

# Adjacent Segment Degeneration Following Laminectomy Versus Degeneration without Laminectomy in Levels Adjacent to those Operated Upon by Lumbar Posterolateral Fixation: A Comparative Study

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## Abstract

**Background:** Adjacent segment degeneration (ASD) is one of the most communal drawbacks of lumbar fixation. Adjacent segment disease means degeneration developing at mobile segments above or below fixed spinal level. The lowest cranial mobile segment is the mostcommunal level for the development of adjacent instability. Laminectomydisturbs the integrity of the posterior spinal complex.

**Aim of Study:** The main aim of this study was to detect the incidence of adjacent segment degeneration following laminectomy and the incidence of degeneration without laminectomy in levels adjacent to those operated upon by lumbar posterolateral fixation via a comparative study and results of 1 year clinical follow-up.

**Patients and Methods:** A retrospective review was conducted on 40 patients who underwent lumbar posterolateral fixation in one institute from June 2021 to January 2022. 20 patients operated upon by laminectomy and fixation of the same levels without any adjacent segment laminectomy. The other 20 patients operated upon by laminectomy and fixation of the same levels with additional laminectomy of a cranially adjacent level.

**Results:** 40 patients underwent lumbar posterolateral fixation. Of those, 20 patients operated upon by laminectomy and fixation of the same levels without any adjacent segment laminectomy, 2 patients only developed ASD. In the other 20 patients operated upon by laminectomy and fixation of the same levels with additional laminectomy of a cranially adjacent level, 12 patients developed ASD either radiologically or clinically.

**Conclusions:** ASD should be well-thought-outto be a long-term drawback of lumbar or lumbosacral fusion. Many studies proved that the fusion enforcesremarkable degree of stress at the adjacent segment. ASD occurs often with additional decompression above the level of posterolateral fixation within lumbar spine surgery. A surgery that maintains as much of the posterior element as possible should be considered to

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guard against future degeneration in cases of which the adjacent segments need decompression in the form of laminectomy.

**Key Words:** *Adjacent segment degeneration – Lumbar – Posterolateral fixation – Laminectomy.*

## Introduction

**ADJACENT** segment degeneration (ASD) is one of the most thoughtful complications of lumbar fusion thatoccurs at the movable segments higher or lower the fused spinal level [1]. The lowest cranial movable segment is the mostcommon level for the development of adjacent instability than the caudal level [2]. Decompression surgery combined with fusion surgery at the same levels is the most accepted surgical strategy for degenerative spine pathology with segmental instability [3]. Posterolateral lumbar transpedicular fixation surgery is considered to be one of the most important interventions for the stabilization of the spine. Pedicular screw fixation, as a fusion procedure, offers lots ofadvantages: (1) It increases thefusion rate compared with fusion without internal fixation, and (2) It assures the early mobilization of its patients [4]. The risk factors for the occurrence of ASD following pedicular screw fixation are still unclear. Many previous reports have shown that the posterior spine column is vital for stabilization of the adjacent segment [5]. The development of adjacent instability becomes more likely if the decompression level extends over the fixed level. Among decompression interventions, posterior laminectomy is the most performedsurgery for spinal canal stenosis.Laminectomy, including removal of the spinous process, supraspinous ligament, interspinous ligament, lamina and ligamentum flavum, affects the integrity of the posterior complex of the spine. However, the success rate

of posterior laminectomy was reported to be only 64%, with the unpleasant success mainly due to the occurrence of postoperative instabilities because it disturbs the posterior supporting elements, as spinous process-inter/supra spinous ligament complex, and the paraspinal muscles [6].

This study is aiming at detecting the incidence of adjacent segment degeneration following laminectomy and the incidence of degeneration without laminectomy in levels adjacent to those operated upon by lumbar posterolateral fixation via a comparative study and results of 1 year clinical follow-up.

### Patients and Methods

Between June 2021 and January 2022, we evaluated 40 patients with pedicle screw-implanted posterolateral fixation for both degenerative and spondylolytic spondylolisthesis. Posterolateral fixation was operated through a midline subperiosteal approach. The degree of the decompressive procedure (laminectomy) was determined by preoperative magnetic resonance images and intraoperative conditions. The bony work of decompression included complete removal of the lamina and spinous processes; however, the soft tissue technique included the supraspinous ligament, interspinous ligament, and ligamentum flavum of the determined levels.

Patients collected data were demographic characteristics, pre-operative clinical data at time of presentation, post-operative clinical and radiological findings. ASD was defined by Okuda et al., as a radiological finding, where narrowing of disc height was  $>3\text{mm}$ , the progressive slipping of adjacent segments was  $>3\text{mm}$  (in comparison with preoperative flexion and extension lateral radiographs), and the posterior opening of adjacent segments was  $>5^\circ$ . These definitions were based on previous reports. In addition, symptomatic ASD was determined as ASD associated with neurological symptoms. All the gathered data were evaluated. Clinical follow-up of the patients was done for the first 2 days in the ward before discharge and in the outpatient clinic 14 days, 1 month, 3 months, 6 months and 12 months after discharge.

**Surgical Technique:** All operations were done under general anesthesia in the prone position with great care given to secure pressure points as the orbit, the anterior iliac crest, the genitalia and the abdomen to reduce pressure in the epidural venous system and bleeding during surgery. All patients should receive standard peri-operative antibiotics. C-arm fluoroscopy is utilized for accurate level

localization. Posterior midline approach with bilateral subperiosteal muscle separation was the standard approach utilized in all our cases.

### Results

A total of 40 patients who underwent lumbar posterolateral fixation were encountered in this study. Of those, 20 patients operated upon by laminectomy and fixation of the same levels without any adjacent segment laminectomy, 2 patients only developed ASD (Group A). In the other 20 patients operated upon by laminectomy and fixation of the same levels with additional laminectomy of a cranially adjacent level, 12 patients developed ASD either radiologically or clinically (Group B).

Table (1): Patients' characteristics.

	Group A	Group B
Average age	45.35 years (range 25- 67)	49.85 years (range 37- 66)
Sex	10 M, 10 F	13 M, 7 F
<i>Pathology:</i>		
Degenerative	11	14
Lytic	9	6
<i>Posterolateral fixation levels:</i>		
L4-S 1	3	4
L5-S 1	5	2
L3-S 1	0	1
L3-L4	3	4
L4-L5	6	7
L2-L3	2	2
L1-L2	1	0
<i>Development of ASD:</i>		
Clinically	2	8
Radiologically	0	4

The average age of patients in group (A) was 45.35 years (range 25-67). 10 males and 10 females. None of them gave history of previous lumbar spine procedure. 11 out of 20 patients had degenerative pathology and 9 cases had lytic pathology. A total of 2 patients only developed ASD in group (A) during follow-up and managed conservatively with medical treatment and rest with satisfactory results.

The average age of patients in group (B) was 49.85 years (range 37-66). 13 males and 7 females. None of them gave history of previous lumbar spine procedure. 14 out of 20 patients had degenerative pathology and 6 cases had lytic pathology.

A total of 12 patients developed ASD in group (B) during follow-up. 4 patients were asymptomatic and discovered radiologically in the routine follow-up period in the form of grade I spondyloisthesis (2 patients) and starting discogenic canal stenosis (2 cases). 8 out of 12 patients who developed ASD were clinically symptomatic in the form of low

back pain (5 cases) and radiculopathy (3 cases). Medical treatment showed satisfactory results in 5 out of 8 patients, while 3 patients didn't show good results and another operation was done to manage the ASD in the form of decompression and extension of posterolateral fixation to the adjacent level.

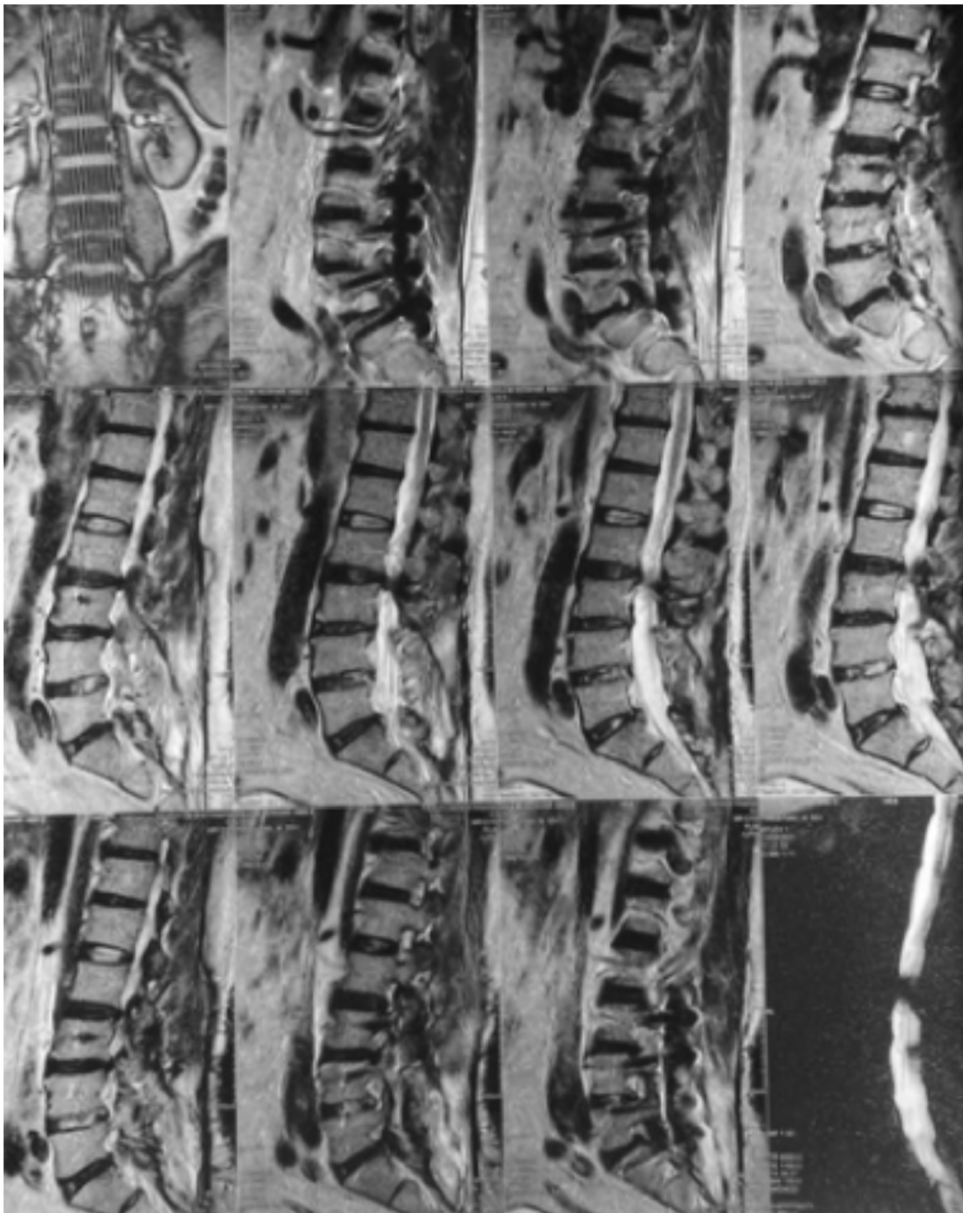


Fig. (1): Sagittal T2 weighted magnetic resonance image showing ASD at level L2/3 following long segment fixation of L3/4/5/S1.

### Discussion

Adjacent segment degeneration is a progressive degenerative pathological process that happens at mobile segments higher or lower than the fused segment [1]. Long time ago, ASD was considered

as a relatively uncommon complication following lumbar posterolateral fixation [7]. Nowadays, ASD has been found to occur more frequently and is now well-thought-out a likely long-term commonly seen sequelae of spinal instrumentation owing to the great increase in the performed lumbar fusion

procedures. Risk factors for developing lumbar postoperative ASD following transpedicular fusion are not obviously clear. However, implant rigidity due to fusion may be the main accused factor [8]. Gender is not a significant contributing factor [9]. Age may play an important role as younger patients have stronger supporting structures, compared with older patients who have higher ongoing degenerative process in the adjacent segments making them more vulnerable to develop ASD [10]. ASD may be problematic in some cases because it may affect the life style and may need further surgical intervention [5]. Surgical treatment for ASD is surrounded by complications, difficulties and poor patient satisfaction postoperatively. Two principals have been agreed with by the authors: (1) Extensive decompression by laminectomy and facetectomy and (2) Length of the transpedicular fusion to the defected level [5].

In our retrospective study, extra decompression higher than the level of fusion resulted in ASD and symptomatic ASD very commonly, and prognosis in cases without ASD were better than this with ASD. ASD is radiographically common as reported by Paul et al. [1]. In our study, by means of the ASD criteria mentioned before by Okuda et al. [11], we found that symptomatic ASD was more frequent than radiographic ASD.

In this study, we didn't detect any significant difference between patients with and without ASD after lumbar posterolateral fixation regarding patients' gender. However, older patients above 45 years showed relatively greater risk than other patients due to the starting degenerative process of the adjacent segment. A major debate about whether ASD is caused by aging or is just following mechanical stress after fusion [12]. In an attempt to better understanding of ASD etiology, plenty of researchers tried to assign the risk factors for this pathology, and concluded some risk factors as: length of the fused segment [13], sagittal balance and metal instrumentation [10].

Regarding metal instrumentation, many researchers found that the stiffness produced by metal instrumentation results in more mechanical stress, leading to more rapid ASD [14]. Patients who undergo full laminectomy above the level of posterolateral fixation had appreciable higher incidence of ASD in comparison to non-laminectomy patients as documented by Ekman and colleagues [15]. Lai reported that destroying the posterior column integrity at adjacent segments by full laminectomy causing adjacent degeneration and instability in a retrospective study of 101 patients

operated with posterolateral fixation [2]. So, decompression by total full laminectomy should not be performed in cases with adjacent segment demands decompression higher or lower than the level of posterolateral fusion. Recently, many researchers have mentioned methods for surgical decompression, in those patients, which are less hazardous to the posterior spinal complex. A unilateral approach using a microscope or endoscope, minimally invasive technique, was noted to be more efficient than the conventional full laminectomy decompression surgery for bilateral spinal canal decompression. This technique preserves both the posterior spinal column, and the paravertebral muscles and facet joints on the other untouched side [16]. Hatta et al. [17] stated a muscle-preserving interlaminar decompression method that can lower the harm to the posterior stabilizing elements, as the facet joints, paravertebral muscles, dorso-lumbar fascia, supra- and interspinous ligaments and spinal processes.

Our study has some drawbacks. First, the number of patients in this study to evaluate the incidence of adjacent segment degeneration following laminectomy and the incidence of degeneration without laminectomy in levels adjacent to those operated upon by lumbar posterolateral fixation is low. Second, we did not assess sagittal balance and Cobb angles of patients' spines. Third, the relatively short follow-up period and the absence of validated score for clinical assessment.

#### *Conclusion:*

ASD could be defined as a long-term sequelae of lumbar or lumbosacral fusion. Plentiful biomechanical studies have confirmed that the fusion process carries out appreciable amount of mechanical stress at the adjacent segment. ASD occurs most often with extra decompression higher than the level of posterolateral fixation in lumbar spine surgery. In those cases, where the adjacent segments need decompression in the form of laminectomy, a surgery that maintains the posterior complex as much as possible should be the plan of choice to guard against future degeneration.

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## تنكس الجزء المجاور بعد إستئصال الصفيحة الفقرية مقابل التنكس بدون إستئصال الصفيحة الفقرية فى المستويات المجاورة لتلك التى يتم إجراؤها عن طريق التثبيت الخلفى الجانبى القطنى : دراسة مقارنة

أن التنكس المجاور فى حالات تثبيت الفقرات هو أحد أهم المشكلات التى تحدث فيما بعد هذه النوعية من الجراحات. التاكل الذى يحدث فى الفقرات المتحركة أعلى وأسفل الفقرات المثبتة يسمى بالتنكس المجاور.

إزالة الصفيحة العظيمة بالفقرات العظمية وإزالة الأربطة يؤثر على ثبات الفقرات سلباً.

هدف الرسالة : الهدف الرئيسى هو دراسة نسبة حدوث التنكس المجاور بعد استئصال الصفيحة العظمية وبين عدم استئصالها فى المستويات التى تعلو الفقرات المثبتة فى حالات التثبيت الخلفى الجانبى بالفقرات القطنية فى دراسة مقارنة ومتابعة طبية إكلينيكية خلال عام.

طريقة البحث : هى دراسة بأثر رجعى تمت على ٤٠ مريض أجريت لهم جراحة تثبيت فقرات ما بين عام ٢٠٢١-٢٠٢٢ . ٢٠ منهم تم عمل توسيع للقناة العصبية باستئصال الصفيحة الخلفية وتثبيت الفقرات على نفس المستويات التى تم توسيعها وآخرون تم إجراء مستوى إضافى من التوسيع أعلى من المستويات المثبتة.

النتائج : ٢٠ منهم أجريت لهم توسيع القناة العصبية بإزالة الصفيحة الخلفية وتثبيت الفقرات على نفس المستوى، ظهر فيهم حالتين من التنكس المجاور فى المستوى الأعلى. ٢٠ منهم أجريت له جراحة تثبيت فقرات ولكن تم توسيع مستوى إضافى أعلى من المستويات المثبتة فيهم ظهرت ١٢ حالة من حالات التنكس المجاور.

الخلاصة : إن التنكس المجاور والذى يحدث ما بعد التثبيت الخلفى بالفقرات القطنية هو أحد المشكلات التى تظهر ما بعد هذه الجراحة المهمة ونحتاج دائماً لدراسة العوامل البيوميكانيكية لثبات الفقرات وصحتها واختيار الخطة الجراحية المناسبة هام جداً لتفادى مثل هذه المشكلات.