

## ORIGINAL ARTICLE

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## The effect of post-operative immobilization on short segment fixation without bone grafting for unstable fractures of thoracolumbar spine

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### Abstract

**Background:** There is a controversy regarding the fixation level for the management of unstable thoraco-lumbar spine fractures, and literature often reports poor results with short segment fixation. The present study is undertaken to compare the effect of fixation level and variable duration of postoperative immobilization on outcome of unstable thoraco-lumbar spine fractures treated by posterior stabilization without bone grafting.

**Design & Setting:** A randomized, prospective, and consecutive series conducted at a tertiary level medical center.

**Patients & Methods:** Thirty six neurologically intact (Frankel type - E) thoracolumbar spine injury patients admitted at our institute between February 2003 and December 2005 were randomly divided into three groups. Group I (n=15) and II (n=11) patients were treated by short segment fixation while Group III (n=10) patients were treated by long segment fixation. In Group I ambulation was delayed to 10<sup>th</sup> -14<sup>th</sup> post operative day, while group II and III patients were mobilized on 3<sup>rd</sup> post operative day. Anterior body height loss (ABHL) percentage and Cobb's angle were measured pre-operatively, post-operatively and at follow-up. Denis' Pain Scale and Work Scales were obtained during follow-up.

**Results:** Mean duration of follow-up was 13.7 months. At the final follow up the mean ABHL was 4.73% in group-I compared to 16.2% in group-II and 6.20% in group III. The mean Cobb's angle loss was 1.8<sup>o</sup> in group-I compared to 5.91<sup>o</sup> in group-II and 2.3<sup>o</sup> in group III. The ABHL difference between group I and II was significant (p=0.0002) while between groups I and III was not significant (p=0.49).

**Conclusion:** The short segment fixation with amenable delayed ambulation is a valid option for management of thoraco-lumbar spine fractures as radiological results are comparable to long segment fixation with the advantage of preserving maximum number of motion segments.

**Keywords:** Dorsolumbar spine fracture; Posterior fixation, Short segment Vs long segment; Delayed ambulation.

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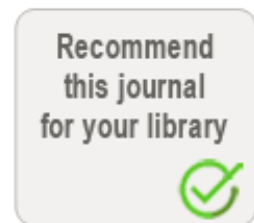
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## Introduction

The thoraco-lumbar segment of spine is an unstable zone between the fixed thoracic and mobile lumbar spine and the goal of surgical management is attainment of normal spinal anatomy, maintenance of reduction, decompression of neurological structures and preservation of mobile segment for better long term results. The optimal treatment of thoracolumbar unstable fractures is still a controversial issue [1],[2]. Many authors have demonstrated multilevel instrumentation techniques both in distraction and compression [3] while others have proposed shorter constructs to maintain motion segments, particularly in the lumbar spine [4],[5]. The surgical treatment of the thoraco-lumbar spine has undergone profound changes in the past decade with emphasis on the preservation of the intact segment (i.e. short segment fixation) [6]. Good results have been reported in flexion distraction injuries [7], however, some studies have reported unacceptable results with short segment fixation [8],[9],[10],[11],[12].

Bone grafting is often added to any type of spine fixation but it is considered that if the reduction is achieved soon after the injury, sufficient bone and soft tissue healing would occur to obviate the need for bone grafting as is the case with internal fixation for the limb fractures [13].

The aim of this study is to evaluate the effect of post-operative period of immobilization on short segment fixation and to compare the results with long segment fixation, without bone grafting in either group.

## Materials and Methods

The study included thirty-six neurologically intact (Frankel Type- E) patients of thoracolumbar spine injury admitted to our department between February 2003 and December 2005, which were randomly divided into three groups. Group I (n=15) and II (n=11) patients were treated by short segment fixation while Group III (n=10) patients were treated by long segment fixation. The indications for surgery were unstable burst fracture, local kyphosis more than 20°, anterior body collapse more than 40% of the vertebral height or more than 30% of canal area involvement. Demographic information, comorbid conditions, other injuries, and neurologic status were recorded. Plain radiographs and MRI were routine pre-operative investigations. Additional CT scan was done whenever needed. Patients were randomly divided into three groups, using random number tables. Group I and II patients were treated by short segment fixation while Group III patients were treated by long segment fixation. In all the cases, pedicle screws were used for stabilization and no bone grafting was done. Preoperative radiographic review included an assessment of the stability of fracture, according to McAfee et al classification. Focal kyphosis was determined by measuring the Cobb angle [14] between the superior endplate of the upper and the inferior endplate of the lower non-injured vertebrae [15]. For calculation of percentage of anterior body height loss (ABHL), anterior body height of the injured and the non-injured adjacent vertebrae above and below were measured, and the ABHL percentage was calculated using the formula adopted by Mumford et al. [16]. All the operations were performed by senior author [SHL]. The operative details, follow-up findings and complications if any were recorded. In Group I ambulation was delayed to 10<sup>th</sup> to 14<sup>th</sup> post operative day, while group II and III patients were mobilized on 3<sup>rd</sup> or 4<sup>th</sup> post operative

day. Mean duration of follow-up was 13.7 months. At each follow-up patient was assessed for Denis Pain Score [17] and neurological status. Radiographs were taken and evaluated for progress of union, focal kyphosis, ABHL percentage and instrumentation stability. Failure was defined as implant failure or an increase of 10° or more in local kyphosis in the latest follow-up radiographs compared with the measurement on the initial postoperative radiographs [11]. Radiographic reviewers were blinded to the functional outcome of the patient and the time of follow-up. The Denis work [17] status assessment scale was used to record functional outcome at follow-up. This provided the most recent evaluation of a patient's back-related postoperative disability. The study was approved by Konkuk University Hospital institutional review board.

## Surgical Technique

All patients were operated under general anesthesia in prone position on commercially made prone bar. A midline posterior approach was performed. The extent of the injury was defined. Posterior decompression was performed whenever indicated to ensure that the disrupted soft tissues or bone fragment did not compress neural elements during final reduction [18]. Decompression also included undercutting the disrupted lamina and evacuation of any epidural hematoma from the enlarged epidural space. The facets and other bony structures were used to judge an anatomic reduction. Depending upon the pre-operative random grouping long segment or short segment fixation was performed and fracture was stabilized with bilateral pedicle screws under fluoroscopy control. For short segment fixation only the injured motion segment was stabilized. For long segment stabilization two segments above and below the injured vertebra were engaged with pedicle screws. No bone grafting was done in any group. Post-operatively all patients with long segment fixation and group-II of short segment fixation were mobilized on 3<sup>rd</sup> or 4<sup>th</sup> day with thoracolumbar spinal brace which was worn for three months. In group-I of short segment fixation patients were ambulated on 10<sup>th</sup> to 14<sup>th</sup> post-operative day. The spinal brace was worn for 3 months postoperatively in all groups.

## Statistical Analysis

ANOVA test and student's *t* tests were performed for statistical analysis to determine comparability of different groups and to compare the final results. Significance was set at  $p < 0.05$ .

## Results

There were 23 males and 13 females in our study with the mean age of 45.667 years (+/-12.9, range 21-83 years) (table-I). The groups were analyzed for between group comparability regarding demographic variables of patient and were found to comparable according to ANOVA test ( $p=0.48$ ). Mode of injury was fall from height in twenty-four patients; slip down in six patients; direct trauma four patients; car accident and pedestrian accident in one patient each. Level of fracture was L<sub>1</sub> in fifteen patients, L<sub>3</sub> in seven patients, L<sub>2</sub> in six patients, T<sub>12</sub> in five patients, L<sub>4</sub> in two patients and T<sub>8</sub> in one patient. According to McAfee classification all fractures were of unstable burst type. Two patients had associated chance fracture of adjacent vertebra, which was managed adequately. These fractures were not included in analysis of data. The average time from injury to operation was 2.78 days (+/- 2.13 days, range 0-7 days). Average time of surgery was 90 minutes (+/-10 min, range 75-110 min). Mean follow-up duration was 13.74 months (+/- 5.58, range 3-27 months).

The preoperative ABHL percentage and Cobb angle was similar in three groups according to ANOVA test ( $p=0.37$  and  $0.22$  respectively). The difference between preoperative and postoperative values of anterior body height loss and Cobb's angle for three groups was also not significant according to ANOVA test ( $p=0.92$  and  $0.26$  respectively), that is all the groups had similar degree of correction after surgery for these indices.

At the final follow up the mean ABHL percentage was 4.73% (+/-3.88%, range 0-12%) in group-I compared to 16.2% (+/-9.16%, range 3-35%) in group-II and 6.20% (+/-6.71%, range 0-21%) in group III. The ABHL difference between group I and II was significant ( $p=0.0002$ ) while the difference between groups I and III was not significant statistically ( $p=0.49$ ). The mean wedge angle loss was  $1.8^{\circ}$  (+/-  $1.7^{\circ}$ , range  $0-4^{\circ}$ ) in group-I compared to  $5.91^{\circ}$  (+/-  $4.48^{\circ}$ , range  $1-16^{\circ}$ ) in group-II and  $2.3^{\circ}$  (+/-  $2.87^{\circ}$ , range  $0-10^{\circ}$ ) in group III. The change in Cobb's angle between group I and II was significant ( $p=0.0033$ ), while the difference between groups I and III was not significant statistically ( $p=0.59$ ).

Mean Dennis pain score for group I, II and III was 2.07, 2.55 and 2.10 respectively. The results of group I were significantly better than group II ( $p$ -value 0.02; student's t-test), where as results of group III were similar to group I ( $p$ -value 0.84; student's t-test). Mean Dennis work score for group I, II and III was 2.07, 2.55 and 2.10 respectively. The results of group I were not significantly better than group II ( $p$ -value 0.55; student's t-test), and the results of group III were similar to group I ( $p$ -value 0.75; student's t-test).

Thus the results clearly indicate that delayed ambulation group of short segment fixation group has outcome similar to long segment fixation and it is significantly better than early ambulation group of short segment fixation. Descriptive statistics summarizing the Cobb angle and percentage anterior body collapse are given in table II, and Denis Pain Scale and Work Scale <sup>[17]</sup> outcome is shown in table I.

## Complications

There were no neurological complications related to surgery, or more specifically to pedicle screw placement. There were no wound infections. In two cases of long segment fixation implant removal was required as there was risk of skin break down due to irritation by the rods. We had one case of screw breakage in group II, however, since the breakage occurred after bony union was achieved, it did not affect the clinical outcome. The screw breakage was a chance finding one routine follow-up x-ray. None of our patients required revision surgery for back pain or deformity. Any medical complications arising from delayed ambulation were not reported in our study.

## Discussion

The debate between operative and non-operative treatment of thoraco-lumbar spine fractures is solved to some extent after Siebenga et al <sup>[19]</sup> demonstrated that, in the treatment of traumatic thoracolumbar spine fractures, the indirect costs exceed the direct costs by far and make up 95.4% of the total costs for treatment in non-surgically treated patients compared to 71.6% of the total costs in the operative group, and in view of cost-effectiveness, the operative therapy of traumatic thoracolumbar spine fractures is to be preferred. The optimal surgical treatment of thoracolumbar burst fractures still remains controversial. Combined anterior-posterior approach allow for three column reconstruction and stabilization <sup>[20]</sup> but the time needed for surgery and morbidity rates associated are much higher than single approach. Anterior approach have proven effective in allowing for extensive decompression and successful fusion with minimal loss of sagittal alignment <sup>[21],[22],[23]</sup>, but it also require longer surgery time and have higher rates of surgery-related morbidity associated with an anterior spinal exposure as compared to posterior approach <sup>[23]</sup>. Posterior fixation has become a popular method in the treatment of thoracolumbar burst fractures after the introduction of transpedicular screws <sup>[24],[25],[26],[27]</sup>. Extension of the posterior pedicle screw-rod construct to include two or more segments above and below the fractured level can reduce instrument failure rates, but it also sacrifices additional motion segments and ultimately reduces the range of motion <sup>[28]</sup>. Preservation of motion segments is desired if at all possible <sup>[7]</sup>, as a short segment fixation result in less spinal stiffness <sup>[29]</sup> and patients performs

comparatively better [30]. In lumbar spine fractures short fixation is best option because loss of lumbar lordosis associated with flat back syndrome can be avoided [31],[32]. Advantage of short segment pedicle screw fixation is that it potentially allows for spinal stabilization while preserving as many motion segments as possible. Immobilization of long segment increases the load and motion not only at the immediate adjacent segment, but also at the distal segments [33], which has detrimental effect in long term. Forces applied to the spine in short segment fixation are not strong and fatigue failure is uncommon [34],[35]. Moreover it is not necessary to remove the construct, although this is often required with long rods. Due to the above mentioned advantages short segment fixation is gaining popularity as a preferred mode of fixation for thoraco-lumbar spine fractures and various additional procedures along with short segment fixation are being reported in recent literature [36],[37],[38].

Bone grafting is often performed as an adjunct to spinal fixation, but there are several advantages in not performing fusion like reduced surgery time and blood loss, often in critically injured patients [13]. Bone grafting itself is not without complications, Frymoyer et al in a long-term study reported that 37% of patients identified donor site pain as a problem ten or more years after operation [39]. Another potential advantage is that the facet joints adjacent to the fracture are less disturbed, because surgical soft tissue stripping required to prepare bone graft bed is no longer needed [13]. In a recent prospective randomized study, Alanay et al [40] found no difference in the failure rates of short-segment pedicle screw constructs supplemented with transpedicular intracorporeal bone graft compared with constructs without graft support. Moreover, transpedicular graft material can cause spinal canal compression if not placed properly [41]. Knop et al [42] also could not show any advantage of intra- and intercorporeal grafting in their series.

In our study we included patients with no neurological deficit only as we believe that the homogeneity of the neurologic status between the study groups may also be important, because the loads acting on the reconstructed injured vertebrae may be different for a patient bedridden with paraplegia compared with a neurologically intact, mobile patient. Our results demonstrated that after a substantial initial correction there was a gradual partial loss of anterior body height and Cobb's angle in all the groups including delayed ambulation short segment fixation, which seems largely due to loss of disc height. This loss of initial correction has been reported by other authors who have routinely fused the spine; some of them reporting a more marked correction loss than that in our series [43],[44],[45],[46]. Our mean follow-up was 13.7 months, which is sufficient to rule out any further collapse, the critical period for which according to Parker et al [30] appears to be six months.

The radiographic evaluation of the fractured vertebral segment at final follow up showed that the increase in kyphosis from postoperative value was substantial in group-II, but the angle change in group-I and III was less pronounced. The difference between results of the latter two groups was also not significant. This clearly shows that though early ambulation in short segment fixation has less satisfactory results as proved by many other studies [9],[11],[40], but results similar to long segment fixation can be achieved by delayed ambulation in short segment fixation.

Tezeren and Kuru [47] demonstrated clinical outcome of short segment fixation and long segment fixation was similar, though their radiographic findings demonstrated that short segment pedicle instrumentation had a high failure rate, i.e.  $> 10^{\circ}$  loss of correction, as compared to long segment fixation. But since clinical outcome data did not show any difference between the short segment and long segment instrumentation, should the failure as defined by the author considered as a true failure for the patient? In our study we also set  $10^{\circ}$  loss of correction as a criteria for failure, but it did not correlate well with clinical findings in two cases which had more than or equal to  $10^{\circ}$  loss of correction. In this study, [47] results are poor in short segment fixation as the post-operative ambulation was started on 3<sup>rd</sup> or 4<sup>th</sup> day in both groups. The fact that our study highlights is that if ambulation is delayed in short segment fixation results can be rewarding.

Moon et al demonstrated that short segment fixation without posterolateral fusion is an effective

procedure for compression and burst fractures, which contribute to the fractured vertebral body consolidation without recollapse and maintain the motion segment function. [48] One limitation of their study was lack of comparison between early and delayed postoperative patients' mobilization and comparison with long segment fixation, which is being addressed in our study.

The main limitation of our study is that it is a small series, but it is the only study of its kind that is randomized, prospective and consecutive series highlighting the benefits of delayed ambulation in short segment fixation. Final results of our study are statistically significant and favor amenable delayed ambulation as a preferred protocol for post-operative management of short segment fixation. It gives results similar to long segment fixation in terms of radiological indices while keeping all the benefits of short segment fixation like less invasive surgical approach with less operating time and minimal soft tissue stripping around the injured vertebra thus maintaining the vascularity, which is most important factor for healing in any type of injury.

## Conclusion

In our opinion patient selection and post-operative compliance for delayed ambulation is the key stone to success of short segment fixation of thoracolumbar spine fractures treated by pedicle screw instrumentation without bone grafting, which definitely has advantage of more mobile segment preservation, with better functional results. The radiological results of short segment fixation with delayed mobilization are similar to long segment fixation.[Figure 1],[Figure 2],[Figure 3]

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**Source of Support:** None, **Conflict of Interest:** None

 **Figures**

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