

Comparison of Clinical and Radiological Evaluations for the Management of Lumbar Fractures between Short and Long Fusion Segments

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Abstract: Background: The evolution of the transpedicular screw fusion system has facilitated the adoption of a short fusion segment (This procedure entails the immobilization of a single intact vertebra both superiorly and inferiorly to the affected region) as a viable and prevalent alternative to a long fusion segment (This procedure entails the stabilization of two adjacent non-affected vertebrae, situated superior and inferior to the traumatized region) in regular clinical practice. To assess and contrast the impact of them for the treatment of lumbar fractures, both of which have shown efficacy. However, a matter of controversy persists regarding the superiority between them. **Methods:** A comprehensive analysis of all lumbar fractures that were managed surgically between February 2018 and March 2020 for a duration of two years was undertaken at Paky Hospital. A collective of 42 patients with lumbar spine fractures were segregated into two distinct groups. Group A (short fusion segment) comprised of twenty-one patients, whereas Group B (long fusion segment) consisted of twenty-one patients. **Results:** Transpedicular fixation was carried out in a total of 42 instances, comprising 26 patients of the male gender and 16 of the female gender, with a gender ratio of male-to-female 1.8:1 person. Most of the patients belonged to the age bracket between 20 to 60 years. The severity of injuries varied among various age cohorts. Injuries are highly predominant at the L1-L2 vertebral level, where compression fractures represent the majority, accounting for 36 cases (85%) of all fractures. The assessment of the outcomes was carried out utilizing Frankel's categorization, the degree of kyphotic deformity in the spinal column, and the height of the body of the vertebrae. None of the patients manifested heightened neurological deficits. Most of the cases demonstrated a progression to the succeeding stage. While the pre-operative kyphotic deformation of the vertebral body amounted to 29.1 ± 4.4 and 27.3 ± 3.4 in groups A and B, correspondingly. No discernible contrast in statistical significance was observed between group A and group B in terms of the kyphotic deformation after the operation of the vertebral body, with group A having a measurement of 11.0 ± 2.7 and group B having a measurement of 9.9 ± 1.8 ($P > 0.05$). **Conclusion:** According to the findings of this investigation, traumatic injuries to the lumbar spine can be treated through spinal fusion utilizing a posterior approach. Both the short and long fusion segments were found to be efficacious in treating such injuries. These approaches aid in neurological recuperation, mitigate pain, and better the status of disability through early rehabilitation. This is achieved even without any noteworthy radiological distinctions when evaluated over the short term.

Keywords: Long fusion segment, fracture lumbar spine, short fusion segment.

INTRODUCTION

The development of techniques and instruments for transpedicular screw fixation has enabled the implementation of short-segment instrumentation (This procedure entails the immobilization of a single intact vertebra both superiorly and inferiorly to the affected region) as a widespread clinical procedure (Jeffrey, W. P. *et al.*, 2000). Spinal fractures and dislocations are severe injuries predominantly prevalent amongst the younger demographic. Approximately 43% of individuals afflicted with spinal cord injuries endure numerous associated traumas. (Leventhal, M. R, 2003) The prevalence of spinal fractures affecting multiple

segments of the spine ranges from 3% to 5%, and such fractures may manifest as either adjacent or nonadjacent injuries. It appears that the frequency of this pathology is gradually escalating over time. (Velmahos, G. C. *et al.*, 2006) The management of fractures which are unstable and dislocation fractures of the lumbar spine remains a contentious issue. (Kaneda, K. *et al.*, 1997) The thoracolumbar junction is notably vulnerable to harm due to the differential mobility of the thoracic vertebrae, which is comparatively rigid, and the lumbar vertebrae, which is comparatively pliant. (Solomon, L. *et al.*, 2001) Since the advent

of fixation by pedicle screws, as elucidated by Roy Camille.(Roy-Camille, R. *et al.*, 1986) The ideal management of thoracolumbar fractures remains a contentious issue (Ahmet, A. *et al.*, 2001).

The objective of transpedicular shortened segmental architecture is to reestablish the anterior vertebral column, thus eliminating the need for preceding strut grafting or fixation by plate and avoiding a strenuous arthrodesis of the segment movements. The aim of management for unstable lumbar injuries is to optimize neural decompression while ensuring stable internal fixation across the minimal number of spinal segments. Fusion can be achieved via the implementation of either anteriorly, posteriorly, or combined methods. Nonetheless, the posterior approach is comparatively less invasive. Pedicle screw instrumentation enables prompt and durable stabilization by traversing all three spinal columns. The utilization of pedicle screws, which have the potential to curtail the extent of spinal segments in order to mitigate harm to delicate tissues and foster a higher rate of synostosis as compared to fixation alternatives such as hooking and wiring, epitomizes the remarkable capabilities of screws of the pedicle as highlighted by studies of the research (Kothe, R. *et al.*, 1997).

The prevalence of spinal fractures affecting multiple segments is estimated to be between 3-5%, and these fractures may occur in either adjacent or nonadjacent areas. The frequency of this condition appears to be on the rise. (Velmahos, G. C. *et al.*, 2006) Pedicle screws are inserted via a posterior approach, one level superior and inferior to the fractured vertebrae for short-segmental fixation and two levels superior and inferior for long-segmental fusion, despite the superiority of short-segmental pedicle instrumentation. (Dick, W. *et al.*, 1985; Kanna, R. M. *et al.*, 2015) Numerous researches indicated that it exhibited a substantial propensity to fail. (Alanay, A. *et al.*, 2001) And other studies demonstrated favorable results. (Muller, U. *et al.*, 1999) After prolonged treatments, numerous reports emerged stating the degradation of nervous functions, exacerbation of spinal stenosis, Increase in pressure on the body of vertebrae, exacerbation of kyphosis, and provocation of radicular pain. (McCormack, T. *et al.*, 1994) The objective of this investigation was to contrast the short fusion segment of pedicle instrumentation with the long fusion segment when addressing lumbar fractures.

METHODS

A comprehensive analysis of all lumbar fractures that were managed surgically between February 2018 and March 2020 for a period of two years was carried out at Paky Hospital. A collective of 42 patients with lumbar spine fractures were segregated into two distinct groups. Group A (short fusion segment) comprised of twenty-one patients, whereas Group B (long fusion segment) consisted of twenty-one patients. The exhaustive medical records, comprising of patient charts, surgical notes, prior and after operation radiographs, CT arm, and MRI, were meticulously examined. Furthermore, the neurological findings were classified according to Frankel's functional classification, and the subsequent records within a timeframe of 12 months were meticulously examined. The surgical indications, such as decompression and fixation, included lumbar fractures accompanied by neurological deficits, kyphosis exceeding 20 degrees, the collapse of vertebrae exceeds than 50% of the height of the vertebral body, and neural canal diminished greater than 50%.

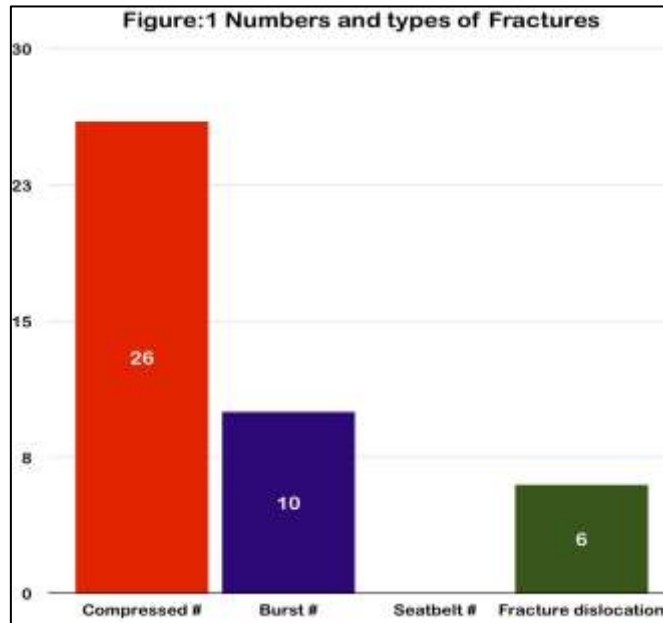
The incidence of fractures was observed in Lumber Vertebrae one in 24 cases, Lumber Vertebrae two in 13 cases, and Lumber Vertebrae three in 5 cases. Notably, there were no occurrences of fractures in Lumber Vertebrae four and five, as indicated in Table no.1. The pre-operative assessment of short fusion segments (group: A) was evaluated using Frankel grading. The outcomes manifested as follows: 3 persons witnessed grade A, five persons witnessed grade B, eight persons witnessed grade C, four individuals witnessed grade D, and one person witnessed grade E. Following the course of treatment, the findings transmuted for the betterment as eight individuals manifested grade A, five persons testified grade B, five individuals confirmed grade C, and three persons certified grade D. Notably, there were no patients observed with grade E post-treatment, as indicated in Table no. 2. While the pre-operative assessment of long fusion segments (group: B) was evaluated using Frankel grading. The results were as follows: grade A was observed in two persons, grade B in six patients, grade C in seven persons, grade D in four individuals, and grade E in two persons. After undergoing treatment, the results improved to grade A in nine persons, grade B in seven patients, grade C in four individuals, and grade D in one patient. Notably, there were no cases observed

with grade E post-treatment, as indicated in Table no. 3.

RESULTS

Transpedicular fixation was carried out in a total of 42 instances, comprising 26 patients of the male gender and 16 of the female gender, with a gender ratio of male-to-female 1.8;1 person. Most patients were between the ages of 20 and 60 years old. The severity of injuries varied among various age

cohorts. Injuries tend to occur with greater frequency at the L1-L2 vertebral level, wherein compression fractures constitute the majority. Specifically, out of all fractures, 36 cases (85%) are attributed to compression fractures, while 10 cases (23.8%) are categorized as burst fractures, and the remaining 6 cases (14.2%) pertain to fracture-dislocations, as evinced in Table 1 and Figure 1.



	Compressed #	Burst #	Seatbelt #	Fracture dislocation
L1 #	13	7	0	4
L2 #	9	2	0	2
L3 #	4	1	0	0
L4#	0	0	0	0
L 5#	0	0	0	0

The assessment of results was performed utilizing Frankel's classification tables - both table no. 1 and table no. 2 - along with an analysis of the magnitude of the kyphotic distortion present in the body of vertebrae. Additionally, a tabulated

measurement of the height of the body vertebrae was conducted in Table No. 4. None of our cases exhibited a rise in neurological impairment. Majority of the patients demonstrated progress and advanced to the succeeding level.

Table: 2 preop. & postop. Frankle Grads in Short fusion Segment

Frankle Grade	Prior to operation		After operation	
	Numbers	%	Numbers	%
A:	3	14%	8	38%
B:	5	24%	5	24%
C:	8	38%	5	24%
D:	4	19%	3	14%
E:	1	5%	0	0%

Table: 3 preop. & postop. Frankle Grads in long fusion Segment

Frankle Grade	Prior to operation		After operation	
	Numbers	%	Numbers	%
A:	2	9%	9	42%
B:	6	28%	7	33%
C:	7	33%	4	19%
D:	4	19%	1	5%
E:	2	9%	0	0%

In groups A and B, the prior-operative kyphosis of the vertebral body was 29.1 ± 4.4 and 27.3 ± 3.4 , respectively. Following the operation, the kyphosis of the vertebral body was 11.0 ± 2.7 in group A and 9.9 ± 1.8 in group B, indicating the absence of any noteworthy dissimilarity in a statistical sense. ($P > 0.05$). Prior to the operation, the degree of

vertebral body height in groups A and B was 0.21 ± 0.050 and 0.23 ± 0.06 , respectively. After the operation, the degree of vertebral body height increased to 10 ± 0.05 in group A and 12 ± 0.06 in group B. No statistically significant disparity was perceived between the two cohorts, as indicated in Table 4.

Table 4: Measurement of deformities in the affected vertebral segment of the study patients (n=42) was conducted preoperatively, and final follow-up after 12 months.

Variable	A: Short fusion segments			B: Long fusion segments		
	Preop.	After op.	p. value	Preop.	After op.	p. value
Kyphotic deformation of the vertebral body	29.1 ± 4.4	11.0 ± 2.7	$P > 0.05$	27.3 ± 3.4	9.9 ± 1.8	$P > 0.05$
Measurement of compression deformity	0.21 ± 0.050	10 ± 0.05	$P > 0.05$	0.23 ± 0.06	12 ± 0.06	$P > 0.05$

DISCUSSION

The objective of this research is to contrast the clinical and image consequences of short fixation segments with those of long fixation segments and managing vertebral fractures are to promptly restore neurological function, anatomically overcome the damage to spinal segments, and achieve robust and steadfast stabilization to facilitate early rehabilitation.

The study revealed that the majority of those injured fell within the demographic cohort between the ages of 20 and 60 (Mean±SD: 40.6 ± 4.4 compared to 43.4 ± 4.4). This age demographic aligns with the observations of Moon and colleagues, 2003. and Kim, et al., 2009. A significant number of casualties were male (70%/30% compared to 80%/20%), as they are the

predominant segment of the working population in our country. Similar results were reported in this study; there was a notable frequency of injuries at the thoracolumbar junction (L1-L2), which could potentially indicate an increased degree of instability at these particular levels. A comparable discovery was also noted in the research conducted by Hur and colleagues, 2015, as well as Kim and co-authors. Pedicle screw fixation is commonly employed as a primary treatment for fractures of the thoracic vertebrae and lumbar vertebrae, as well as posterior-lateral synostosis, in numerous medical facilities. (Aebi, M. *et al.*, 1987)

Sasso and colleagues conducted clinical evaluations and analyses of various surgical instrumentation, including rods, hooking, rods of Luque, wiring, and screws of pedicle with a cohort of 70 patient samples. They discovered that pedicle screws, as a posterior fixation method, these instruments exhibited the ability to be applied to shorter segments in contrast to other fixation devices in the posterior region. (Sasso, R. C. *et al.*, 1993) Thus, utilization of pedicle screw fixation constitutes an efficacious method for posterior fixation that is fitting for said intention. (Kim, K. S. *et al.*, 2006) Hence, fixation of the pedicle screw is a favorable posterior fusion technique apt for this objective. (Kaneda, K. *et al.*, 1997)

In relation to clinical variables, the Frankel grading scale revealed that prior to the surgical procedure, grade C was prevalent in both Group A and Group B, with figures of 7 (33.3%) and 8 (38%), respectively ($p > 0.05$). Moreover, after the surgical intervention, Frankel grading A is predominant in Group B: 8 (38.0%) vs 9 (42.8%) ($p > 0.05$). As for pain scores or disability status, no discernible dissimilarities were encountered between the two groups. With regards to the radiological outcome, no significant variations were identified, regardless of whether short fusion segments or long fusion segments were considered. The primary benefits of using the posterior approach in both short fusion segment and long fusion segment are the preservation of the motion segment along with its simplicity and familiarity to spine surgeons. However, a notable limitation of this method is the challenge it poses in reconstructing the anterior column. The inability to regaining the support of the anterior column can result in a kyphosis later on, instability, pain, and delayed onset of neurologic impairment. These consequences primarily depend on the fractured

vertebral body's residual load transfer capacity. (Kim, K. S. *et al.*, 2006)

It has been reported that sagittal plane kyphosis cannot be remedied by screw fixation of the pedicle in cases of the thoracic column and lumbar column fractures, as deterioration of the bone was detected during the 6-month follow-up examination. (Dick, W. *et al.*, 1985) This research demonstrated favorable results as none of the patients experienced neurological impairments following the implementation of pedicle screw fixation. Pedicle screws are a viable option for treatment in both lumbar and thoracic vertebrae, particularly in cases of severe fractures like fracture-dislocation. Based on documented reports, the approximate rate of infection is 6%. (Roy-Camille, R. *et al.*, 1976) Following fixation of the posterior and synostosis, however, this study did not observe any instances of infection. A study by Humford, *et al.*, indicated that temporizing approaches yielded favorable prognoses for patients suffering from segmented fractures in the thoracic column and lumbar column without concomitant nerve impairment. (Dorr, L. D. *et al.*, 1982) Nonetheless, according to Denis, *et al.*, Patients with segmented fractures in the thoracic vertebrae and lumbar vertebrae who did not suffer from nerve damage displayed an improved ability to resume their regular activities following surgical spinal fusion. (Denis, F. *et al.*, 1984) However, These discoveries were not in accordance with the radiographic observations and did not encounter any significant bending of screws or hardware breakage. Progressive ossification with a gradual decline of bone structure integrity was observed in a paraplegic individual, however devoid of any intensified perception of pain. Jacobs, *et al.*, 1984, conducted comparative analyses between surgical procedures and provisional interventions. And concluded that surgical interventions surgically were superior to temporizing techniques in terms of ameliorating fractures, reinstating nervous functionality, mobilizing patients, and mitigating complications. (Jacobs, R.R. *et al.*, 1984) Burst fractures frequently encompass the breach of the lower and/or upper endplates, engendering consequential deformity due to the gradual subsidence of the discs into the fractured endplates and vertebral body. Farcy, *et al.*, have proposed that a sagittal index exceeding 15 degrees creates a biomechanical environment that promotes the progression of kyphosis. (Patrick, T. *et al.* 2003) Kyphotic deformation of the vertebral body (post-operative) was 11.0 ± 2.7 in group A and 9.9 ± 1.8 in

group B. Kyphotic angle was reduced in both cases, which is consistent with the findings of Kim, *et al.*, 2009 and Moon, *et al.*, 2003.

CONCLUSION

According to the findings of this investigation, traumatic injuries to the lumbar spine can be treated via spinal fixation utilizing a posterior approach. Both the short and long fusion segments were found to be efficacious in treating such injuries. These approaches aid in neurological recuperation, mitigate pain, and better the status of disability through early rehabilitation. This is achieved even without any noteworthy radiological distinctions when evaluated over the short term.

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