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RESEARCH PAPER

The Prevalence of Adjacent Segment Disease and Reoperation Following Transpedicular Screw Fixation of Lumbar Spine

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A B S T R A C T:
Background: Adjacent segment disease is a condition in which the mobile level next to the fused section degenerates as a result of increased biomechanical stress and mobility, it may be rostral, caudal, or both rostral and caudal to fused segment.
Patients and Methods: A retrospective study was conducted on 110 patients who underwent transpedicular screw fixation of the lumbar spine between January 2011 and May 2019. Demographic data of the patients, including patient's age, gender, symptoms, type of fixation, the extent of fixation, segments fixed, date and pathology causing first and second surgery, were taken from patients attending the outpatient department of Hawler Teaching Hospital on Mondays and Wednesdays from October 2018 to May 2021.
Results: Thirty-six (32.72%) patients of 110 patients who were included in the study developed ASD. Eleven (10%) patients needed a second surgery for ASD.
Conclusions: The rate of developing ASD was (32.72%) out of 110 patients who were included in our study and had transpedicular screw fixation. The rate of patients that needed a second surgery for ASD was (10%). Male gender, advanced age, floating fixation and multiple level fixation were variables that contributed to a higher rate of developing ASD. Multiple level fixation was the only variable with clinical significance. These rates in our study were comparable with the literature's stated prevalence of ASD after spinal fixation and reoperation for ASD.

KEY WORDS: Adjacent; Segment disease; Reoperation; Lumbar spine; Spinal fixation
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1.INTRODUCTION :

For a variety of pathologic disorders of the spine, spinal fixation is a common operation. The number of spinal fixation surgery has risen considerably in the recent decade (Kersten et al.,2016) Even though spine fusion procedures are frequently performed, there is still disagreement over some of the most fundamental aspects, such as the reasons for fixing, the best surgical techniques, and the likelihood of ASD. (Masevnin et al., 2015: Kersten et al.,2016)

ASD is a condition in which biomechanical stress and increased mobility cause degeneration of the mobile segment next to the fused segment. (Masevnin et al., 2015: Li XF et al., 2021) A study Aiki et al. (2005) have made an extensive review based on 16 different studies and show that this condition has been found radiographically in 30%–53% of patients who have been followed up for 5 years or more following lumbar fixation surgery. However, a small proportion of these patients needed revision surgery due to ASD. Revision surgery rates for ASD have been reported to range from 0% to 18% in the literature.

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Various follow-up studies (Wang et al., 2017: Lawrence et al., 2012; Nayar et al., 2021) have been conducted looking into the risk factors for ASD based on the radiographic investigation. While research concentrating on the prevalence of ASD and patients who require revision surgery have been limited to sectional studies. (McGirt et al., 2011: Adogwa et al.2012: Lee et al., 2014: Scemama et al., 2016)

In this analysis, the authors looked at the clinical and radiographic characteristics of patients who had fixation surgery for the lumbar spine based on certain surgical indications, some of them developed ASD and a small percentage of them had to undergo reoperation for ASD.

The research aimed to

1. Analyze the rate of developing ASD and reoperation for ASD after transpedicular screw fixation of the lumbar spine.
2. Analyze factors such as (patient-specific factors) including age, gender, (surgery-related factors) like mono-segmental or multi-segmental, floating or non-floating fixations that increase the risk of ASD following spinal fixation surgery.

2. MATERIALS AND METHODS

A retrospective study was conducted on 110 patients who underwent transpedicular screw fixation of the lumbar spine. Demographic data of the patients, including patient's age, gender, symptoms, type of fixation, the extent of fixation, segments fixed, date and pathology causing first and second surgery, were taken from patients attending the outpatient department of Hawler Teaching Hospital on Mondays and Wednesdays from October 2018 to May 2021. All of the patients who were included in our study have undergone transpedicular screw fixation of lumbar spine between January 2011 and May 2019.

In order to be included in the study, patients had to be followed for at least two years. Lower limb weakness, radicular pain, and neuralgic claudication that had not responded to conservative treatment were the reasons for spinal fixation surgery using transpedicular screws and rods along with the placing of bone chips on transverse processes of fixed segments to achieve fusion. Low back pain alone was not a sufficient reason for surgical intervention. The use of spinal fixation for a spinal fracture or a spinal malignancy was stated as an exclusion criterion for this study. Patients were suffering from degenerative spondylolisthesis, isthmic spondylolisthesis, dynamic instability, degenerative scoliosis or failed back syndrome. Dynamic instability was described as sliding of greater than 3 mm or during flexion and extension a change of angle of greater than 10°. Failed back surgery syndrome was described as lumbar spinal pain of unknown origin either persisting despite surgical intervention or appearing after surgical intervention for spinal pain. (Orhurhu et al., 2020)The mean follow-up was 5 years and 7 months (range 2–10 years), with 67 patients receiving at least a 5-year follow-up. There were 53 male and 57 female participants, with a mean age of 58.6 years (range 34-77 years).

In 54 cases, the diagnosis was degenerative spondylolisthesis; in 28, it was isthmic spondylolisthesis; in 16, it was failed back syndrome; in 6, it was degenerative scoliosis; and in 6, it was dynamic instability.

Posterolateral fusion was performed on all patients using transpedicular screw fixation. Other methods of fixation were specified as exclusion criteria for this study. Thirty-one patients had one level fixed, fifty-two patients had two levels fixed, seventeen patients had three levels fixed, six patients had four levels fixed, two patients had five levels fixed, one patient had six levels fixed, and one patient had seven levels fixed . In 70 patients, the fixation was confined to the lumbar vertebrae (floating fusion), in 38 patients, it was extended to the sacrum, and in two patients, it was extended to both the thoracic spine and sacrum. Nerve root decompression was done at the fusion segment(s) in all of the patients. Age, gender, initial pathologic state, and first spinal fusion and decompression surgeries were all taken into account when determining the risk of reoperation. Fisher's exact probability test was used to assess the data in a 2X2 cross contingency table. Statistical significance was determined as a probability of less than 0.05.

Inclusion criteria:

1. Patients who had lumbar spine fixation for lower limb weakness, radiculopathy and neurological claudication.
2. Patient had been followed up for at least 2 years after surgery.

Exclusion criteria:

1. Patients who had lumber spine surgery for back pain alone, spinal fracture, or spinal malignancy.
2. A period of less than two years has elapsed from the time of operation.

3. RESULTS AND DISCUSSION

Out of 110 patients who had lumbar spinal transpedicular screw fixation between January 2011 and May 2019, 36 patients developed ASD (Fig. 1).

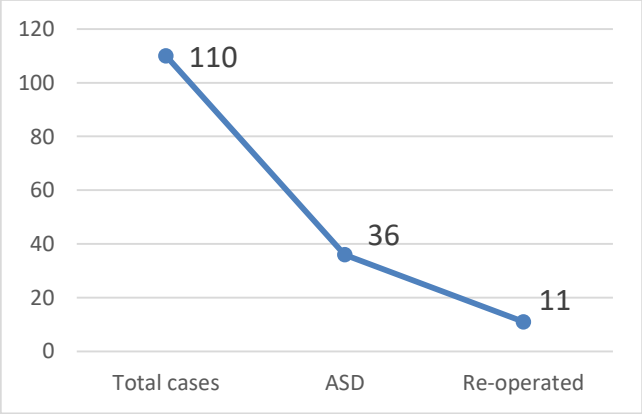

Figure 1: Cases who developed ASD and required second operation

The average time between surgery and developing ASD was 6 years and 9 months (range 2 years and 7 months to 10 years). Among all thirty-six patients who acquired ASD, the pathology was degenerative spondylolisthesis in 16 patients, degenerative scoliosis in 5 patients, failed back syndrome in 3 patients, isthmic spondylolisthesis in 10 patients, and dynamic instability in 2 patients. Spinal segments that were involved in spinal fixation surgery in cases that developed ASD were limited to the lumbar spine in 24 patients (floating fusion), extending to the sacrum (non-floating fusion) in 11 patients, and extending to both the thoracic spine and sacrum in 1 patient. Four patients had mono-segmental fixation. Thirty-two patients had two or more spinal segments fixed. The pathological presentation of the adjacent segment was stenosis alone in 21 patients, stenosis and disc herniation in 8 patients, stenosis and dynamic instability in 3 patients, stenosis and spondylolisthesis in 3 patients, stenosis and retrograde spondylolisthesis in 1 patient. The ASD was at the segment proximal to the fixation in 32 patients, it was distal to the fixed segments in 3 patients, and both proximal and distal segments were involved in 1 patient. Thirty-four cases had single ASD, while two cases had two ASDs each, one of which had both ASDs proximal to the fixed segments, while the other case had a segment proximal and a segment distal to the site of fixation.

Eleven (10%) of 110 patients who underwent lumbar fusion surgery needed a second surgery for ASD (Fig. 1). Between the first and second surgeries, the average time was 6 years and 6 months (range 2 years and 7 months to 10 years). All the cases who underwent reoperation for ASD were suffering from spinal stenosis, either alone or with another pathology, at the adjacent segment. Throughout all eleven patients, the pathology revealed spinal stenosis alone in (one patient), spinal stenosis in association with spondylolisthesis (three patients), retrograde spondylolisthesis (one patient), dynamic instability (three patients), or disc herniation (three patients) at the second surgery. These conditions were found in eight patients' upper adjacent segments and three patients' lower adjacent segments. The rate of reoperation was studied in relation to age, gender, extent of initial spinal fixation, and the type of fixation (floating or non-floating) (Table 1).

Table (1): Rate of ASD related to variables

	Rate of ASD		P Value
	No.	Percent	
Gender			
Male	21/53	39.6%	0.137
Female	15/57	26.3%	
Age			
<60	19/60	31.7%	0.795
≥60	17/50	34%	
Type of fusion			
Floating	24/70	34.3%	0.645
Non-floating	12/40	30%	
No. of fusion segments			
one segment	4/31	12.9%	0.006
Multiple segments	32/79	40.5%	

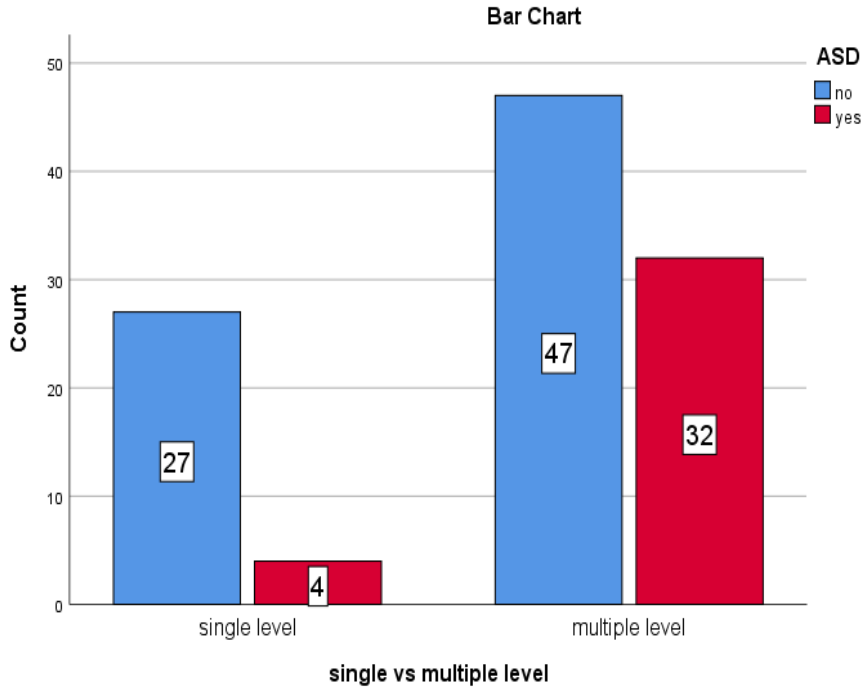

Figure 2: Single and multiple segment fixations.

Multiple segment fixation, floating fixation, and male patients aged 60 and above were all linked to a high reoperation risk. Multiple segment fixations were statistically significant (0.006) among these factors. Patients with a diagnosis of degenerative spondylolisthesis prior to the first surgery had a 9.25 percent reoperation rate, patients with isthmic spondylolisthesis had a 7.14 percent reoperation rate, patients with degenerative scoliosis had a 33.33 percent reoperation rate, patients with failed back syndrome had a 6.25 percent reoperation rate, and patients with dynamic instability had a 16.66 percent reoperation rate.

Out of 110 patients who had lumbar spinal fixation surgery and were included in this study, 36 (32.72%) developed ASD. seven patients developed ASD within five years of surgery, whereas twenty-nine patients developed ASD more than five years after surgery.

Male patients had a higher chance of having ASD than female patients. Out of the 53 male patients who were included in our study, twenty-one patients acquired ASD (39.6%), while fifteen of the 57 female patients in our study developed ASD (28%).

After spinal fixation surgery, patients over the age of 60 were more likely to have ASD. Our research comprised 50 patients older than 60 years old, 17 of whom acquired ASD (34%), and 60 patients younger than 60 years old, 19 of whom had ASD (31.66 %).

Patients' chance of developing ASD according to the pathology prior to surgery were as follows: degenerative scoliosis had a higher likelihood of developing ASD (83.33%), degenerative spondylolisthesis (29.6%), dynamic instability (33.3%), failed back syndrome (18.75%), and isthmic spondylolisthesis (35.71%). Surgery-related risk factors for developing ASD included multi-segment fixation and floating fixation.

Thirty two of the 79 patients who had multi-segmental fixation (40.5%) developed ASD, whereas only four of the 31 patients who had mono-segmental fixation acquired ASD (12.9 %) (Fig. 2).

Out of 70 patients with floating fixation, 24 (34.28 %) had ASD, while out of 40 patients with non-floating (extending to the sacrum) spinal fixation, 12 (30%) developed ASD (Fig. 3).

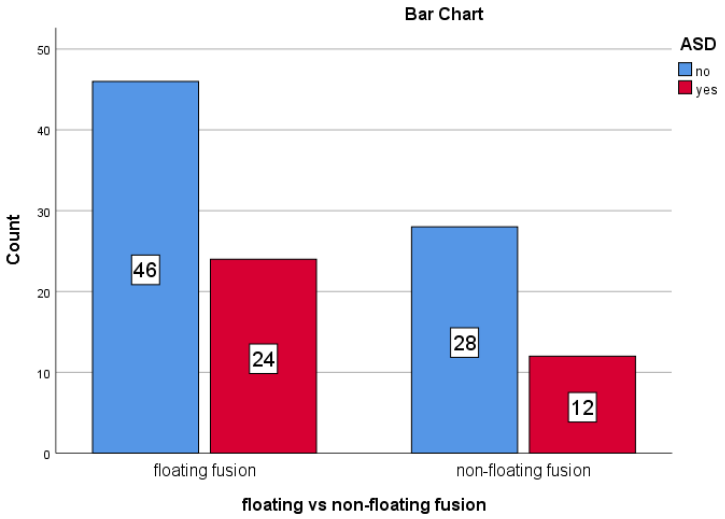

Figure 3: Floating and non-floating spinal fusion.

Table (2) Clinical picture of patients re-operated upon.

Case no.	Age/ Years	Gender	Diagnosis	Fusion level of first operation	Pathology	Fusion level of second operation	Time of re-operation from first operation
1	44	male	Dynamic instability	L4-L5	stenosis, disc herniation	L3-L4	≥ 5 years
2	61	male	Degenerative scoliosis	L2-S1	stenosis, instability	L1-L2	< 5 years
3	48	male	Degenerative spondylolisthesis	L3-L5	Stenosis	L2-L3	≥ 5 years
4	67	female	Degenerative scoliosis	L3-L5	stenosis, retrograde spondylolisthesis	L2-L3	≥ 5 years
5	69	male	Degenerative spondylolisthesis	L2-L5	stenosis, instability	L5-S1	< 5 years
6	58	female	Degenerative spondylolisthesis	L3-L5	stenosis, disc herniation	L2-L3	≥ 5 years
7	65	female	Degenerative spondylolisthesis	L2-L5	stenosis, spondylolisthesis	L5-S1	≥ 5 years
8	60	male	Failed back syndrome	L3-L5	stenosis, instability	L2-L3	< 5 years
9	63	female	Degenerative spondylolisthesis	L2-S1	stenosis, spondylolisthesis	L1-L2	≥ 5 years
10	40	male	Isthmic spondylolisthesis	L3-L5	stenosis, disc herniation	L2-L3	≥ 5 years
11	50	male	Isthmic spondylolisthesis	L2-L4	stenosis, spondylolisthesis	L4-L5	≥ 5 years

was on radiographs, only a minor percentage of patients needed revision surgery for ASD.

Out of these cases eleven patients (10%) needed a second surgery for ASD after lumbar fixation surgery in the current study. According to our operational criteria, each of these patients had neurological complaints, spinal stenosis, and adjacent segment degeneration

Patients who underwent multiple segment fixations, particularly for degenerative scoliosis had a high rate of revision surgery. The literature evaluation is summarized in Table 2, with an emphasis on the rate of adjacent segment disease and revision surgery following lumbar fixation. The frequency of ASD rises after the initial surgery, according to imaging studies. ASD has been found in 5%–25% of patients in studies with a mean follow-up period of fewer than 5 years. (Aiki et al., 2005) In studies with an average follow-up of 5 years or longer following lumbar fixation surgery, it has been found in 30%–53% of patients (Table 2). The degenerative character of ASD is supported by these observations. In contrast to the very high incidence of ASD that (reported to be 0%–18%). (Aiki et al., 2005) The frequency of reoperations may have been impacted by differences in surgical indications, in addition to the occurrence of patients with symptomatic ASD.

More than 50 % of the patients in sectional studies of reoperation cases with ASD (Table 2) had undergone multiple segment fixations. In our study, patients with multiple-segment fixations had a greater reoperation rate (12.65 %) than those with single-segment fixations (3.22 %). Even though there was no statistical significance, patients with floating fixation had a greater incidence of reoperation than those without such variables. A significant reoperation rate was unrelated to male gender or advanced age.

For degenerative lumbar scoliosis and other conditions requiring multiple-segment fixation, our findings suggested restriction of posterolateral transpedicular screw fixation. In these circumstances, the application of intervertebral

cages in fixation surgery to restore coronal and sagittal balance or preventive decompression of the adjacent level may help to avoid adjacent segment stenosis. Selective decompression without fixation may also become an alternative, especially in patients with advanced age and limited physical activity.

The absence of a radiographic analysis, absence of information regarding patients BMI, pre-existing adjacent disc degeneration and adjacent facet degeneration, some of the patients living in other cities or rural areas were study's weaknesses. However, the study's strength comes from uniformity in operating indications and techniques. Although there are many other risk factors (nearly a dozen of them) contributing to the development of ASD, the researchers focused more on some specific factors and parameters due to time limitations, un-availability of some instruments, over crowdedness of the consultation rooms and un-cooperativeness of some patients.

3..CONCLUSIONS

The rate of developing ASD was (32.72%) out of 110 patients who were included in our study and had transpedicular screw fixation. The rate of patients that needed a second surgery for ASD was (10%). These results were comparable with the literature's stated prevalence of ASD after spinal fixation and reoperation for ASD. Male gender, advanced age, floating fixation and multiple level fixations were variables that contributed to a higher rate of developing ASD. Multiple-level fixation was the only variable with clinical significance.

Conflict of Interest

There are no conflicts of interest by the researchers with regard to the current research

References

Adogwa O, Parker SL, Shau DN, Mendenhall SK, Aaronson OS, Cheng JS, Devin CJ, McGirt MJ. Preoperative Zung Depression Scale predicts outcome after revision lumbar surgery for adjacent segment disease, recurrent stenosis, and pseudarthrosis. The Spine Journal. 2012 Mar 1;12(3):179-85.

Aiki H, Ohwada O, Kobayashi H, Hayakawa M, Kawaguchi S, Takebayashi T, Yamashita T. Adjacent segment stenosis after lumbar fusion requiring second operation. Journal of Orthopaedic Science. 2005 Sep;10(5):490-5.

Kersten, R. F. M. R., et al. "Lumbar spinal fusion: indications, surgical techniques and post-operative management." A survey among spine surgeons in the Netherlands. MOJ Orthop Rheumatol 4.6 (2016).

Lawrence BD, Wang J, Arnold PM, Hermsmeyer J, Norvell DC, Brodke DS. Predicting the risk of adjacent segment pathology after lumbar fusion: a systematic review. Spine. 2012 Oct 15;37:S123-32.

Lee JC, Kim Y, Soh JW, Shin BJ. Risk factors of adjacent segment disease requiring surgery after lumbar spinal fusion: comparison of posterior lumbar interbody fusion and posterolateral fusion. Spine. 2014 Mar 1;39(5):E339-45.

Li XF, Lv ZD, Yin HL, Song XX. Impact of adjacent pre-existing disc degeneration status on its biomechanics after single-level anterior cervical interbody fusion. Computer Methods and Programs in Biomedicine. 2021 Sep 1;209:106355.

Masevnin S, Ptashnikov D, Michaylov D, Meng H, Smekalenkov O, Zaborovskii N. Risk factors for adjacent segment disease development after lumbar fusion. Asian Spine Journal. 2015 Apr;9(2):239.

McGirt M, Adogwa O, Parker S, Shau D, Mendenhall S, Aaronson O, Cheng J, Devin CJ. Preoperative Zung Depression Scale Predicts Outcome After Revision Lumbar Surgery for Adjacent Segment Disease, Recurrent Stenosis and Pseudoarthrosis. The Spine Journal. 2011 Oct 1;11(10):S110-1.

Nayar G, Roy S, Lutfi W, Agarwal N, Alan N, Ozpinar A, Hamilton DK, Okonkwo DO, Kanter AS. Incidence of adjacent-segment surgery following stand-alone lateral lumbar interbody fusion. Journal of Neurosurgery: Spine. 2021 Jun 18;35(3):270-4.

Orhurhu VJ, Chu R, Gill J. Failed Back Surgery Syndrome. StatPearls. Treasure Island (FL). StatPearls Publishing. Retrieved September. 2020;7:2020.

Scemama C, Magrino B, Gillet P, Guigui P. Risk of adjacent-segment disease requiring surgery after short lumbar fusion: results of the French Spine Surgery Society Series. Journal of Neurosurgery: Spine. 2016 Jul 1;25(1):46-51.

Wang H, Ma L, Yang D, Wang T, Liu S, Yang S, Ding W. Incidence and risk factors of adjacent segment disease following posterior decompression and instrumented fusion for degenerative lumbar disorders. Medicine. 2017 Feb;96(5).