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Original Article

Adjacent Segment Disease after the Fractured Lumbar Vertebrae Fusion

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Abstract

Objective: Lumbar spine fracture is one of the most common disorders in neurosurgery departments of all around the world due to high rates of trauma from car accidents and falling. About 150,000 cases of spinal fractures are reported in the United States each year, among which 11,000 are associated with Spinal Cord Injury (SCI).

Material and Methods: 50 trauma patients aged between 18 to 50 years old who suffered from lumbar vertebral fracture L1-L4 (lumbosacral) were divided into two 25 patients groups; the first group underwent Short Segment Fusion (SSF) surgery and the others underwent Long Segment Fusion (LSF) surgery.

Results: Intervertebral space was 0.73±0.13 in LSF group and 0.68±0.10 in SSF group (p=0.656), and also mean lower intervertebral space was 0.63±0.07 in LSF group and 0.67±0.08 in SSF group (p=0.183), differences were not statistically significant between two groups.

Conclusion: None of the spine stabilization methods (LSF or SSF) were preferred to other one and both can be used according to the patients' condition.

Keywords: *Lumbar vertebral fracture, Short segment fusion, Long segment fusion, Intervertebral space*

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Introduction

According to the reports of International Spinal Cord Injury Organizations and Associations, 40% of SCI is caused by motorcycle accidents [1, 2], About 40% of SCI is associated with occupational and sport injuries and the rest 20% occurs due to fall from height [3, 4]. Because of the severity of injuries, many cases require surgical interventions, lumbosacral spinal fusion or fixation or more complex procedures [5]. In addition to the great benefits of biomechanical correction of surgical intervention, sometimes these procedures cause side effects in patients. One of the most important and significant side effects which seen in some patients after a while, is the development of degenerative changes in the vertebrae adjacent to surgical site. These changes cause specific clinical symptoms and signs in patients and appear in imaging findings. Classical imaging methods such as x-ray imagings can be used as an initial method in order to follow surgical site (mostly lumbosacral region) in patients who undergo surgery. Although previous biomechanical studies demonstrated that disc replacement normalizes adjacent segment motion but on the other side some studies suggested that adjacent segment disease (ASD), can cause some sensory symptoms,ache and discomfort in related zones and changes in the capability and range of motion of spinal column which can afford temporary or permanent movement restrictions. Because of not enough information in this matter, there are still concerns regarding the biomechanical effects of vertebral fusion and ASD on the mobile motion segments. It should be noted that the effects of disc space height reduction in adjacent fused segments is unknown on biomechanical function and few studies have focused on this issue. Based on recent investigations, incidence of ASD after surgical intervention, decompression and fusion procedures are about 2-3% annually [6]. Review studies conducted in 2014, aimed to determine and assess the damage pattern and outcome of thoracolumbar fractures. Most of fractures happened between

T10-L2 and been identified as a factor for disability and morbidity in patients but fortunately recent decades' medical advances improved the management methods and surgical procedures and leaded to better outcomes [7]. According to several studies about short and long fixation with regard to thoracolumbar fractures, it has been showed that long fusion is more effective than short fusion in both thoracolumbar and thoracic fractures, and also long fixation had better outcomes than short fixation in treatment of thoracolumbar fractures [8].

The aim of this study is to assess adjacent segments disease (ASD) post-spinal fusion surgery of damaged lumbosacral vertebrae and also to evaluate ASD radiological findings in traumatic patients with lumbar vertebral fractures, who underwent surgical intervention and treated with spinal fusion surgery.

Materials and Methods

In our study, 50 traumatic patients aged between 18 to 50 years old who suffered from lumbar vertebral fracture L1-L4 (lumbosacral) and with BMI between 18.5 to 30 kg/m^{2,} were respectively enrolled in tandem. Patients were treated according to the Declaration of Helsinki tenets and local guidelines for care by approve of ethics committee of Tabriz University of Medical Sciences (TUOMS). Patients were randomly divided into two groups each one including 25 cases; one of the groups underwent Short Segment Fusion (SSF) surgery and the other group underwent Long Segment Fusion (LSF) surgery. Segments upper and lower to the fusion zone, were investigated in each of two groups to measure the amount of spinal lordosis in adjacent segments. Six months post fusion surgery, the indexes recalculated, results were analyzed and compared among two groups and symptomatic patients were defined as novel neurologic deficit. Also, Lateral radiographs were used in order to measure intervertebral space and Lumbar Lordosis Angle (LLA). In all of 50 patients, a line was drawn to determine a space between T12-L1vertebrae and other line to illustrate L5-S1 space. Obtained angle from the intersection of these two lines considered as LLA (Figure 1). Among trauma patients with spinal fracture including L1, L2, L3 and L4 vertebrae, 20 patients who treated with LSF surgery were compared with other 20 patients who underwent SSF surgery. Counting the loss of our study subjects, 25 patients were selected for each group and finally 19 and 16 patients (total of 35) were referred to be following up.

Statistical analysis

Microsoft Excel worksheet and data analysis was performed using SPSS software (Version 23) for Windows. Differences between two groups were tested by the χ 2 statistics (Chi-square) and t-test. A $p<0.05$ was taken as significant.

Results

Counting the loss of our study subjects, 50 patients aged between 18 to 50 (Figure 2) with mean age of 35.8±9.9 years and weigh 55 to 90 kilograms with mean weight of 73.5±8.7 kilograms, were qualified to participate in the present study. But

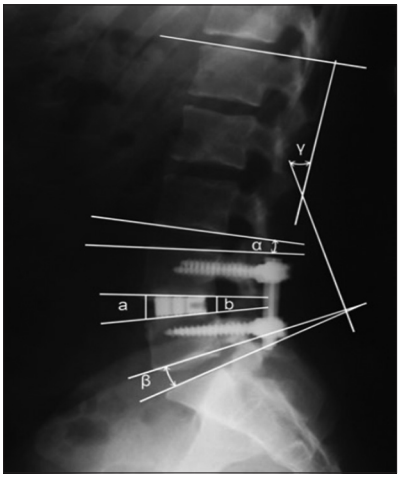

Figure 1. Intervertebral space calculation method.

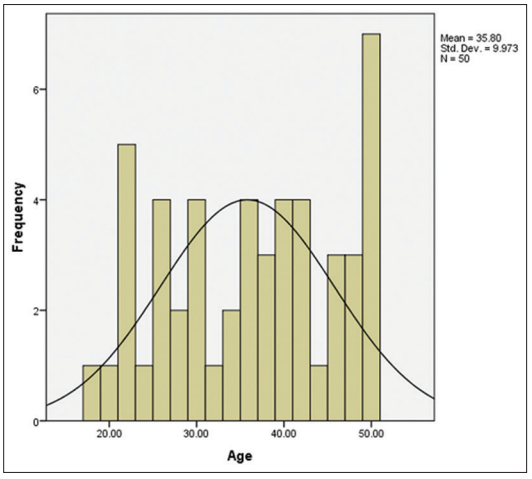

Figure 2. Shows the patients age histogram.

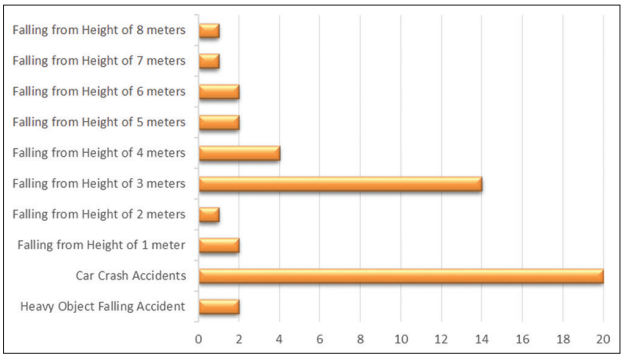

Figure 3. Shows the patients' mechanism of injury frequency.

only 35 cases were chosen for six months' follow up. The mean LLA of 35.1±4.7 degrees with maximum LLA of 47 degrees and minimum LLA of 27 degrees calculated in considered patients. Mean ± SD of upper and lower intervertebral space achieved 0.71±0.11 and 0.66±0.07, respectively. All patients' information before surgery is presented in Table 1. The differences between two groups were not statistically significant ($p>0.05$) in terms of any of the studied factors such as age, weight, LLA, upper and

lower intervertebral space before and after the surgery. Due to the multiplicity of mechanisms of injury in patients (Figure 3), the most common mechanisms of injury in our study was traffic accidents and falling from a height of 3 and 4 meters. Results also revealed that the frequency of vertebral damage (L2, L3 and L4) was 26 (52%), 12 (28%) and 10 (20%) cases respectively. Based on our results, neither various injury mechanisms (p=0.582) nor vertebral damage frequency (p=0.803), were not statistically significant different between two SSF and LSF groups; which implies concurrence of two groups in terms of studied variables Table 2. In follow up studies, and in 31 (88.2%) cases out of 35 considered patients for follow up, surgical intervention had desirable and compelling outcomes and just in 4 (11.8%) cases, the fusion surgery outcome was not satisfying. Hence, only 2 patients in each study groups did not have desirable and satisfying outcomes. So, in terms of intervention success rate variable, SSF and LSF methods did not show statistically significant differences (p=0.630). According to results of follow up group and also according to control lumbar spine x-ray radiograph findings after six months, mean LLA 36.3±4.3 degrees in patients with LSF and 35.5±5.6 degrees in patients with SSF, showed differences which were not statistically significant between two groups in six months after lumbar lordosis surgery. Due to the mean upper intervertebral space 0.73±0.13 in LSF group and 0.68±0.10 in SSF group (p=0.656); and also mean lower intervertebral space0.63±0.07 in LSF group and 0.67±0.08 in SSF group (p=0.183), differences were not statistically significant between two groups.

Table 1: Patients' evaluation before surgery group

	Long segment fusion group (LSF)	Short segment fusion group (SSF)	p-value
Age	37.5±10.3	34.4±9.4	0.216
Weight	72.8±7.1	74.2±9.1	0.536
Lumbar lordosis angle (LLA)	36.1±4.4	34.1±4.8	0.143
Superior intervertebral space	0.71±0.13	0.70±0.10	0.762
Inferior intervertebral space	0.65±0.7	0.68±0.7	0.220

Discussion

Spinal fractures are the most severe damage in young people's third decade of life. Lumbar fractures among young people occur usually due to high-energy accidents such as falling from a height or vehicle crashes. Instability is one of the most important factors in these injuries that may cause serious complications such as spinal cord injury or deformities of the spine with poor prognosis. Radiography is the first step of evaluation of spinal fractures to diagnose this type of damage (unstable and stable) and also it plays important role to determine and achieve sustainable reform after surgery. Depending on the patients' status, approach to lumbar injuries includes conservative treatment and surgical intervention. Surgical indication is based on neurologic disorders, deformity and instability. Surgical treatment of lumbar fracture requires initially open fixation of the deformity which is followed by stabilization of the broken part. The most proper treatment in unstable fractures is surgery.

In our study, 50 patients with traumatic lumbar spinal fractures were included. Patients who had the indication for surgery were selected to be followed up for about six months, after receiving therapy and surgical intervention by anterior-posterior, lateral, flexion and extension radiographic imaging. Despite great efforts, during this study, 16 patients did not return for follow up. Patients of two groups were compared in terms of variables such as age, weight, lumbar lordosis and upper and lower intervertebral space, before and after surgery. Differences were not statistically significant between two groups before surgery which suggested that two groups were matched in terms of above factors. Among total 34 participated patients in follow up, only in 2 patients in each of LSF and SSF groups (totally 4 (11.7%) patients), fusion surgery failed and outcome

Table 2: Two group evaluations by mechanism of injury and injured vertebras

	Long segment fusion group (LSF)	Short segment fusion group (SSF)	p-value
Type of accident			
Heavy object falling accident	0	2	0.582
Car crash accidents	9	11	
Falling from height of 1 meter	1	1	
Falling from height of 2 meters	1	0	
Falling from height of 3 meters	8	6	
Falling from height of 4 meters	2	2	
Falling from height of 5 meters	2	0	
Falling from height of 6 meters	1	1	
Falling from height of 7 meters	0	1	
Falling from height of 8 meters	1	0	
Injured vertebra			
L2	12	14	0.803
L3	8	6	
L4	5	5	

was not desirable and satisfying. Most injury mechanisms that cause damages in patients were vehicle accidents followed by fall from height of 3 meters; which classified as high-energy injuries. According to reports of International Spinal Cord Injury Organizations and Associations, 40% of SCIs happen due to the motorcycle accidents [1, 2] which confirm the high rate of SCIs that caused by traffic accidents. Patients' mean age was 35.8±9.9 years. As mentioned earlier, SCIs usually happen in the third decade of life, followed by high-energy injuries [9]. In our study, an L2 vertebra was the most common site of fracture which is not compatible with the results of Wood et al study. The difference in results of two studies is due to the differences in inclusion and exclusion criteria, so despite of Wood et al study, our study focused on the Lumbar Spine injuries and thoracic vertebrae was not included [7]. Study conducted by Cho et al in 2007 showed that, the differences were not significant among two groups in terms of lumbar lordosis [10].

Similar to the results of present study, patients had partial response compared with preoperative situation but differences were not significant between two groups. Cho et al study showed in LSF surgical method that LLA was bigger than SSF method. In our study, LLA was measured in patients before and after surgery. According to the results, lumbar lordosis was reduced in both groups after surgery as expected, but no significant difference was observed between two groups. In other words, despite the distinction between LSF and SSF surgical methods, LLA differences were not significant [10]. In 2005 in a study, Tezeren et al showed that long fixation was better in treatment of thoracolumbar fractures and is preferred to short fixation, although significant difference was not observed eventually [8]. Also in 2006 a published study review by McLain et al showed that LSF was better than SSF in vertebral thoracic fractures. In our study, the upper and lower intervertebral spaces were measured in both groups either before and after surgery, which was not significantly different between two groups after six months of follow up; that suggests there was no difference between two LSF and SSF surgical methods in short-term in changes of upper and lower intervertebral space [11].

Our clinical study had some limitations such as accuracy and proficiency of x-ray department staff, limit sample size and loss of our study subjects due to lack of patients' cooperation for six month follow up.

Conclusion

Although few factors such as accuracy and proficiency of x-ray department staff, limit sample size and loss of our study subjects due to lack of patients' cooperation for six month follow up (16 patients did not return for follow up), were factors which might influenced results of our study; but our results suggested similar to previous related studies. LSF is more effective than SSF. However, the information didn't have a significant difference, Given that in none of the patients after six months follow up, significant changes were observed in results. On the other hand in terms of End plate and Sclerosis, there were not considerable changes between two groups. Hence, considering the results of our study, at least in the short-term, none of the spine stabilization methods (LSF or SSF) were preferred to other. One or both of above methods can be used due to the patients' condition and based on discretion and insight of the surgeon. But more studies with bigger sample size are recommended to be done to confirm or refute findings of our study.

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