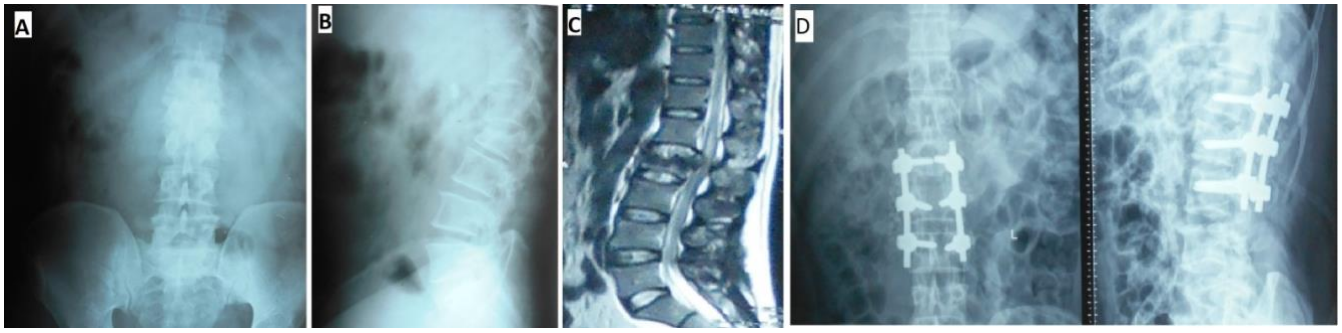

Figure 1: 32 year old male with burst fracture of L2, **A and B:** Pre-operative antero-posterior and lateral views **C:** MRI sagittal image, **D:** Post-operative antero-posterior and lateral views

height to 79%. The difference between immediate post-operative measurements and follow-up measurements for both Cobb angle and anterior vertebral height was also significant ($p<0.0001$). Despite the loss of correction, difference between pre-operative and final follow-up measurements for both Cobb angle and anterior vertebral height was still significant ($p<0.0001$).

Complications noted in this study were superficial wound infection in two patients, bed sores in eight patients and recurrent urinary tract infections in 14 patients. Wound infection settled with antibiotics in both patients. None of our patients had implant failure or screw pull-out.

DISCUSSION

This study demonstrates effective correction of kyphotic deformity in fractured vertebra with posterior short segment fixation as evident in improved Cobb angle and anterior vertebral height. However, some loss of correction was observed at final follow-up due to vertebral collapse. Despite this, achieved correction (difference between pre-operative deformity and final follow-up) remains significant. The clinical impact of these minor radiological changes on patient-reported outcome measures is uncertain.

Transpedicular screws, introduced by Boucher in 1959[14], are widely used due to easy application, preservation of motion segments and improved construct stability with three column fixation[2]. Although short-segment posterior fixation (SSPF), which involves instrumentation of one vertebra cephalad and caudal to the fractured vertebrae, is most commonly used construct[2,4], it has 9-54% incidence of implant failure and re-kyphosis on longterm follow-up[2,7].

To counter these pitfalls of SSPF, several strategies have been proposed including long-segment posterior fixation or augmentation of anterior column[2,8]. Dick et al.[15] introduced addition of intermediate screws at fractured vertebra into SSPF construct demonstrating biomechanical advantages and decreased chances of loss of reduction due to more even stress distribution on each screw[15]. Subsequent studies by different authors have reported favorable results, including good reduction, comparable clinical results, and fewer hardware pull-outs with this 6-screw SSPF construct[3,6,7,9]. The results of this study are concordant with the published literature. Although, we used open technique of SSPF, pedicle screw instrumentation can be done with minimally invasive technique too which reduces trauma to surrounding tissues and reduces blood loss and risk of infection[5]. In cases of severe comminution of vertebral body, anterior column reconstruction is recommended. This may be achieved by corpectomy via anterior approach which is extensile and has greater risk of pulmonary and vascular complications. Transpedicular corpectomy and use of expandable cage togather with SSPF offers combined advantage of anterior and posterior column reconstruction whilst minimizing risk of complications[16].

A meta-analysis conducted by Kapoen et al. further supported the efficacy of SSPF with intermediate screws at the fracture level. The analysis revealed significant reductions in pain, improved immediate and long-term follow-up Cobb angles, and decreased implant failures compared to conventional SSPF. However, these additional screws incurred greater blood loss and operative time. However, significance of such small differences in clinical, operative and radiological parameters on patient-reported-outcome measures and quality of life remains questionable[4].

The study does acknowledge certain limitations, including its retrospective design, a relatively small sample size, and a short follow-up duration. Despite these constraints, the findings of this study align with

existing literature, contributing valuable insights into the potential benefits and considerations associated with the use of intermediate screws in the context of short-segment posterior fixation for thoracolumbar spinal fractures.

CONCLUSIONS

The study findings confirm safety and effectiveness of short segment posterior spinal fixation with screws in fractured vertebra in correcting kyphotic deformity in immediate post-operative period. However, there is insignificant amount of loss of correction at one year follow-up.

Conflict of Interest: None

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