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# Motion Characteristics of the Vertebral Segments with Lumber Degenerative Spondylolisthesis in Elderly Patients

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## Abstract

**Background Data:** Spondylolisthesis refers to the forward displacement of one vertebra relative to another. Whether degenerative spondylolisthesis (DS) leads to instability was controversial in the literature. DS was conventionally considered to be instable but some papers have reported that there was no evidence that the range of motions (ROMs) of the vertebrae with DS were increased compared with normal vertebrae.

**Purpose:** The aim of the work was to study motor characteristics of the vertebral segments with lumber degenerative spondylolisthesis in elderly patients after surgical management.

**Study Design:** This is a prospective study.

**Patients and Methods:** Thirty patients (age more than 55 years) with lumbar DS and failed conservative measures for at least three months before surgical treatment were included. Vertebral kinematics obtained using dynamic plain X. ray; also MRI and/or CT scan of lumbosacral spine were done. During functional postures, vertebral instability was studied. All cases operated upon from May 2013 to December 2013 in the Neurosurgery Department of Banha University hospital and followed up 6 months for at least. Patients were grouped into 2 groups according to vertebral instability: Group A (fifteen cases ) and Group B (fifteen cases) chosen without privilege to sex , or weight, but suffering from midline low back pain and/or claudication that were proven to be attributed to spondylolisthesis. Clinical follow-up: done immediately, at 3 and 6 months intervals. The evaluation included the Japanese Orthopedic Association (JOA). Preoperative and last postoperative standing were done to measure the degree of slip and percentage of slip.

**Results:** Adequate lumbar decompression alone in cases of Group A (with no evident range of motion) showed good outcome with less complications when compared with cases of Group B(showing instability) treated with decompression

with posterolateral instrumented fusion using bilateral pedicle screw fixation.
**Conclusion:** Lumbar DS is a degenerative disease of lumbar spine results in neural compression but does not result necessarily in vertebral instability, some cases of lumbar DS may need only neural decompression as re-stabilization process may have occurred but other cases show instability which required decompression with instrumented fusion. (2014ESJ082)
**Key words: Lumbar spondylolisthesis, Pedicle screw fixation, Vertebral kinematics**

## Introduction

Five types of listhesis have been described according to the Wiltse-Newman-Mac Nab classification system and include the isthmic, degenerative, dysplastic, traumatic, and pathologic forms.[8] Lumbar degenerative spondylolisthesis (DS) is the forward slippage of a superior lumbar vertebra relative to the inferior vertebra due to degeneration, with the pars interarticularis intact.[10] Degenerative spondylolisthesis (DS) typically occurs at the level of L4-L5. It is then most likely at L3-L4, followed by L5- S1. Elderly people are most commonly affected. It is more likely to occur in women than men, Parity has been associated with an increased incidence of spondylolisthesis. Clinically patients frequently complain of intermittent low back pain, symptoms of neurogenic claudication, occasionally radicular pain from compression by the degenerative facet.[8]

Imaging including plain X-ray (antero-posterior, standing lateral, right and left obliques, flexion and extension views) of the lumbosacral spine, CT or MRI of lumbar spine.[3] Although eight decades have passed since Junghanns firstly described the condition in 1930, the etiology, pathogenesis, and treatment of DS are still controversial.[19]

The treatment included non-operative care and operative intervention indicated for patients with progressive neurological deficit and those who failed to improve on proper non-operative treatment, specifically, those with persistent pain, either radicular or claudicatory, that interferes with professional and personal activity as well as the quality of life.[18] Instability is an important factor in explaining clinical symptoms and determining the surgical method, such as decompression without fusion and posterolateral fusion with or without instrumentation. Whether DS leads to instability was controversial in the literature. DS was conventionally considered to be instable [(19)] but some papers have reported that there was no evidence that the range of motions (ROMs) of the vertebrae with DS were increased compared with normal vertebrae.[15,19]

The first fusion was performed in 1911 by Albee et al,[1] who used bone from the tibia (leg bone) in order to perform a crude posterolateral fusion (PLF) for a patient suffering from painful tuberculosis of the spine. The technique then underwent several important modifications (especially by the addition of posterior instrumentation) over the years until the modern version of PLF came to being as reported by Wiltse in 1975.[21]

The goal of every fusion surgery is to achieve a solid ossification (solid fusion or arthrodesis) between the two vertebra of the motion segment, because recent medical research has demonstrated that patients who are successfully fused, have significantly better clinical outcomes.[7]

Internal fixators, including pedicle screws, have been developed rapidly during the past years, and now spinal fusion with pedicle screws is widely used.[2,23] The addition of pedicle screw instrumentation to the fusion procedure increases the initial stability and the probability of achieving a successful spinal fusion in the fusion segment.[1,21]

However, there are some drawbacks, such as a larger surgical exposure, greater blood loss, a higher likelihood of reoperation and nerve injury.[2,22,23]

The aim of the work was to study motor characteristics of the vertebral segments with lumber degenerative spondylolisthesis in elderly patients after surgical management.

## Patients and Methods

This study included thirty patients (over 55 years old) of short segment lumbar spondylolisthesis. All cases tried conservative measures for at least three months of physiotherapy program, non-steroidal anti-inflammatory medications & lumbosacral brace before going to surgical treatment. All cases were operated upon in the Neurosurgery Department of Banha University Hospital, and were grouped into two groups: Group A (fifteen cases) and Group B (fifteen cases), These cases were chosen without privilege to sex, or weight, but all share the fact that

they suffer from midline low back pain, neurogenic claudication and /or sciatica that proved to be attributed to spondylolisthesis.

All patients were submitted for complete history taking and clinical examination including, vital signs, back examination, motor power, Sensory deficits, deep reflexes and gait disturbance. Radiological investigations included plain X-ray lumbosacral spine (A-P view, standing Lateral view, right and left oblique views to exclude fracture pars interarticularis, dynamic views for determination of stability). Magnetic resonance imaging (MRI) lumbosacral spine performed in all cases to define: Cause and degree of neurological compression & the abnormal anatomy of spondylolisthesis, degenerative changes, and narrowed disc space. Computed tomography (CT) lumbosacral spine was done in some of the cases: It defines the level and grade.

We divided the cases into two groups: Group A with vertebral stability which was treated by decompression only, and Group B with vertebral instability which was treated by decompression with bilateral pedicle screw fixation and posterolateral bony fusion. For group (A) cases: Adequate decompression of the stenotic levels was accomplished. Laminectomy was performed in all cases with foraminotomy of the nerve root on both sides and discectomy was done if significant disc herniation was found. For group (B) cases: As above but bilateral pedicle screw fixation with posterolateral bony fusion was done in all cases.

***Operative Procedure:***

Under general anesthesia the patient was positioned in the prone position on a bridge. The C-arm was brought into position for intra-operative fluoroscopy. A midline skin incision was used overlying the affected level with exposure of one or two levels above and below that level for adequate exposure, the paraspinous musculature was dissected off laminae. Dissection was continued laterally over the facets and transverse processes. Removal of the spinous processes of the levels to be decompressed, and the laminectomy was performed. Once an adequate level of exposure had been obtained, the involved nerve roots were identified and foraminotomy was performed, the disc spaces were examined for any herniated disc causing neural compression to be removed.

The first step in placement of the pedicle screws was to identify important pedicle landmarks. The external landmarks were visualized over the dorsal surface of the lumbar spine (Figure. 1&2). The point of intersection of a line drawn through the axial plane of the transverse process and the sagittal plane through the lateral superior facet marks the center of the pedicle which is the pedicle entry point information.

Next radiographic confirmation of the location of the pedicle can be obtained. Lateral fluoroscopy can be used to identify the superior and inferior margins of the pedicle and the relative position of the disc space and neural foramina. The anatomic features of the sacral pedicle differ markedly from those of the lumbar spine. The S1 pedicle is the largest pedicle of the spine and can be entered from medial or lateral aspect. The medial entry is medial and just caudal to the facet, while the lateral entry point is lateral to the facet.

***Post-operative follow-Up:***

Clinical follow-up: done immediately, at 3 and 6 months intervals. The evaluation included the Japanese Orthopedic Association (JOA) score (assessment of the rate of improvement of preoperative low back pain, sciatica, ability to walk, straight leg raising (SLR) test, sensory deficits and motor power).

Radiological follow-up: Immediate post-operative and 6 months postoperative, including plain radiography (anteroposterior & standing lateral radiograph, dynamic flexion and extension) .The last follow up radiology was compared with the preoperative one. Preoperative and postoperative standing lateral radiographs were done to measure the degree of slip and percentage of slip. Slip progression was assessed by comparing preoperative and post-operative degree of slip. Evaluation of the range of motions on postoperative dynamic radiographs were done in both groups.

In group B, A-P and lateral views were evaluated for intact hardware. A-P view can show the presence of adequate bone mass with trabeculation bridging the fusion area (Successful fusion may take place from 6–12 months post operatively.

***Statistical analysis:***

The data were collected and analyzed using the Statistical Package for Social Sciences (SPSS, version17; SPSS Inc., Delaware, USA) software.

Arithmetic Mean, SD, number, and percent were calculated. For numerical data, the t-test was used to compare two Groups. The level of significance was 0.05.

## Results

The data collected from thirty cases of surgically managed spondylolisthesis were analyzed. (Group A) fifteen cases with age range 55-63 years old (mean=58) were treated by decompression only, while (Group B) fifteen cases with age range 55-59 years old (mean=56) were treated by decompression with bilateral instrumented fusion.

The female cases were nineteen cases and the males eleven cases (53% of the cases of the group (A) were males) and 47% of the cases are female while 80% of the cases of the group (B) were females and (20%) of the cases were males. The need of instrumented bony fusion was higher in females. Group (A) had higher mean duration of symptoms (18 months) than group (B) (10 months)

Table 1 shows that most of the cases in both groups present with back pain, claudication pain and sensory deficits. The group (B) had higher % of cases presenting with sciatica 73% than did group (A) 67%.

Group (A) showed spondylolisthesis in 6cases (40%) at L4-5 level, 3 cases (20%) at L3-4, 3 cases (20%) at L3-4& L4-5 and 3 cases (20%) at L4-5&L5-S1. Group (B) showed spondylolisthesis in 7 cases (47%) at L4-5 level, 5 cases (33%) at L5-S1, 1 case (7%) at L3-4, and 2 cases at L4-5&L5-S1. Most common level was L4-5 in both groups. Double level was more common in group A than group B which means the longer the duration of the condition causing affection of adjacent levels. Level L5–S1 was more common in group (B) than group (A).

According to the JOA score system for low-back pain. [11] (Total score = 15 points)

Rate of improvement =

$$\frac{\text{Postoperative score} - \text{Preoperative score}}{\text{15 full score} - \text{preoperative score}} \times 100\%$$

Group A showed rate of improvement ranging from 57% - 80% (Mean ± SD = 70 ± 6.9) Group B had a rate of improvement ranging from 66%-81% (Mean ± SD = 73 ± 4.2). The mean of rate of improvement of group B was higher than that of group A but this difference between group A and group B is of no statistical significance regarding the JOA score system for low-back pain ( p value > 0.05%)

No slip progression was detected when comparing preoperative and post-operative degree of slip on standing lateral plain x-ray in both groups and also no detected movement on 6 months postoperative dynamic views in both groups indicating vertebral stability

Post-operative complications in group (A); superficial infection in one case (6.5%) that responded to antibiotics, dural tear in two cases (13%) discovered and repaired with non-absorbable water tight suture during surgery, CSF leak in one case (6.5%) managed conservatively, While in group (B) superficial infection in two cases (13%) that also responded to antibiotics, dural tear in three cases (20%) and dural repair done. Post-operative CSF leak seen in 2 cases , one managed conservatively and the other case was associated with root injury .Group (B) showed more incidence of complications than group (A) as a result of longer duration of operation and the use of instrumentation

***Table 1.*** Clinical Presentation of the two Groups.

| Clinical findings | Group A | | Group B | |
|---|---|---|---|---|
| | N | % | N | % |
| Back pain | 12 | 80 | 15 | 100 |
| Claudicating pain | 15 | 100 | 15 | 100 |
| Sciatica | 10 | 67 | 11 | 73 |
| Sensory deficit | 12 | 80 | 13 | 87 |
| Motor deficit | 2 | 13 | 1 | 6.5 |

***Table 2.*** Rate of Improvement (6 months postoperatively).

| Groups | Range | Mean±SD | P value |
|---|---|---|---|
| Group A ( N=15) | 57 %- 80% | 70±6.9 | 0.2 |
| Group B (N=15) | 66%- 81% | 73±4.2 | |

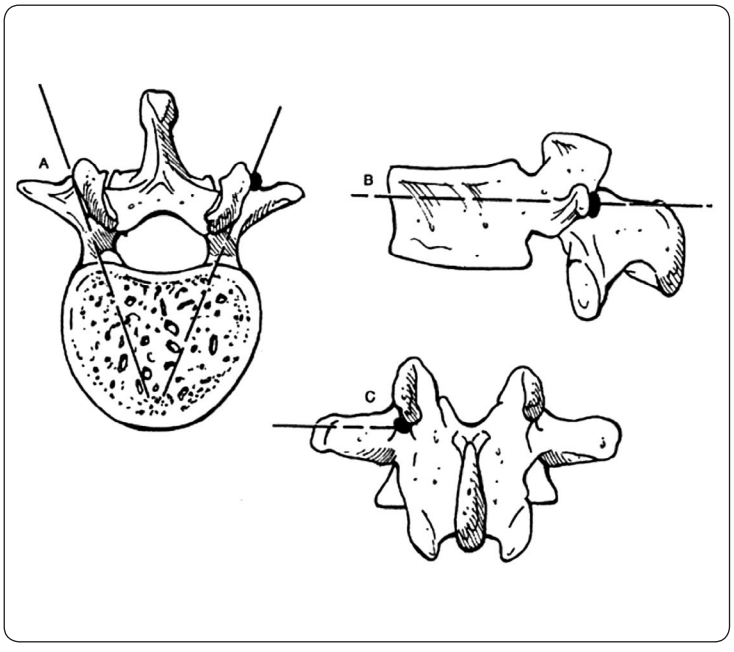


***Figure 1.*** Axial (a), lateral (B) and posterior (C) diagrams demonstrating the pedicle screw trajectory (dashed lines) and entry sites (black dots) on the vertebra. (After Sam W et al.)[17]

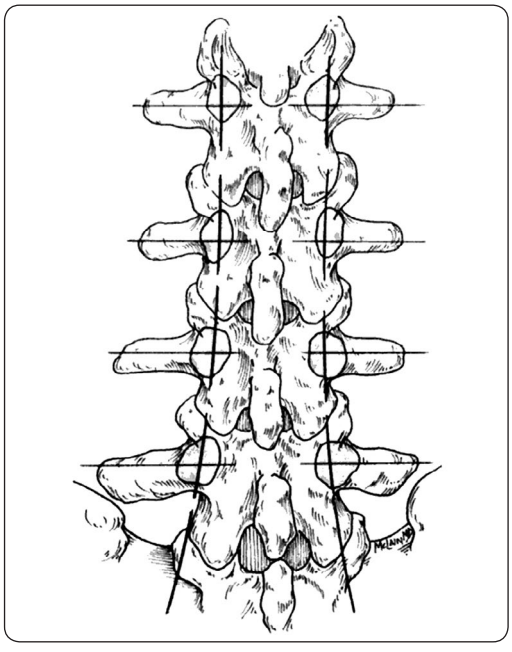

***Figure 2.*** Diagram demonstrating the entry point to the lumbar pedicles based on intact posterior anatomy. As instrumentation proceeds caudally, the entry point shifts further from midline. (After Sam W et al.)[17]

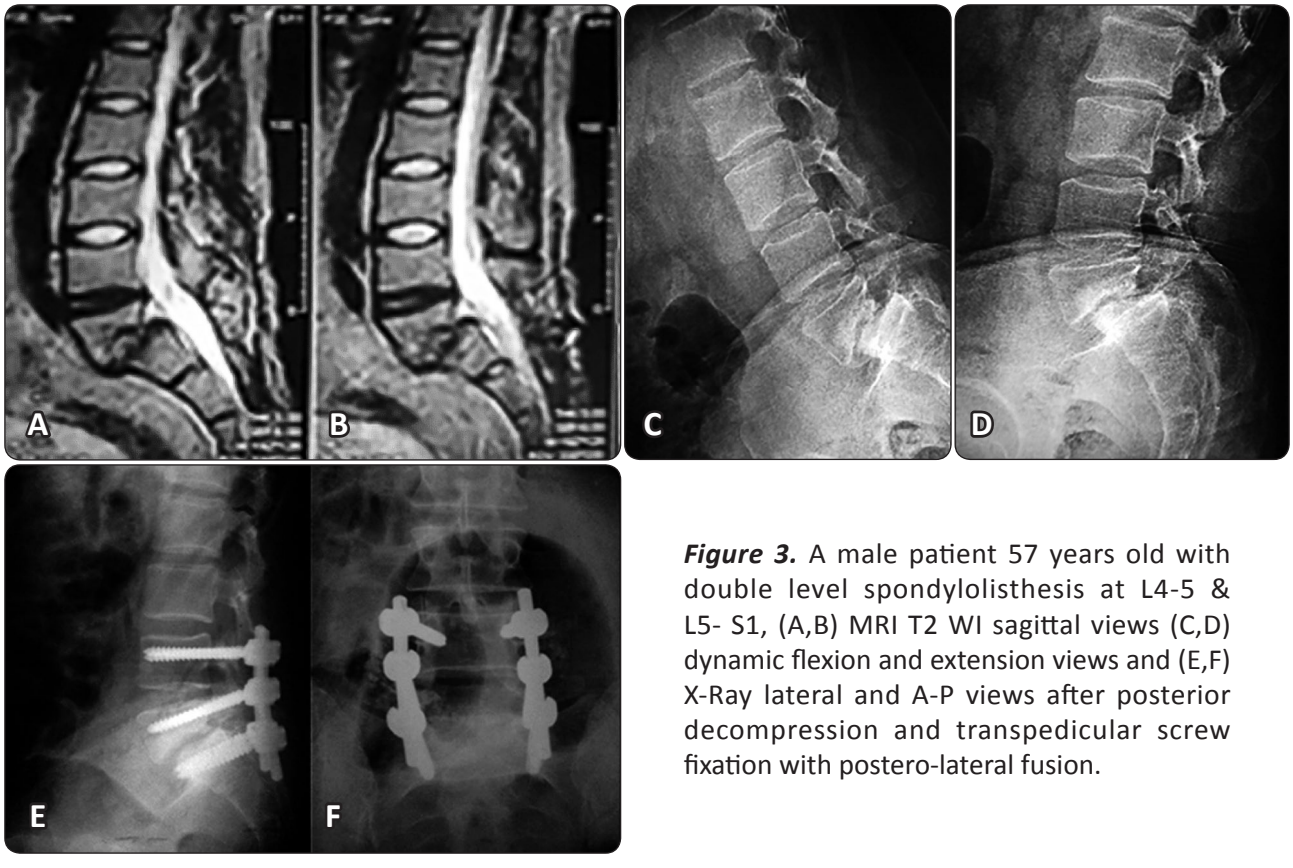


***Figure 3.*** A male patient 57 years old with double level spondylolisthesis at L4-5 & L5- S1, (A,B) MRI T2 WI sagittal views (C,D) dynamic flexion and extension views and (E,F) X-Ray lateral and A-P views after posterior decompression and transpedicular screw fixation with postero-lateral fusion.

## Discussion

Lumbar degenerative spondylolisthesis is a degenerative disease of lumbar spine results in neural compression but does not necessarily result in vertebral instability. Although eight decades has passed since Junghanns firstly described the condition in 1930, the etiology, pathogenesis, and treatment of DS are still controversial[19] Instability is an important factor in explaining clinical symptoms and determining the surgical method, such as decompression without fusion and posterolateral fusion with or without instrumentation. DS was conventionally considered to be instable[19] but some papers have reported that there was no evidence that the range of motions (ROMs) of the vertebrae with DS were increased compared with normal vertebrae.[15,19]

This study included 30 patients (over 55 years old) with short segment lumbar spondylolisthesis. All cases tried conservative measures for at least three months before going to surgical treatment. All cases were operated upon in the Neurosurgery Department of Banha University Hospital. Fifteen cases were operated upon with lumbar decompression only while the other fifteen cases were operated upon by lumbar decompression with bilateral pedicle screw fixation and posterolateral fusion.

Fifty three percent of the cases of the group (A) were males while 80% of the cases of the group (B) were females. This means that the need of instrumented posterolateral fusion is higher in females as a result of generalized joint laxity, hormonal factor, weak back muscles and obesity may be also risk factors. Group (A) had higher mean duration of symptoms than group (B) .The long standing condition gave chance for fusion of unstable segment and more stability .This was coinciding with Jacobson et al,[12] They reported that most cases which were operated upon for only lumbar decompression had longer duration of symptoms.

Most of the cases presented with back pain, claudication pain and sensory deficits in both groups. The group (B) had higher percentage of cases presenting with sciatica 73% than did the group (A) 67%. In group B, we noted that back pain was reported in 100% of cases, claudication pain in 100% of cases and sciatica in 73% of the cases. In group A, claudication pain was in 100% of cases, back pain was present in 80% of cases and sciatica in 67% of the cases that almost corresponds to the findings of Blotz & Benini,[5] They reported predominance of severe back pain 84% of his studied cases and sciatica in 60% of cases. Preoperative sensory manifestations seen in 80% of cases in group A and 87% of cases in group B. Preoperative motor deficits were reported in two cases in group A and in one case in group B .All improved on physiotherapy started one week postoperatively. The most commonly affected level in both groups was L4-5 (in 40% in group A and 47% in group B). Double level was more common in group A which means the longer the duration of the condition the more affection of adjacent levels. In a study by Schnake KJ et al,[18] the most affected level was L4-5.

Group B show more incidence of complications (as dural tear and intraoperative blood loss) than group A due to the longer duration of the operations and the use of instrumentation which was also reported by Schnake KJ et al,[18] Group B show less post-operative back pain than group A. Adequate neural decompression without fixation in cases with no evident range of motion showed good outcome when compared with cases treated by decompression with instrumented fusion. Instrumentation had a good role in improvement of back pain in group B. The goals for decompression were to relieve radicular symptoms and neurogenic claudication. The goals for fusion are to relieve back pain from a degenerated disc and/or facet joints by elimination of instability, this is coinciding with Vibert.[20] These results are concomitant also with a study by Blumenthal et al,.[4]

In addition to the morphologic changes, altered kinematics is assumed to be another important factor that is related to DS and its surgical treatment[9,14] Due to slippage, kinematics of the vertebrae with DS is altered, which may lead to a series of pathological processes and clinical symptoms. To reveal pathogenesis, explain clinical symptoms and decide treatment methods, kinematics of DS has been studied using a variety of techniques including flexion–extension radiographs[6] Kirkaldy-Willis[13] subdivided the lumbar degenerative process into three stages: temporary dysfunction, unstable and restabilization stage. Using this classification, the presence of DS does not necessarily mean instability

when restabilization occurred.[16] The mean age of our patients was relatively high and the lumbar degeneration process may have entered into the third stage of restabilization which may explain the good result in patients of group A.

## Conclusion

Lumbar DS is a degenerative disease of lumbar spine that results in neural compression but does not result necessarily in vertebral instability, so some cases of DS may need only neural decompression as restabilization process may have occurred but other cases show vertebral instability which requires decompression with instrumented postero-lateral fusion.

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## الملخص العربي

**الخصائص الحركية للفقرات القطنية في حالات التزحزح الفقاري في كبار السن**

شملت هذه الدراسة 30 مريض يعانون من التزحزح الفقاري الانحلالي اعمارهم تزيد علي 55 عاما يشتركون في معاناتهم من آلام أسفل الظهر وتم تقسيم الحالات الي مجموعتين مجموعه أ ( 15 مريض ) والتي تشترك في عدم وجود تغير حركي في الاشعه الحركيه وقد تم اجراء الجراحه لهم لتوسيع القناه العصبيه فقط والمجموعه الاخري مجموعه ب (15 مريض) والتي تشترك في وجود تغير حركي في الاشعه الحركيه وقد تم اجراء الجراحه لتوسيع القناه العصبيه وتثبيت الفقرات بواسطه شرائح ومسامير مع الترقيع العظمي وتم التدخل الجراحي في قسم جراحه الاعصاب بمستشفي بنها الجامعي في الفتره من مايو 2013 الي ديسمبر 2013 و متابعه الحالات لمده سته اشهر علي الاقل و قد اظهرت النتائج ان حالات التزحزح الفقاري الانحلالي الذي يحدث في كبار السن يعني وجود تزحزح فقاري ولكن ليس بالضروره وجود تغير حركي في الاشعه الحركيه والذي يستوجب في بعض الحالات عمل توسيع للقناه العصبيه القطنيه بدون تثبيت للفقرات القطنيه ولكن في الحالات التي ظهر فيها تغير حركي في الاشعه الحركيه استوجب توسيع القناه العصبيه القطنيه مع تثبيت الفقرات القطنيه.