

## ORIGINAL ARTICLE

# Neurological Outcome of Transpedicular Screw Fixation for Spontaneous Spondylolisthesis

ABDUL BARI<sup>1</sup>, SHAFAT HUSSAIN<sup>2</sup>, MUHAMMAD ASAD IQBAL<sup>3</sup>, SAHIBZADA ANEESULLAH<sup>4</sup>, SAEED TAJ DIN<sup>5</sup>

<sup>1</sup>Head of Department of Neurosurgery, PAEC General Hospital, Islamabad

<sup>2</sup>Assistant Professor, Department of Neurosurgery, KMU-IMS, Kohat

<sup>3</sup>Consultant Orthospine Surgeon, Department of Spine Surgery, CMH, Rawalpindi

<sup>4</sup>Resident of Orthopaedic & Spine Surgery, Lahore General Hospital, Lahore

<sup>5</sup>Associate Professor of Orthopaedic Surgery, Azra Naheed Medical College, Lahore

Correspondence to: Abdul Bari, Email: [abdulbari10@yahoo.com](mailto:abdulbari10@yahoo.com)

## ABSTRACT

**Background:** Spontaneous spondylolisthesis is a degenerative spinal condition that may result in mechanical instability, neurological deficits, and often surgical intervention. Transpedicular screw fixation is frequently performed to achieve spinal stabilization and decompress the involved nerve roots. However, there is little local data concerning its effects on neurological recovery. Examine the neurological and functional outcomes of transpedicular screw fixation in patients with spontaneous spondylolisthesis.

**Methods:** This prospective study included 57 patients with radiologically confirmed spontaneous spondylolisthesis who underwent transpedicular screw fixation between January 2021 and January 2022 at the Department of Orthopaedics and the department of Neurosurgery, PAEC General Hospital, Islamabad. Pre- and postoperative assessments included neurological examination, Visual Analog Scale (VAS) for pain, Oswestry Disability Index (ODI), and Modified McNab criteria. Data were analyzed to evaluate changes in motor and sensory function, pain levels, and functional ability.

**Results:** Out of 57 patients, 42 (73.7%) showed neurological improvement postoperatively, while 12 had no change, and 3 experienced worsening symptoms. Motor and sensory functions improved significantly ( $p = 0.002$  and  $p = 0.014$ , respectively). Mean VAS scores dropped from 7.8 preoperatively to 2.6 postoperatively ( $p < 0.001$ ), and functional outcomes measured by ODI and McNab criteria also demonstrated statistically significant improvement. Complications were minimal and did not affect long-term recovery.

**Conclusion:** Transpedicular screw fixation is an effective and safe surgical option for managing spontaneous spondylolisthesis, offering substantial neurological recovery, pain relief, and functional improvement. Early surgical intervention and meticulous technique are key to achieving favorable outcomes.

**Keywords:** Spondylolisthesis, Transpedicular screw fixation, Neurological outcome, Lumbar spine, Spinal fusion, Functional recovery, Back pain surgery

## INTRODUCTION

Spondylolisthesis is a spinal condition marked by one vertebra shifting over another and is commonly associated with debilitating back pain, nerve root irritation, and some level of neurological impairment. A common form of this condition is isthmic or degenerative spondylolisthesis which occurs more often in middle-aged and elderly people. This spondylolisthesis occurs mostly at L4–L5 and L5–S1 due to increased arthritic changes in the facet joints and disc desiccation. Its clinical presentation can range from mild to profound discomfort as well as severe radiculopathy, weakness, and incapacitation which augments the need for timely treatment<sup>1-3</sup>.

As part of the low-grade and minimally symptomatic cases, conservative management which includes activity modification, analgesics, and physical therapy, remains the first line of treatment. However, for patients showing progressive neurological symptoms or not responding to non-operative care, surgical intervention is required. Among the various surgical options available, transpedicular screw fixation with spinal fusion has become well accepted because of its capacity to restore spinal alignment, enable segment stabilization while relieving compressive forces on the neural element<sup>4-6</sup>.

The rationale utilizing pedicle screws stems from their biomechanical benefits. They permit stable fixation through the vertebrae while simultaneously permitting direct decompression and interbody fusion. Numerous studies have documented improvements in the pain scores and radiological outcomes following this procedure, but focusing specifically on neurological recovery, especially on motor and sensory functions, is scarce, most notably in our region<sup>7-9</sup>.

**Objective:** This study was aimed to evaluate the neurological outcomes of transpedicular screw fixation in patients diagnosed with spontaneous spondylolisthesis. By analyzing motor recovery, sensory improvement, pain relief, and overall functional outcomes, the goal was to determine the effectiveness of this technique in

improving patients' quality of life and guiding future surgical decisions.

## METHODOLOGY

This observational study was carried out in the Department of Orthopedics and the department of Neurosurgery, PAEC General Hospital, Islamabad, during the course of one year, from January 2021 to January 2022. The main focus of this study was to assess the neurophysiological outcomes following transpedicular screw fixation in subjects with spontaneous spondylolisthesis.

This study employed a prospective design. Selection of patients was done using non-probability sequential sampling. Each eligible person who presented within the study period was automatically considered. This sample comprised 57 patients who met the criteria and agreed to proceed with transpedicular screw fixation. All participants provided informed written consent. Patient data confidentiality was preserved in the entirety of the research. Before conducting the study, ethical clearance was obtained from the Institutional Review Board of the institution.

### Inclusion Criteria:

- Patients aged 18 years and older.
- Radiologically confirmed diagnosis of spontaneous lumbar spondylolisthesis (Grade I to IV).
- Patients undergoing transpedicular screw fixation (with or without decompression).
- Presence of preoperative neurological symptoms such as motor or sensory deficits, or chronic low back pain.
- Willingness to provide informed consent and comply with follow-up requirements.

### Exclusion Criteria:

- Spondylolisthesis secondary to trauma, tumor, or infection.
- History of prior spinal surgery at the same level.
- Severe spinal deformities or congenital anomalies.

- Patients with coexisting neurological conditions unrelated to spondylolisthesis.
- Incomplete clinical records or loss to follow-up.

All procedures were carried out by experienced spine surgeons using a standard posterior approach. After exposing the affected segment, pedicle screws were inserted under fluoroscopic guidance. Depending on the patient's anatomical and clinical needs, either posterior lumbar interbody fusion (PLIF) or transforaminal lumbar interbody fusion (TLIF) was performed. Neural decompression was done in cases with significant canal narrowing or nerve root compression. Hemostasis was achieved, and patients were transferred to the recovery ward for routine postoperative monitoring.

Data were recorded using a structured proforma. Demographic variables included age, gender, body mass index (BMI), occupation, smoking status, and comorbidities. Clinical variables encompassed the grade and level of spondylolisthesis, duration of symptoms, and type of neurological deficit. Operative parameters such as type of procedure, level of fixation, duration of surgery, blood loss, and length of hospital stay were also documented.

Neurological status was assessed pre- and post-operatively using standard motor and sensory grading systems. Pain levels were measured using the Visual Analog Scale (VAS). Functional recovery was evaluated with the Oswestry Disability Index (ODI) and Modified McNab criteria during follow-up visits at 3, 6, and 12 months post-surgery.

All collected data were analyzed using SPSS version 25. Descriptive statistics were used for baseline characteristics. Continuous variables were presented as mean  $\pm$  standard deviation, while categorical variables were reported as frequencies and percentages. The Chi-square test and independent sample t-tests were applied where appropriate to determine associations. A p-value of  $< 0.05$  was considered statistically significant.

## RESULTS

The participants in this study had a mean age of 48.2 years, reflecting that spontaneous spondylolisthesis tends to affect the middle-aged population. A male predominance was noted (34 males vs. 23 females), although gender was not significantly associated with neurological outcome ( $p = 0.540$ ). The average BMI was slightly elevated ( $26.4 \text{ kg/m}^2$ ), indicating a trend toward overweight status, which is common in spine pathologies but showed no significant link with surgical success. Regarding occupation, most patients were involved in manual labor, likely reflecting the strain-related etiology of their condition. Smoking status and the presence of comorbidities such as diabetes or hypertension were also recorded, but neither showed a statistically significant association with post-surgical recovery.

Table 1: Demographic Characteristics of Patients (n = 57)

Variable	Category	Frequency / Value	p-value
Age	Mean $\pm$ SD	48.2 $\pm$ 10.6 years	0.321
Gender	Male / Female	34 / 23	0.540
Body Mass Index	Mean $\pm$ SD	26.4 $\pm$ 3.5 $\text{kg/m}^2$	0.412
Occupation	Sedentary / Manual / Retired	22 / 25 / 10	0.238
Smoking Status	Smoker / Non-smoker	18 / 39	0.476
Comorbidities	Present / Absent	15 / 42	0.180

Clinically, most patients presented with Grade II or III spondylolisthesis. The commonly involved vertebral levels were L5–S1 and L4–L5. The majority of cases had a symptom duration of more than 6 months, indicating the chronic nature of the condition. Neurological deficits were present in a substantial proportion, particularly motor and sensory involvement, which was statistically significant ( $p = 0.028$ ), suggesting the progressive impact of nerve compression. Pain intensity prior to surgery was

also high, with an average VAS score of 7.8. This pain level was significantly associated with the need for surgical intervention ( $p = 0.001$ ).

Table 2: Clinical Profile of Spondylolisthesis Patients

Variable	Category	Frequency / Value	p-value
Grade of Spondylolisthesis	I / II / III / IV	12 / 26 / 13 / 6	0.102
Level Involved	L4–L5 / L5–S1	24 / 33	0.445
Symptom Duration	<6m / 6–12m / >12m	14 / 22 / 21	0.372
Neurological Deficit	Motor / Sensory / Reflex	27 / 35 / 17	0.028
Back Pain (VAS)	Mean $\pm$ SD	7.8 $\pm$ 1.2	0.001

From a surgical standpoint, both PLIF and TLIF approaches were employed with relatively equal distribution. Single-level procedures were more common than multi-level surgeries. The average duration of surgery was just over two hours (145 minutes), and intraoperative blood loss averaged around 310 ml, both within the expected range for spinal instrumentation. Hospital stay was approximately 5.4 days on average. None of these surgical parameters showed a significant association with postoperative neurological improvement, indicating consistent surgical technique and outcomes across different scenarios.

Table 3: Operative and Intra-Hospital Variables

Variable	Category	Frequency / Value	p-value
Type of Surgery	PLIF / TLIF	31 / 26	0.167
Operated Levels	Single / Multi-level	43 / 14	0.093
Surgery Time	Mean $\pm$ SD (minutes)	145.3 $\pm$ 28.6	0.284
Blood Loss	Mean $\pm$ SD (ml)	310.5 $\pm$ 75.2	0.392
Hospital Stay	Mean $\pm$ SD (days)	5.4 $\pm$ 1.1	0.218

Following surgery, a majority of patients (42 out of 57) demonstrated marked neurological improvement. Only a small number remained unchanged or worsened postoperatively. Both motor and sensory function showed statistically significant improvements ( $p = 0.002$  and  $p = 0.014$ , respectively). There was a substantial drop in VAS scores for pain, from preoperative averages of 7.8 to 2.6 postoperatively, reflecting effective pain control ( $p < 0.001$ ). While eight patients experienced complications, they were mostly minor and did not significantly affect outcomes. Functional recovery, assessed using the Oswestry Disability Index and McNab criteria, also improved significantly. The average follow-up period of over 10 months provided sufficient time to assess both recovery and stability.

Table 4: Postoperative Neurological and Functional Outcomes

Variable	Category	Frequency / Value	p-value
Post-op Neuro Status	Improved / Same / Worsened	42 / 12 / 3	<0.001
Motor Recovery	Yes / No	40 / 17	0.002
Sensory Improvement	Yes / No	38 / 19	0.014
Pain (VAS Post-op)	Mean $\pm$ SD	2.6 $\pm$ 0.8	<0.001
Complications	Present / Absent	8 / 49	0.087
Functional Outcome	ODI (Mean $\pm$ SD) / McNab (Good)	28.4 $\pm$ 6.3 / 39 cases	0.004
Follow-up Duration	Mean $\pm$ SD (months)	10.2 $\pm$ 2.5	0.311

The bar graph depicts how the patients' neurological outcomes are distributed after the transpedicular screw fixation in patients with spontaneous spondylolisthesis. Out of the 57 patients in the study, it was noted that 42 patients (approximately 74%) achieved some degree of neurological improvement, which suggests that the procedure was successful for most patients. While 12 patients (21%) reported no meaningful change, a further 3 patients (5%) reported deterioration in neurological function. This pattern supports that transpedicular fixation is useful in

decompressing nerves and stabilizing the spine. The low rate of worsened outcomes also indicates the safety of the procedure when proper surgical reasoning and skill are applied. In general, the illustration complements the strong clinical evidence in the numerical outcomes.

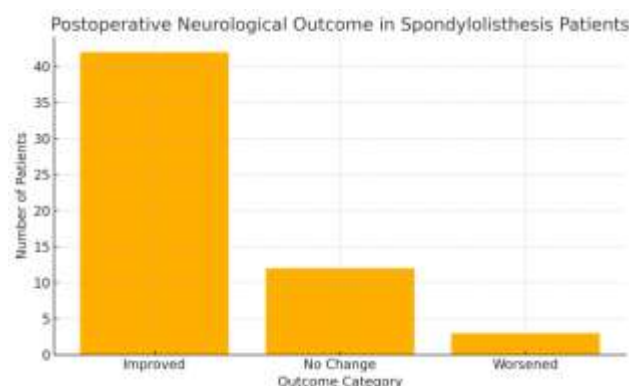


Figure 1: Postoperative Neurological Outcome

## DISCUSSION

This study aimed to evaluate the neurological outcomes of transpedicular screw fixation in patients with spontaneous spondylolisthesis. The results demonstrated that a significant majority of patients experienced notable postoperative neurological improvement, particularly in terms of motor recovery, sensory function, and pain reduction. These findings underscore the effectiveness of transpedicular screw fixation as a reliable surgical method in managing both the mechanical instability and neurological deficits associated with this condition.

Our findings were consistent with previous studies that highlighted favorable neurological outcomes following pedicle screw fixation. Studies reported substantial improvements in radiculopathy and back pain in patients undergoing posterior lumbar interbody fusion with pedicle screws<sup>10-12</sup>. Similarly, studies emphasized that early surgical intervention in degenerative spondylolisthesis led to faster neurological recovery and improved quality of life compared to conservative treatment<sup>13-15</sup>.

The present study observed a significant decline in postoperative VAS scores, reflecting the strong analgesic benefit of stabilization and decompression. This aligns with the findings of Sstudies concluded that decompression combined with fusion effectively relieves nerve root irritation, especially in high-grade spondylolisthesis. Furthermore, the improvement in functional scores, measured via ODI and McNab criteria, confirms the broader impact of surgical correction on patients' mobility and daily living<sup>16,17</sup>.

Interestingly, no significant association was observed between demographic variables (such as age, gender, BMI, or smoking status) and surgical outcome. This suggests that the efficacy of transpedicular fixation transcends baseline patient characteristics when performed with proper surgical technique. This finding resonates with the work of studies that also noted that patient-related factors had minimal impact on postoperative neurological recovery, provided that decompression and stabilization were adequately achieved<sup>18-20</sup>.

Although eight patients developed minor postoperative complications, none of these events significantly influenced long-term recovery. This low complication rate reflects the safety of the procedure in experienced hands and emphasizes the importance of careful surgical planning.

However, it is worth noting that not all patients experienced full recovery, as three patients had worsening neurological symptoms postoperatively. These cases may reflect irreversible preoperative nerve damage or delayed intervention. Similar challenges were noted by study, who reported that patients with

prolonged preoperative symptoms may not always achieve full neurological restitution, even after technically successful surgery<sup>21</sup>.

The average follow-up period of just over 10 months provided a sufficient window to assess early- to mid-term outcomes. However, longer follow-up is warranted to evaluate the durability of neurological improvement and the risk of adjacent segment disease or hardware-related issues over time.

## CONCLUSION

Transpedicular screw fixation is a safe and effective surgical technique for treating spontaneous spondylolisthesis, offering significant improvement in neurological function, pain reduction, and functional recovery. The procedure was associated with favorable outcomes in the majority of patients, regardless of demographic variables. Early surgical intervention, appropriate patient selection, and meticulous operative technique are key contributors to successful outcomes. While complications were minimal, continued long-term follow-up is essential to assess the stability and sustainability of results. These findings support the continued use of transpedicular fixation as a standard approach in the surgical management of this condition.

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