

# Functional Outcomes of Transforaminal Lumbar Interbody Fusion for Single-Level Spondylolisthesis

Neel Soni<sup>1\*</sup>, Thulasi Raman<sup>2</sup>, Rajesh Rajavelu<sup>3</sup>

<sup>1</sup>Postgraduate, Department of Orthopaedics, Meenakshi Medical College Hospital and Research Institute, Kanchipuram, MAHER University, Chennai. Email: [neelsoni.7798@gmail.com](mailto:neelsoni.7798@gmail.com) (Corresponding Author)

<sup>2</sup>Professor and HOD, Department of Orthopaedics, Meenakshi Medical College Hospital and Research Institute, Kanchipuram, MAHER University, Chennai

<sup>3</sup>Assistant Professor, Department of Orthopaedics, Meenakshi Medical College Hospital and Research Institute, Kanchipuram, MAHER University, Chennai

## ABSTRACT

**Introduction:** Lumbar spondylolisthesis is a common cause for lower back ache leading to significant functional impairment. When the conservative management fails for the patients, surgical procedure is indicated. Transforaminal Lumbar Interbody Fusion (TLIF) is one of the well-established options. We aim to access the functional outcome of TLIF in single level spondylolisthesis.

**Materials and methods:** This prospective follow-up study was conducted in the Department of Orthopaedics at Meenakshi Medical College Hospital and Research Institute, Kanchipuram, over a period of 9 months. A total of 20 patients with single level spondylolisthesis who underwent TLIF. Patient assessment and data collection was done at baseline and at regular post-operative intervals to access surgical parameters, fusion rates, pain relief and complications.

**Results:** A total of 20 patients were included with a mean age of 46.3 years. Most commonly involved level was L4-L5. TLIF provided significant post-operative functional improvement with VAS score at 6 months. Radiological fusion achieved in 95% of patients. At final follow up ODI improved from 56.5 pre op to 15.7 post-op and VAS improved from pre op 8.1 to 1.7 post-op. Complications included superficial surgical site infection (SSI) in 1 case. No cases were seen deep SSI, dural tear or persistent radicular pain.

**Conclusion:** TLIF is a reliable and effective surgical technique in cases of single level symptomatic spondylolisthesis providing excellent symptomatic relief and functional outcomes with minimal complications.

**Keywords:** TLIF, Spondylolisthesis, Spinal fusion, Persistent back pain, Functional outcome

**How to cite this article:** Soni N, Raman T, Rajavelu R. Functional Outcomes of Transforaminal Lumbar Interbody Fusion for Single-Level Spondylolisthesis. *Int J Drug Deliv Technol.* 2026;16(20s): 248-253. DOI: 10.25258/ijddt.16.20s.31

**Source of support:** Nil.

**Conflict of interest:** None

## Introduction

When one vertebra is abnormally translated in relation to the other, it is called spondylolisthesis. Spondylolisthesis frequently involves lumbar spine or lumbo-sacral junction. [1]

Depending on the translation between two vertebral bodies in lateral x-ray image, Mayerding graded spondylolisthesis. In this classification grade I included 0-25%, Grade II defined as 25%-50%, Grade III defined as 50%-75% and grade IV was defined as 75%-100% of translation. Grade V was later added, which has been referred to as translation >100%, or Spondyloptosis. [2]

Based on etiological and anatomical features, spondylolisthesis was classified into six types. Type I is the type of dysplastic that is congenital. It is due to congenital dysplasia of the S1 vertebra that leads to

anterior and superior rounding of it allowing translation of the L5 vertebra over it anteriorly. Type II is isthmic type it is due to defect in pars interarticularis. Type III is degenerative type. Facet joint arthritis is the leading reason for it, which reduces mobility causing lesion and instability. This results in weakness of ligamentum flavum (soft tissue present between the vertebrae) resulting in further translated instability of one over other. Type IV is post-traumatic type in nature, with high energy trauma the cause. Type V is a pathological type and it can be caused by metabolic conditions such as osteoporosis, osteopetrosis or lytic bone tumors. Type VI is iatrogenic type. [3]

Later on The Spinal Deformity Study Group developed a mainly new classification not only encompassing slip grade but also spinopelvic and global spinopelvic

## Functional Outcomes of Transforaminal Lumbar Interbody Fusion for Single-Level Spondylolisthesis

alignment. But it is not applicable to degenerative type of spondylolisthesis. [4,5]

In which the two common types are degenerative and isthmic, occurring commonly in adults and adolescents respectively. Spondylolisthesis of the degenerative type occurs due to segmental instability as a result of disc degeneration and facet remodelling. That is also why it occurs later in life. The most affected segment (that is, the one with the highest incidence) was L4-L5 — 6 times more than any other segment. [6] Degenerative type is the most common in adult population. It is thought to be the consequence of the degenerative cascade described by Kirkaldy-Willis. [7] The lytic defect of pars interarticularis at any level hinders the body that vertebra gets separated from its inferior facet resulting in instability and permitting anterior translation/ Isthmic type spondylolisthesis. [8] Isthmic spondylolisthesis is most commonly seen at L5-S1. A study reported that 90% of cases were at L5 level involving pars abnormality, at L4 level in 5% and remaining elsewhere. [9]

Isolated isthmic spondylolisthesis is usually asymptomatic & the majority of cases will be diagnosed incidentally. And symptomatic subject also have involvement pain, which is caused by presenting symptoms. [10] A patient with degenerative spondylolisthesis typically presents with symptoms of low back pain, radicular pain in the lower extremities, and neurogenic claudication leading to functional disability. The base treatment of patients is conservative, including analgesics, lifestyle modification, physical therapy and epidural injection. However when this conservative measures fail to relieve the symptoms or there is evidence of progressive slip or patient presents with neurological deficit requires surgical intervention and preferred surgical treatment is fusion surgery. [11]

Lumbar fusion surgical techniques are instrumented and non-instrumented. Instrumented fusion has generally higher fusion rates compared to non-instrumented. [12] Posterolateral Fusion (PLF), Anterior lumbar Interbody Fusion (ALIF), Posterior lumbar Interbody Fusion (PLIF) & TLIF. Among these, TLIF is the preferred method due to certain advantages. TLIF allows access to posterior aspect by single approach, both decompressive and fusion with use of pedicle screws, rods and interbody cage in one step that minimises the iatrogenic insults as well as minimizes the iatrogenic instability. Other advantages of TLIF include less neuronal retraction and high fusion rates. [13]

However, these functional outcome and radiological fusion results may be mitigated by differences in age of patient, comorbidities, type and level of spondylolisthesis, surgical techniques used as well. Advantage of TLIF Procedure but Complications Associated With It Like Infection, Nerve Root Injury, Dural Tear, Pseudoarthrosis. [6]

Thus, the current study was carried out to assess the functional outcome of TLIF in symptomatic spondylolisthesis patients.

### Material And Methods

This prospective follow-up study was conducted in the Department of Orthopaedics at Meenakshi Medical College Hospital and Research Institute, Kanchipuram, over a period of six months. The study population consisted of patients diagnosed with single-level spondylolisthesis who underwent transforaminal lumbar interbody fusion (TLIF). A total of 20 patients were included and selected through purposive sampling based on predefined inclusion and exclusion criteria. Eligible participants were adults aged between 19 and 60 years with a confirmed diagnosis of single-level spondylolisthesis, presenting with persistent symptoms despite at least six weeks of conservative management, and demonstrating a clear correlation between clinical findings and radiological evidence. Patients were excluded if they were younger than 18 years or older than 60 years, had multi-level spondylolisthesis, cauda equina syndrome, lack of clinical-radiological correlation, or a history of previous lumbar spine surgery.

### Data collection procedure

After selection of eligible patients, a detailed clinical history was obtained and thorough clinical examination was performed. Baseline assessment included evaluation of pain and functional status using the Visual Analogue Scale (VAS), Oswestry Disability Index (ODI). Standard radiological evaluation was carried out using Xray of Lumbosacral spine – AP and Lateral views, MRI lumbar spine. Based on clinical and radiographic findings, the diagnosis was established. Routine preoperative investigations were performed in all patients. Written informed consent for surgery as well as participation in the study was obtained from all patients.

### Surgical procedure

All patients were operated under general anaesthesia in prone position. Under strict aseptic precautions midline posterior approach was used. Paraspinal muscles were retracted and deep dissection done. Pedicle screw insertion was done at affected level vertebrae. Decompression via facetectomy and laminectomy

## Functional Outcomes of Transforaminal Lumbar Interbody Fusion for Single-Level Spondylolisthesis

done. Disc space was prepared using serial shaver and distractor application. Insertion of cage with bone graft was done. Rods fixation and final tightening was done and adequate reduction of listhesis was achieved. Thorough wash given. Layered skin closure was done and sterile dressing application was done.

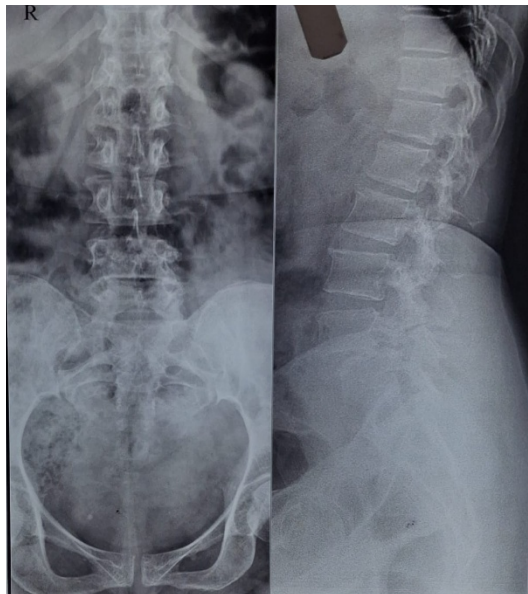


Figure 1 Preoperative X-ray - AP & Lateral view

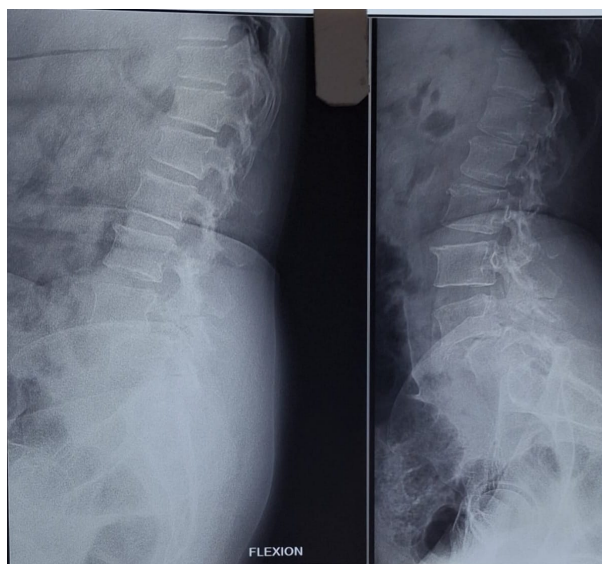


Figure 2 Pre-operative X-ray Lateral \_ Flexion & Extension views



Figure 3 MRI Image- Sagittal Section

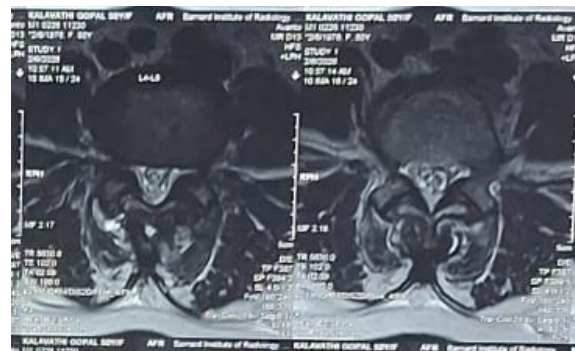


Figure 4 MRI Image- Axial sections at L4-L5

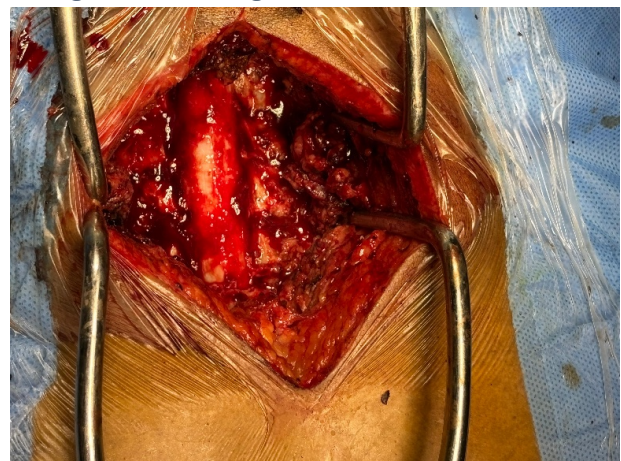
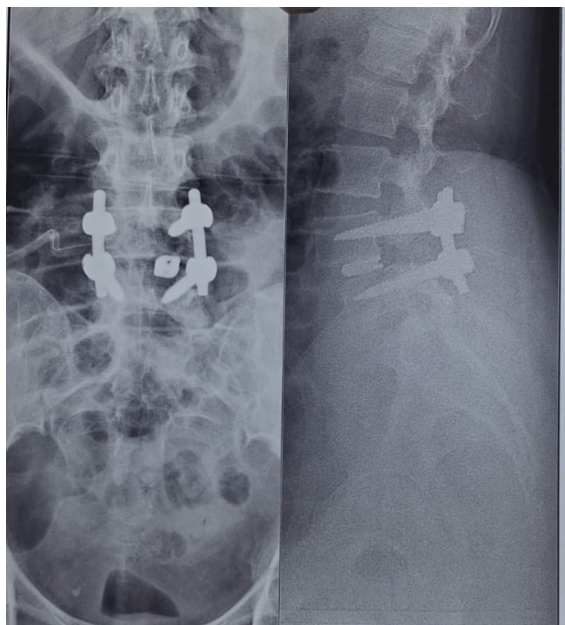


Figure 5 Intra-op clinical picture - Exposure

### Postoperative protocol and follow-up

Clinical and radiological evaluation was done at immediate post-op time. Early mobilization was done as per patient tolerance. Dressings were done at regular intervals and suture removal done on 14<sup>th</sup> postoperative day. All patients were followed up at 2 weeks, 6 weeks, 3 months and 6 months.

## Functional Outcomes of Transforaminal Lumbar Interbody Fusion for Single-Level Spondylolisthesis



**Figure 6 Post-op X-ray AP & Lateral views**

Outcome measures included duration of surgery, intraoperative blood loss, time to mobilization, pain relief assessed using the Visual Analog Scale (VAS), functional outcome measured by the Oswestry Disability Index (ODI), radiological evidence of fusion at six months, and any postoperative complications. The collected data were entered and analyzed using IBM SPSS Statistics. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were used to summarize the data. Preoperative and postoperative VAS and ODI scores were compared using paired *t*-test to assess the significance of functional improvement. A *p*-value of <0.05 was considered statistically significant. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were presented as proportions. Where appropriate, correlation analysis was performed to evaluate the relationship between clinical and radiological outcomes.

### RESULTS

A total of 20 patients with symptomatic single level Spondylolisthesis who underwent TLIF were included in the study and completed follow-up. The mean age of the study participants was 46.3 years. The majority of patients belonged to the 46–60 years age group (50.0%), followed by the 31–45 years age group (30.0%). Female patients were more common than male patients, accounting for 64.0% of the study population. Female patients were more common than male, accounting 65% of the study population.

**Table 1. Age distribution of study participants (n = 20)**

Age group (years)	Number (n)	Percentage (%)
18 – 30	4	20.0
31 – 45	6	30.0
46 – 60	10	50.0
Total	20	100

**Table 2. Sex distribution of study participants (n = 20)**

Sex	Number (n)	Percentage (%)
Male	7	35.0
Female	13	65.0
Total	20	100

L4-L5 level was affected more than L5-S1 level, accounting 70% of the study population.

**Table 3. Level affected (n = 20)**

Side	Number (n)	Percentage (%)
L4-L5	14	70.0
L5-S1	6	30.0
Total	20	100

Intra-operative and early post-operative results are shown in following Table 4. An average operative time was 190 minutes and mean blood loss of 320 ml. All patients were mobilized within an average of 36 hours.

**Table 4. Intra-op and Post-op Outcomes (n = 20)**

Parameter	Mean $\pm$ SD
Duration of surgery	190 $\pm$ 30 minutes
Blood loss	320 $\pm$ 50 ml
Time to mobilize	36 $\pm$ 12 hours

At each follow-up, there was steady decline in VAS score ODI scores. Mean VAS score was 8.1 in pre-operative time which at the end of follow-up was 1.7. Mean ODI score was 56.5 in pre-operative time which at the end of follow-up was 15.7 Like this, VAS score was improved by 79.01% and ODI score was improved by 72.2 %.

**Table 5. VAS and ODI score at each follow-up (n = 20)**

Time Point	Mean VAS (0–10)	Mean ODI (%)
Preoperative	8.1 $\pm$ 1.1	56.5 $\pm$ 8.1
2 Weeks Post-op	5.1 $\pm$ 1.3	43.2 $\pm$ 7.3
6 Weeks Post-op	3.4 $\pm$ 1.1	26.3 $\pm$ 6.4
6 Months Post-op	1.7 $\pm$ 0.8	15.7 $\pm$ 4.2
% Improvement (6 months)	79.01 (VAS)	72.2 % (ODI)

### Fusion Rates at 6<sup>th</sup> month follow-up

At 6 months follow-up, 19 out of 20 patients showed radiological evidence of fusion.

## Functional Outcomes of Transforaminal Lumbar Interbody Fusion for Single-Level Spondylolisthesis

**Complications:** Intra operative complications like nerve root injury or dural tear was not seen in any of the patient. One patient developed superficial surgical site infection which was managed with anti-biotic as per hospital policy and it resolved. One patient reported persistence of radicular pain.

**Table 6. Intra-op & Post-op complications**

Side	Number (n)	Percentage (%)
Nerve root injury	0	0.00
Dural tear	0	0.00
Superficial wound infection	1	5.00 %
Deep infection	0	0.00
Persistent radicular pain	0	0.00
Implant failure	0	0.00

### Discussion

Our present study proved that TLIF give excellent functional outcome if we take care to mobilize early post operative time and we have good improvement with VAS score and ODI score. In patients who underwent TLIF, the efficacy of early mobilization within 2 days of surgery and improved wound healing rates indicates post operative recovery.

Among all available options in cases of spondylolisthesis, TLIF has emerged as a standard option due to its advantages over other techniques and comparable biomechanical & clinical outcomes. [13]

The mean operative time for single segment reported by Roh YH et al was 201 minutes with average blood loss of 210 ml. [14], which matches our current study.

The average time of surgery and mean blood loss was higher than study by Wang Y et al which ballpark an average of 130 mins & reasoned as the study was done through a minimally invasive approach. (2) Note that fusion rates at other centers above 90 % are comparable to this study which reported 98% fusion rates. [15]

Gadekar G et al. also had comparable results considering intra operative variables such as mean blood loss of 350 ml, surgical time of 180 minutes and post-operative outcomes such as fusion rates above on most follow ups (>90 %) and improvement in VAS and Odi score more than 75 %. [16]

De Kunder SL et al conducted a systematic review and meta-analysis Özcakır et al reported in their meta-analysis of TLIF and PLIF on lower ODI scores post

operative time but same goes for patients underwent TLIF. TLIF has the extremely favorable aspect of achieving fusion and decompression from a single incision, with less surgical insult and risk as compared to separate incision. [17]

### Conclusion

TLIF is a safe, reliable and effective surgical treatment for symptomatic spondylolisthesis as shown in our study. TLIF employs posterior route of fusion with decompression resulting in less surgical insult to patient and improved wound healing. This study demonstrated significant improvement VAS scores and ODI score suggesting good functional recovery of the patient after TLIF.

In our study intra operative and postoperative complications were also low, fusion rates at the end of follow up significantly high, indicates safe profile and efficacy of TLIF. Thus based on our study, we propose TLIF as a better line of management in neglected single level spondylolisthesis with persistent symptoms following failed conservative treatment.

However multicentric study, comparison with control group and long duration of follow up is must to validate these findings.

### LIMITATIONS OF THE STUDY

The current study was carried out on a limited small sample of 20 patients, therefore the application of finding to general population is confined. The mean follow-up was short (6 months post-surgery) and thus long-term functional outcome, late complications and long-term implant related outcomes could not be evaluated. Our study was single centric and has the potential for institutional/surgeon bias. Demographics, surgical competence, post operative care vary from institution to another; therefore external validity may be limited. Relation comparative effectiveness of ALIF,PLIF would have add strength to study which is multifactorial yet been discussion edge of study.

CT scan helps for better visualization of the bone graft, adjacent bone and fusion. Whereby Xrays may exaggerate or underestimate the fusion due to metallic implants interfering with the propagation of Ax rays through bony structures and trabecular continuity being hard to assess. Thus, these restrain this study from merely deciding the exact conclusion of the fusion with help of X- rays alone.

### References

- Gagnet P, Kern K, Andrews K, Elgafy H, Ebraheim N. Spondylolysis and spondylolisthesis: A review of the literature. *J Orthop.* 2018;15(2):404-407. Published 2018 Mar 17. doi:10.1016/j.jor.2018.03.008

## Functional Outcomes of Transforaminal Lumbar Interbody Fusion for Single-Level Spondylolisthesis

- 2) Meyerding HW. Spondylolisthesis. *Surg Gynecol Obstet.* 1932;54:371-7. doi:10.3346/jkms.2022.37.e105. Published 2022 Apr 4.
- 3) Wiltse LL, Newman PH, Macnab I. Classification of spondylolysis and spondylolisthesis. *Clin Orthop Relat Res.* 1976;(117):23-29.
- 4) Mac-Thiong JM, Duong L, Parent S, et al. Reliability of the Spinal Deformity Study Group classification of lumbosacral spondylolisthesis. *Spine (Phila Pa 1976).* 2012;37(2):E95-E102. doi:10.1097/BRS.0b013e3182233969
- 5) Mac-Thiong JM, Labelle H, Parent S, et al. Reliability and development of a new classification of lumbosacral spondylolisthesis. *Scoliosis.* 2008;3:1917. Published 2008 Dec 10. doi:10.1186/1748-7161-3-19
- 6) Azar, F. M., Beaty, J. H., & Canale, S. T. (2021). *Campbell's Operative Orthopaedics* (14th ed.). Elsevier.
- 7) Paine, K W E M.B., F.R.C.S.\*; Cauchoix, Jean M.D.\*\*; Mcivor, Graeme M.D.\*; Willis, W H Kirkaldy M.D., F.R.C.S.\*. Lumbar Spinal Stenosis. *Clinical Orthopaedics and Related Research* 99():p 30-50, March 1974.
- 8) Ganju A. Isthmic spondylolisthesis. *Neurosurg Focus.* 2002;13(1):E1. Published 2002 Jul 15. doi:10.3171/foc.2002.13.1.2
- 9) Wiltse LL, Winter RB: Terminology and measurement of spondylolisthesis. *J Bone Joint Surg Am* 65:768–772, 1983
- 10) Bhalla A, Bono CM. Isthmic Lumbar Spondylolisthesis. *Neurosurg Clin N Am.* 2019;30(3):283-290. doi:10.1016/j.nec.2019.02.001
- 11) Frymoyer JW. Degenerative Spondylolisthesis: Diagnosis and Treatment. *J Am Acad Orthop Surg.* 1994;2(1):9-15. doi:10.5435/00124635-199401000-00002
- 12) Wasinpongwanich K, Nopsopon T, Pongpirul K. Surgical Treatments for Lumbar Spine Diseases (TLIF vs. Other Surgical Techniques): A Systematic Review and Meta-Analysis. *Front Surg.* 2022;9:829469. Published 2022 Mar 14. doi:10.3389/fsurg.2022.829469
- 13) Chan AK, Bydon M, Bisson EF, et al. Minimally invasive versus open transforaminal lumbar interbody fusion for grade I lumbar spondylolisthesis: 5-year follow-up from the prospective multicenter Quality Outcomes Database registry. *Neurosurg Focus.* 2023;54(1):E2. doi:10.3171/2022.10.FOCUS22602
- 14) Roh YH, Lee JC, Hwang J, et al. Long-Term Clinical and Radiological Outcomes of Minimally Invasive Transforaminal Lumbar Interbody Fusion: 10-Year Follow-up Results. *J Korean Med Sci.* 2022;37(13):e105. Published 2022 Apr 4. doi:10.3346/jkms.2022.37.e105
- 15) Wang Y, Zhang Y, Chong F, Zhou Y, Huang B. Clinical outcomes of minimally invasive transforaminal lumbar interbody fusion via a novel tubular retractor. *J Int Med Res.* 2020;48(5):300060520920090. doi:10.1177/0300060520920090
- 16) Gadekar G, Gaikar C, Bagal I. Functional recovery after TLIF in single-level lumbar spondylolisthesis: a prospective clinical study. *Eur J Cardiovasc Med.* 2025 Apr;15(4):1092-1098. doi: 10.61336/ejcm/25-04-178.
- de Kunder SL, van Kuijk SMJ, Rijkers K, et al. Transforaminal lumbar interbody fusion (TLIF) versus posterior lumbar interbody fusion (PLIF) in lumbar spondylolisthesis: a systematic review and meta-analysis. *Spine J.* 2017;17(11):1712-1721. doi:10.1016/j.spinee.2017.06.018