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# Long Segment Fixation in High Grade Lumbar Spondylolisthesis

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## Abstract

**Background:** Grade Spondylolisthesis is considered a challenge for neurosurgeons because many surgical strategies have been accepted, but no absolute strategy has been described, and it is becoming increasingly complex.

**Objectives:** To assess the long segment lumbar fixation as a surgical treatment for high-grade lumbar spondylolisthesis and its impact on patient's complaints, neurological deficits, and radiological findings.

**Patients and methods:** This prospective research conducted on 25 cases with lumbar spondylolisthesis (high grade) according to meyerding classification with grades (IV, V, Spondyloptosis) underwent long segment transpedicular lumbar fixation started from March 2021 to June 2023 in Al Azhar university hospitals ( Al Hussien hospital) and Nasser institute for medical treatment and research.

**Results:** Twenty five patients were enrolled in our research with three male cases (12.0%) and 22 female patients (88.0%). In the majority of cases, back and radicular pain improved, and there was statistically significant enhancement in back and radicular pain according to VAS score where  $P < 0.001$ , and claudication pain showed statistical significance where  $P < 0.001$ . There were two patients (8.0%) who had no change in neurological deficit from the pre-operative setting of the studied group. There was a statistically significant enhancement in Sensations and Sphincters where  $P < 0.001$  and  $< 0.004$ .

**Conclusion:** Although different surgical techniques were accepted as a treatment for high-grade lumbar spondylolisthesis, long-segment transpedicular lumbar fixation showed improvement regarding patients' complaints of decreased VAS for both back and radicular pain and satisfactory outcomes with less complication rate.

**Keywords:** Long Segment Fixation, High grade Spondylolisthesis, Meyerding classification

## 1. Introduction

Spondylolisthesis is the condition characterized by the forward sliding of one vertebral body over the one below. The name is derived from the Greek words "spondylos," which signifies vertebra, & "olisthesis," which means "to slip."<sup>1</sup> High grade Spondylolisthesis is further slippage of vertebrae which is considered challenging condition.

The Meyerding classification grade is ascertained through the utilization of standing, neutral lateral radiographs of the lumbar spine to quantify the degree of slip. The slip is divided into five grades according to the classification system: Grades I consist of (0 percent-25 percent), Grade II of (25 percent -50 percent), Grade III of (50 percent -75 percent), Grade IV of (75 percent -100 percent), Grade V exceeds

100 percent degree slip. By drawing a line through the posterior walls of the superior and inferior vertebral bodies and calculating the translation of the superior vertebral body as a percentage of the distance between the two lines, the grade percent can be determined. Neural decompression, pain relief, correction of kyphotic slip angle, and solid fusion are all objectives of the surgical procedure.<sup>2</sup>

Instrumented posterolateral fusion, in situ posterior fusion, circumferential interbody fusion, sacral dome osteotomy, vertebral resection, or a combination are all feasible surgical options. While circumferential fusion procedures often result in positive clinical and radiographic fusion rates, the severity of the fall may hinder direct anterior interbody fusion in cases of higher-grade spondylolisthesis.<sup>3</sup>

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High-grade lumbar spondylolisthesis commonly presents with concurrent anomalies such as anterior displacement and kyphosis, often resulting in a global sagittal imbalance of the spine. Spinopelvic sagittal balance is crucial for assessing and managing patients with severe spondylolisthesis. Traditionally, fixing has required putting pedicle screws into the sliding and lower vertebral bodies, a procedure known as "short segment fixation." Long-segment stabilization was accomplished by inserting additional pedicle screws into the higher vertebrae of the sliding vertebra.<sup>4</sup>

Multiple surgical approaches are designed to improve fusion rates and patient satisfaction. However, it is uncertain if the more intricate method, when integrated, leads to better clinical outcomes.<sup>5</sup> Additional methods for attaining three-column fixation have emerged due to developments in instrumentation techniques. A considerable number of surgical strategies were executed using the posterior approach in order to achieve direct decompression & stabilization through the usage of pedicle screw fixation.

The purpose of current research was to assess the efficacy of long segment lumbar fixation as a surgical intervention for high grade lumbar spondylolisthesis, with a particular focus on the effects of the procedure on patients' complaints, neurological deficits, & radiological findings.

## 2. Patients and methods

This prospective research was conducted on 25 cases with lumbar spondylolisthesis (high grade) according to metering classification with grades (IV, V, and Spondyloptosis) underwent long segment transpedicular lumbar fixation started from March 2021 to June 2023 in Al Azhar University hospitals ( Al Hussien hospital) and Nasser institute for medical treatment and research.

Inclusion criteria: Adult patients above 18 years age group, traumatic and isthmic.

Exclusion criteria: Pediatrics below 18 years of age group, spondylodiscitis, recurrent cases, and pathological causes.

Ethical Considerations: Informed written consent was acquired from all cases involved in the study.

### Methods:

The subsequent was administered to every patient: full neurological examination, Full history taking, VAS for back and radicular pain, and Meyerding grading system.

### Meyerding grading system:

Grade III is (50 percent-75 percent), grade IV is (75 percent -100 percent), and grade V (spondylosis) exceeds 100 percent slippage.

### Pre-operative radiological assessment.

Prior to the procedure, an MRI of the lumbar spine was requested and done for all cases. Radiography of the dynamic lumbar spine was done to verify the high-grade vertebral slippage and possibly the etiology of it.

### Functional status assessment:

The functional status was evaluated both preoperatively and postoperatively using functional status questionnaires, such as VAS, as primary assessment for pain.

Surgical techniques: Under continuous general anesthesia, a posterior median incision was made. Followed by vertebral laminectomy. The hypertrophic yellow ligament was removed, and proliferated osteophytes were cleared away to fully reveal the dural sac and nerve root. The spinal canal and nerve root canal were creeping and expanded to completely decompress the nerve root. Under the C-arm X-ray fluoroscopy perspective, the displacing pedicle was conventionally implanted with two pulling nails, and the lower vertebral body was inserted with two pedicle screws. Another two pedicle screws were required to implant into the upper vertebral body of the patient's candidate for long-segment fixation. Titanium rods were placed, the nut was locked, and then lifting and reduction were completed, followed by a fixation. The autologous cancellous bone graduals from laminectomy were placed between the displaced pedicles to pressure the graft or perform the bilateral intertransverse fusion. A drainage tube was indwelled, and the incision was sutured.

### Postoperative evaluation

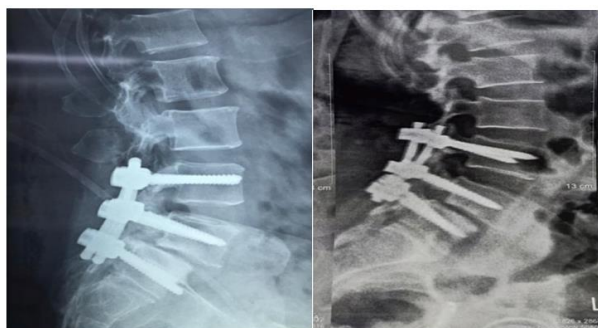
cases were followed up at 2 weeks, 1 month, 3 months, 6 months, and 1 year following surgery. Postoperative radiological evaluation using X-ray A-P and lateral views CT scans, Functional status questionnaires counting the VAS was calculated at the postoperative follow-up visit<sup>6</sup>, and patients' complications and condition were assessed.



(A)



(B)



(C)

Figure 1. (A): L4-5 spondylolisthesis from pre-operative MRI, (B): X-ray lateral view with L5-S1 spondylolisthesis, and (C): Long segment fixation postoperative

### 3. Results

As shown in Table 1, the ages of the participants varied from 31 to 59 years with a mean of  $46.4 \pm 6.6$  years. There were 3 men cases (12%) & 22 female cases (88%).

Table 1. Distribution of examined sample concerning demographic data.

	NUMBER	PERCENT%
AGE (YEARS)		
RANGE	31-59	
MEAN $\pm$ S.D.	$46.48 \pm 6.640$	
SEX		
MAN	3	12.0%
WOMAN	22	88.0%

All cases had Low Back Pain, all cases had Radicular Pain, 13(52.0%) had leg pain, 8(32.0%) had Sciatica, 4(16.0%) had Femoralgia and 8(32.0%) had Claudication pain and it showed improvement in claudication after 1 month follow up (Table 2).

Table 2. Distribution of examined sample concerning Complain.

Complain	Number	Percent%
Low Back Pain	25	100.0%
Radicular Pain	25	100.0%
Leg pain	13	52.0%
Sciatica	8	32.0%
Femoralgia	4	16.0%
Claudication pain	8	32.0%

Patients complaining of numbness and tingling showed improvement up to post-operative follow up after 3 months while patients with motor power deficit showed no improvement in Motor power with physical and medical management. There was statistically significant improvement in Sensations and Sphincters where  $P < 0.001$  & 0.004 respectively (Table 3).

Table 3. Comparison among pre & post-operative according to clinical presentation.

Clinical presentation	Pre-operative	Post-operative	$\chi^2$	P value
	No.	%	No.	%
Motor power				
Motor intact	23	92.0	23	92.0
Motor deficit	2	8.0	2	8.0
Sensations				
Paraesthesia	15	60.0	0	0
Intact	10	40.0	25	100

sensation						
Sphincters						
Urgency	8	32.0	0	0	-----	0.004*
Intact	17	68.0	25	100		

Table 4 demonstrated that statistically significant improvement in back & radicular pain according to VAS score where  $P < 0.001$ .

Table 4. Comparison among pre & post-operative according to back and radicular pain VAS score.

Pain VAS score	Pre-operative	Post-operative	U	P value
Back Pain				
Range	7-8	1-2	0.000	$< 0.001^*$
Mean $\pm$ S.D.	$7.16 \pm 0.374$	$1.16 \pm 0.374$		
Radicular pain				
Range	5-7	0-1	0.000	$< 0.001^*$
Mean $\pm$ S.D.	$5.80 \pm 0.957$	$0.24 \pm 0.436$		

VAS: Visual analogue scale.

The majority of cases had back, radicular and claudication pain improved and it showed statistically significant improvement where  $P$  below 0.001 (Figure 1).

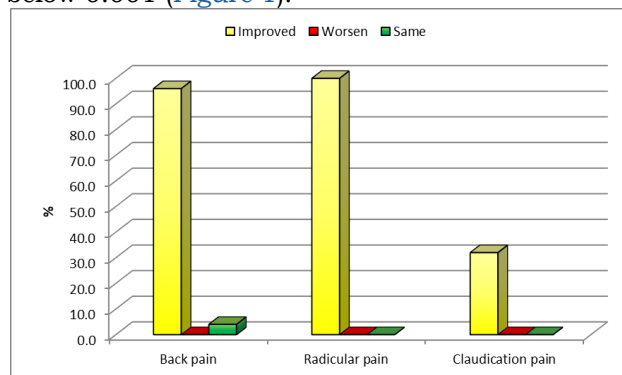


Figure 2. Comparison between outcome concerning pain

Two patients suffered complications, one patient had post-operative CSF leak and 2 patients had post operative infection.

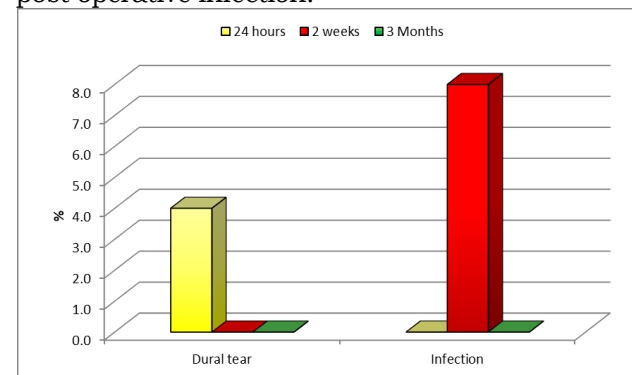


Figure 3. post-operative complications.

### 4. Discussion

High-grade lumbar spondylolisthesis is considered a challenge for neurosurgeons to choose the best surgical strategy to achieve fusion and relief. Patients complain about extended follow-up.

According to our findings, the age of the participants varied from 31 to 59, with a mean of



46.4±6.6 years. There were three male cases (12%) and 22 female cases (88%).

The demographic data in our study align with Dewald et al.<sup>7</sup> research on the assessment & therapy of high-grade lumbar spondylolisthesis in adults. They retrospectively reviewed 21 consecutive individuals who received lumbar spinal surgery for high-grade spondylolisthesis between 1990 and 2004. There were thirteen women & eight men, with an average age of thirty-five years (range, 21–68 years), indicating a predominance of woman cases.

All cases had Low Back Pain with a mean VAS value of 7.16±0.3; all cases had Radicular Pain with an average VAS value of 5.80±0.9. Radicular pain was divided into (13(52.0%) had leg pain, 8(32.0%) had Sciatica, 4(16.0%) had Femoralgia) and 8(32.0%) had Claudication pain. 2 patients (8.0%) had preoperative motor power weakness in the form of foot drop and knee flexion GIV.

Our findings agree with Aboelkhir et al.,<sup>8</sup> who intended to assess the outcome of long segment vs short segment in High Grade Spondylolisthesis with regard to prior to surgery information, the average VAS value for leg pain was 7 ± 1.5, whereas the average VAS value for back pain was 5.46 ± 2.3. The mean JOA score was 6 ± 0.94, & ten percent of the cases had undergone previous operations.

Furthermore, the patient's pre-operative complaints agreed with Iguchi et al.<sup>9</sup> who stated that the majority of cases had Pain in the lower back, & and leg pain.

The outcome of the studied group showed that highly statistically significant enhancement was noted in back and radicular pain according to VAS score with mean VAS values for back pain and radicular pain were (1.16±0.3) and (0.24±0.43) where  $P < 0.001$  and the  $P < 0.001$  respectively. The majority of patients had back, radicular, and claudication pain improved, and it showed highly statistically significant Enhancement where  $P < 0.001$ ,  $P < 0.001$ , and  $P < 0.001$ , respectively. Highly statistically significant enhancement was noted in Sensations and Sphincters where  $P < 0.001$  & 0.004, respectively. 2 patients (8.0%) had no change in motor power from pre-operative findings with follow-up to 3 months with the help of physical therapy but showed no improvement.

The postoperative results of our investigation align with Rivollier et al.,<sup>10</sup> 2020, who examined seven individuals with L5-S1 spondylolisthesis (two in grade II, four in grade IV, and one in grade V). The median lumbosacral angle (LSA) rose from 76 to 94 degrees. Following surgery, the Meyerding grades of two patients remained

unchanged, while three cases decreased by two rankings and two cases decreased by one rank. Significant variations were seen in the postoperative radiological parameters with a  $p$ -value of 0.036. There is no widespread dissemination of a serious infection. The median ODI and VAS ratings showed improvement in pain and disability.

The postoperative outcomes are consistent with the findings of Aboelkhir et al.<sup>8</sup> The postoperative VAS rating for back pain was 2.4 ± 1.5, the mean VAS rating for leg pain was 1.5 ± 2.3, and the mean JOA score was 13.2 ± 2.2, with no death reported.

Also, our findings supported with Ekman et al.,<sup>11</sup> concluded, it has been demonstrated that both long-segment & short-segment PLF surgery methods improve main clinical consequences (such as success & high satisfaction rates, visual analogue scale scores for legs & back pain, & JOA score) equally effectively. However, the short-segment PLIF group of cases had a higher incidence of complications.

Our findings align with Dawood et al.<sup>12</sup> study from 2021, which also showed a notable reduction in back pain measured by VAS after surgery ( $P$  less than .001) and a considerable decrease in leg pain measured by VAS after surgery ( $P$  less than .001).

Concerning complications, a total of 3 cases suffered from complications; of them, 1 case (4.0%) had a dural tear, and 2 cases (8.0%) had wound infection.

The results of our study are consistent with the conclusions reached by Aboelkhir et al.<sup>8</sup> who reported that the complication rate was lower in the PLF group than in the PLIF group.

In contrast to the findings of Harada et al.<sup>13</sup> which indicated that multilevel fusions were associated with increased rates of reoperation, dural tears, our findings are in contrast with those of Harada et al.<sup>16</sup>, who observed that multilevel fusions were correlated with enhanced rates of dural tears, reoperation, & facility discharge, in addition to decreased final visual analogue scale -back scores, in comparison to 1-level fusions.

#### 4. Conclusion

Although different surgical techniques were accepted as a treatment for high-grade lumbar spondylolisthesis, long-segment transpedicular lumbar fixation showed improvement regarding patients' complaints of decreased visual analog scale for both back and radicular pain, & and satisfactory outcomes with less complication rate (regarding system failure compared to short segment fixation). Further studies are needed with larger scales to confirm our results.

## Disclosure

The authors have no financial interest to declare in relation to the content of this article.

## Authorship

All authors have a substantial contribution to the article

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## Conflicts of interest

There are no conflicts of interest.

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