Original Article

HEALTH SCIENCES
MEDICINE

DOI: 10.32322/jhsm.1250055
J Health Sci Med 2023; 6(2): 519-525

The late-term results in our patients operated for lumbar spine fractures

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Cite this article as: İzci EK, Pekince O, Keskin F. The late-term results in our patients operated for lumbar spine fractures. J Health Sci Med 2023; 6(2): 519-525.

ABSTRACT

Aim: The current study aimed to evaluate the late-term results of patients operated for lumbar spine fractures in our clinic.

Material and Method: 134 patients from January 2012 to January 2020 were treated with "short-segment pedicle instrumentation" for lumbar fractures in our neurosurgery department. Patients with a burst fracture of a single lumbar vertebra were included. The final sample consisted of 67 patients who were followed up over the years with radiographs before and after surgery and CT scans at the final follow-up.

Results: The results showed that 60% of the patients were rated as Denis P1, 35% as P2, and 5% as P3. Screw breakage was observed in seven patients, and 67 patients underwent revision surgery. Furthermore, the fractured vertebral body's height was improved at the final follow-up stage, and an increase was witnessed from the preoperative figure of 16.4 mm to 25.8 at the final follow-up. At the final follow-up, the average Cobb angle was -11.6° preoperatively, and 6.3° after the operation and the correction loss was 12.1° which was severe in the middle part of the vertebra. By the final follow-up, disc spaces were narrowed below and above the fractured vertebra, and no correlation was found between clinical outcomes and adjacent disc degeneration.

Conclusion: We concluded that short-segment pedicle instrumentation produced satisfactory long-term results for lumbar fractures. To achieve adequate outcomes, correct management of complications and evaluation of various factors must be focused on.

Keywords: Lumbar, spinal fractures, spinal surgery

INTRODUCTION

Lumbar spine fractures result of major trauma, and it has been reported that over 765,000 new cases are reported of traumatic spinal fractures per year worldwide (1). New developments in research have shown with a population of over 84 million (2), Turkey observes 650 to 1700 new cases of injury to the spinal region every year. Furthermore, several individuals with spinal fractures rehabilitated account for 15 to 42% of the new cases (3).

Spinal injuries can be caused by a direct shock of a moving item bumping into the spine or incidental impact caused by movements of the spine (4,5). In the older population, lumbar spinal fractures occur due to falls, whereas young individuals have lumbar spine fractures due to road accidents (6). The main cause of spinal injury reported in Turkey is falling, which causes significant damage to the thoracic and lumbar regions (3). It has been reported that lumbar fractures are more common among adult women (59.8%) compared to adult men, as women have lower bone density (7,8).

Lumbar spinal fractures regarded as a major concern in the matter of public health, which causes a significant burden on patients, both economically and physically (9-11). Furthermore, high morbidity and mortality rates are linked to spinal fractures (9,11).

Different treatments for lumbar fractures are available based on the patient's severity, injury classification, and demographic characteristics (12). For lumbar spine trauma, the usage of pedicle screw and implants are common in treating thoracolumbar and lumbar fractures (13). The operative care involving surgical treatment, such as pedicle screw implants, is targeted to generate stability and reduce pain (14). Turkey reported a higher number of surgical interventions than other regions (3). The late results of surgical procedures have not been extensively studied in Turkey; however, studies

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Received: 12.02.2023 **Accepted:** 13.03.2023

in different regions have shown that post-operative back pain is a common complaint, and some patients may also experience vertebral height loss in the long-term which hinder the recovery of spinal stability (15,16).

Removal of pedicle screw may result in infection, degeneration of disc, osteopenia, and allergic reaction. Second surgical procedure, which is performed to remove the implant, increases the risk of site infection and neurovascular injury (17,18). Furthermore, it has been revealed that inactivity can lead to muscle weakness and negative outcomes of surgery (19-21). Most individuals with lumbar spine surgeries who opt for surgical treatment require narcotics post-operatively, and the usage extends beyond one month (16). Opioids are commonly used to manage pain, recovery can be costly, and analgesia use can have negative impacts (16). Other drugs utilized to manage back include nonsteroidal anti-inflammatory drugs (NSAIDs) and calcitonin (22). Individuals experience back pain that affects day-to-day functioning, and post-operative patients sometimes have to change their jobs due to lumbar surgery (23).

Lumbar surgeries are associated with acute post-surgical pain and affect the patient's recovery, directly impacting their quality of life (24,25). There is a lack of updated and extensive research on the long-term outcome of surgeries for lumbar spine fractures. The late-term results of such surgeries must be evaluated to provide better patient care. Hence, the present study aims to determine the late-term results in patients operated on for lumbar spine fractures and to add significant theoretical knowledge to the limited literature on late-term outcomes in patients operated on for lumbar spine fractures.

MATERIALS AND METHOD

The study was carried out with the permission of KTO Karatay Medical Faculty Non-Pharmaceutical and Non-Medical Device Researches Ethics Committee (Date: 30.12.2022, Decision No: 50512). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. For the present retrospective study, the data of all patients were collected from Meram Medicine Faculty.

Inclusion and Exclusion Criteria for Patients

From January 2012 to January 2020, 134 patients were treated with "short-segment pedicle instrumentation" for lumbar fractures in Meram Medicine Faculty neurosurgery department. According to Denis classification, 88 patients had a burst fracture of a single lumbar vertebra, and they were included in this study. However, the patients with severe intrusion in their spinal canal and who had neurological issues were not included in this study. The patients with a vertebral collapse of more than 60% were also not included in this study because they underwent anterior surgery. At the final follow-up, 3 patients died due to different medical issues, and 18 patients didn't show up, so the final sample for the present study included 67 patients.

Surgical Treatment

All selected patients were treated within 12 days of injury under general anesthesia. Standard trans-pedicular fixation was performed via a "posterior midline approach." Two types of pedicle implants (short-segmented) were utilized for fixation and reduction. The first one included "posterior short-segment fixation" (PSSF), which was used in 26 patients, and the other was "screw-rod angle pedicle fixation" (APF) which was used in 41 patients. However, 35 patients were found to be neurologically compromised, so laminectomy was performed on them. The facet's lateral part was preserved, and the dural sac's laceration was sutured. The pedicle screws were connected with the help of the rods. Later, a reduction force was applied using an instrument for distraction and lordosis. The segmental lordosis and body height of the vertebra were restored, and intraoperative fluoroscopy was used to check them. However, in 35 patients who went through a laminectomy, grafting was done. The patients were recommended to wear a lumbar corset to carry out different activities for at least three months. Revision surgery was recommended within the first year of operation for implant removal.

Follow-up Evaluation and Data Analysis

67 patients were followed-up for an average of 8 years. The clinical evaluation of these patients was done by the outpatient department. Lateral and anterior-posterior (AP) radiographs were also taken pre and post-surgery. A CT scan was also advised at the final follow-up; only 16 patients gave the green signal. The measurements in the context of lateral plain radiograph include the fractured vertebral body's height in the middle and posterior, the Cobb angle, and the fractured vertebra's sagittal angulation. The adjacent vertebra's (present under the fracture) height was taken as the reference, and reduction was determined as the difference between before and after surgery in lordosis and height. Correction loss was also determined as the difference in lordosis and height between pots-operative and pre-implant removal. The smallest distance between the lower and upper screw tips was also determined on the lateral radiograph just before the removal of the implant and after the operation. The shortening of this distance was considered implant deformation. The Mimura method (26) (**Table 1**) was used to assess the discs which were adjacent to the fractured vertebra and to compare them between "pre-operative and final follow-up" with lateral and AP radiographs.

Table 1. Discs' radiographic grading

DH (AD %)	OF (SOP on 8 edges: "<3 mm 1 pt., >3 mm 2 pts.")	ES
0=nor.	0=0 pt.	0=none
1=mil. (>75%)	1=1 to 4 pt.	1=either EP
2=mod. (>50%)	2=5 to 8 pt.	2=both EP
3=sev. (>25%)	3=9 to 12 pt.	
4=v. sev. (<25%)	4=13 to 16 pt.	

DH= disc height; AD= adjacent discs; nor.= normal; mil.= mild; mod.= moderate; sev.= severe; v. sev.= very severs; pt.= points; EP= endplates; ES= endplate sclerosis; OF= osteophyte formation; SOP= sum of points

RESULTS

Demographics of Patients

Table 2 shows that the total number of selected patients was 67.23.8% of these were male, while 76.1% were female. The average age of the patients was 32.9 years. The fractured levels were found to be T11 (2.9%), T12 (17.9%), L1 (40.2%), L2 (51.8%), L3 (14.9%), and L4 (2.9%). 37.3% of patients had fracture type Denis A (37.3%), B (56.7%), and C (5.9%). 35 patients were neurologically compromised integrating Frankel A (17.1%), B (14.2%), C (20%) and D (48.5%). Pre-operative CT and radiographs were taken in all selected patients.

Table 2. Demographics of patients

Characteristics	(n, %)
Gender	
Male	16 (23.8%)
Female	51 (76.1%)
Total	67 (100%)
Average age	32.9 years
Fracture level	
T11	2 (2.9%)
T12	12 (17.9%)
L1	27 (40.2%)
L2	14 (51.8%)
L3	10 (14.9%)
L4	2 (2.9%)
Total	67 (100%)
Fracture types	
Denis A	25 (37.3%)
Denis B	38 (56.7%)
Denis C	4 (5.9%)
Total	67 (100%)
Neurological compromise (pre-operative)	
Frankel A	6 (17.1%)
Frankel B	5 (14.2%)
Frankel C	7 (20%)
Frankel D	17 (48.5%)
Total	35 (100%)

Clinical Results

Denis's evaluation scale is provided in **Table 3**. The results obtained from this study showed that 60% of the patients were rated as "P1," 35% were rated as P2, and 5% were rated to be P3. 46% of the patients changed their work habits, while 10% could not carry out their daily activities.

Table 3. "Denis evaluation scale" (47)

Grade	Criteria
P1	There is no pain
P2	Minimal pain and no medication required
P3	Occasional medication, moderate pain
P4	Pain ranges from moderate to severe
P5	Chronic medication, severe pain constantly

Failure of Implant

Screw breakage was observed in seven patients, and the smallest distance between the lower and upper screw tips was found to be 2.5 mm between immediately post-surgery and just before removal of the plant. 61 patients had revision surgery for plant removal at an average of 14 months. Screws were loosened in a single patient, while two patients had bent screws (**Figure 1**) and were broken in five patients (**Figure 2**). Six patients were not willing to revision surgery. One of these patients had a loosened nut at 7 years (**Figure 3**). A screw was found to be broken in two patients at 6 and 7 years (**Figure 4**), and a foreign reaction was observed in two patients at 7 and 9 years. All these patients later went through revision surgery.

Figure 1. For a 51-year-old male with T12 burst fracture, PSSF was used for his treatment), post-operative radiograph (6 months) representing pedicle screws that were bent

Figure 2. A 42-year-old male with L2 burst fracture, APF was used for his treatment), lower pedicle screws are broken

Figure 3. A 49-year-old male with L1 burst fracture, PSSF was used for his treatment), post-operative radiograph (8 years) representing loose nuts

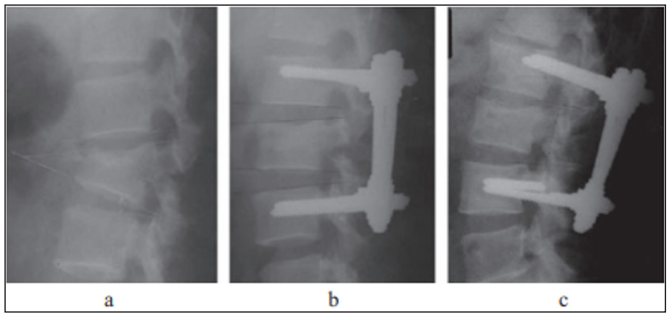

Figure 4. For a 47-year-old male with L2 burst fracture, APF was used for his treatment), (a) pre-operative radiograph, (b) post-surgery radiograph, (c) radiograph after 6 years of operation, showing broken pedicle screw and upper disc degeneration

Moreover, among 26 patients (who had PSSF fixation), implant failure was observed, which included a loose screw, nut, and screw breakage in one patient each, whereas a bent screw was observed in two patients. However, in 41 patients with APF fixation, implant failure was observed in six patients, and about 12 patients had implant failure with a loose screw and nut.

Correction Loss and Reduction

The fractured vertebral body's height was improved at the final follow-up compared to the pre-operative condition. The average height of the anterior vertebra was 16.4 mm preoperatively. At the final follow-up, it was found to be 25.8 mm. Therefore, a 9.4 mm average reduction was observed. The correction loss of the anterior and middle vertebra was 0.7 mm and 1.9 mm, as shown in **Table 4**. The average Cobb angle was -11.6° preoperatively and 6.3° after the operation (an average reduction of 17.8° and -5.8° was observed at the final follow-up), and the correction loss was 12.1°. The final reduction was 5.9°. Therefore, the correction loss was found to occur before implant removal, followed by implant deformation. The correction loss was found to be more severe in the middle part of the vertebra when checked at follow-up.

Table 4. Correction loss and reduction in adjacent discs and fracture vertebral body (mean±SD)

Index	PO	Red.	Loss before IR	Loss at F-U	Final F-U
ADH (mm)	6.1±2.5	3.2±2.6	4.2±4.4	6.2±3.6	2.8±2.2
AVH (mm)	16.5±4.8	9.8±6.2	0.5±1.4	0.7±1.2	25.7±5.6
ABH (mm)	9.7±3.6	1.4±1.6	3.3±2.8	5.2±3.8	6.3±4.2
MVH (mm)	19.2±5.6	6.3±5.8	1.6±3.2	1.7±3.2	23.2±5.7
PDH (mm)	3.3±1.8	0.6±2.3	1.5±1.7	1.8±2.2	1.8±1.8
PVH (mm)	34.2±2.5	0.8±2.8	−0.2±1.2	−0.5±1.3	35.2±1.8
PBDH (mm)	4.3±2.7	0.8±1.7	1.3±1.6	1.3±2.4	4.2±2.1
LD (degree)	3.8±3.5	3.5±4.5	4.5±4.8	6.2±3.5	1.1±2.6
LV (degree)	−22.4±10.3	13.4±9.3	0.5±3.7	1.5±3.7	−10.5±6.24
LLD (degree)	6.8±4.2	1.3±4.6	2.6±3.8	4.5±3.7	3.6±3.8

"ADH= anterior up disc height; AVH= anterior vertebra height; ABH= anterior below disc height; MVH= middle vertebra height; PDH= posterior up disc height; PVH= posterior vertebra height; PBDH= posterior below disc height; LD= lordosis in up disc; LV= lordosis in the vertebra; LLD= lordosis in the lower disc." Red= reduction; F-U= follow-up; PO= pre-operative; IR= implant removal

Adjacent Discs Changes

By final follow-up, the disc spaces were found to be narrowed both below and above the fractured vertebra. Fusion occurred spontaneously in 26 patients in upper disc space. At the same time, spontaneous fusion at lower disc space was observed in 13 patients (**Figure 5**). According to the Minura classification, the degeneration of lower and upper adjacent discs was significant at the time of final follow-up compared to the pre-operative situation, as the value of p was less than 0.01, as shown in **Table 5**.

Figure 5. For a 52-year-old male with L2 burst fracture, PSSF was used for his treatment); the implant wasn't removed for 11 years, and good functioning instead of adjacent discs degeneration

Table 5. Discs degeneration pre-operation and at final follow-up

MG	UAD		LAD	
	PO (67 cases)	Final F-U (61 cases)	PO (67 cases)	Final F-U (61 cases)
1	21		45	
2	46		22	2
3		20		37
4		41		22

MG= Mimura Grade; UAD= Upper adjacent disc; LAD= Lower adjacent disc; PO= preoperative; F-U= follow-up, UAD (x^2= 67.11, v= 2, $p < 0.01$); LAD (x^2= 119.37, v= 2, $p < 0.01$)

Correlation between Radiological Findings and Long-term Clinical Outcomes

Table 6 shows no significant correlation between clinical outcomes and adjacent disc degeneration, as the value of p was greater than 0.05.

Table 6. Back pain comparison between patients with and without 20° kyphosis

Patients	D-P1	D-P2	D-P3
Wit. >20° kyphosis	39	21	1
WO >20° kyphosis	3	2	1
Tot.	42	23	2

D= Denis; wit= with; WO= without, Tot= total, (x^2= 16.8, v= 2)

DISCUSSION

Our results showed that "short-segment pedicle instrumentations" effectively reduced lumbar burst fractures and restored the body height of vertebrae and physical lordosis. It was also observed that instead of correction loss at the time of final follow-up, the spinal alignment was found to be improved significantly. According to Kim et al. (27) and Li et al. (28), posterior surgery effectively treats posterior injuries such as facet protruding or lamina into dural theca lancination. Verlaan et al. (29) has reported that surgical treatment of traumatic spine fractures is safe and effective. In their studies An et al. (30) and Smith et al. (31) has stated that short rigid fixation with pedicular instrumentation is more beneficial in surgical treatment of spine fractures. There are also different studies (32-35) in the literature that support the research results and draw attention to the safety of the use of short-segment pedicle instrumentation.

It has also been observed that neurological recovery was not satisfactory in patients with conus medullaris syndrome. Local kyphosis (greater than 20°) was found to be associated with back pain. This result was also advocated by Doğu (36). It has been observed that the patients who took extra care after the operation took less time to recover than those who kept on handling heavy objects . As indicated by Brown et al. (37) good postoperative care, can make the difference between success and failure of treatment.

Moreover, the late-term effects observed in patients treated with APF and PSSF showed that few of the patients suffered bent screws and loosened screws. They were recommended to undergo revision surgery to remove the plants and prevent further discomfort. This explains the efficiency of longer follow-ups for patients who have undergone surgery due to lumbar fractures. Similar to our results Xu et al. (38) concluded that short-segment pedicle instrumentation provided satisfactory reduction for thoracolumbar and lumbar burst fractures. It has also been shown in different studies that surgical intervention for lumbar spine fractures improves long-term quality of life.

The correction loss was found to be more obvious at the follow-up time due to the severely fractured vertebral body's preoperative collapse. Therefore, the correlation between reduction and correction was found to be positive, and collapse was found to be insignificantly correlated to reduction. This shows that minor collapse occurs post-sufficient reduction.

Research Implications

This research study has proven to be efficient in determining the association between back pain and local kyphosis. This study will also improve the information on the correlation between radiological findings and clinical outcomes of patients with lumbar fractures (treated with APF and PSSF). This study will also effectively promote awareness programs for patients with lumbar fractures who have undergone surgeries to take important measures to ensure proper healing. As a result, more rehabilitation management programs will be encouraged for such patients for effective outcomes.

Limitations and Future Research

The present study has some limitations which can be overcome in future studies. This study was limited to clinical outcomes of patients with lumbar fractures. In contrast, no focus was given to the patients' pre and post-operative personal or professional lives. Therefore, future studies can also be conducted in this context. This study only focused on APF and PSSF treatments due to researcher bias. In order to overcome this issue, future studies can also focus on other treatments such as laminectomy, balloon vertebroplasty, etc.

CONCLUSION

In Turkey, lumbar fractures among adults rapidly increase due to stress and accidents. These fractures are more commonly observed among older women as compared to men. This study was conducted to determine the later-term results in patients operated on for lumbar spine fractures. This study's main focus was on reduction, correction loss, and implant removal. For this study, a total of 67 patients (26 treated with PSSF and 41 treated with APF) were included, and the follow-up from January 2012 to January 2020 was one. The results obtained from this study showed that "short-segment pedicle instrumentations" are effective in providing successful reduction for lumbar burst fractures. Despite correction loss at the time of final follow-up, the spinal alignment was found to be improved significantly. However, the correlation between back pain and local kyphosis was significant.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of KTO Karatay University Medical Faculty Non-Pharmaceutical and Non-Medical Device Researches Ethics Committee (Date: 30.12.2022, Decision No: 50512).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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