Section: Orthopedics

Original Research Article

FUNCTIONAL OUTCOME OF SURGICAL TREATMENT FOR SPONDYLOLISTHESIS USING POSTERIOR STABILIZATION AND FUSION TECHNIQUES

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ABSTRACT

Background: Spondylolisthesis is a spinal condition characterized by the forward displacement of one vertebra over another, leading to instability and associated symptoms. Surgical intervention is often recommended for patients with symptomatic spondylolisthesis unresponsive to conservative treatment. The objective of this study was to analyze the functional outcomes of surgical management utilizing posterior stabilization and fusion techniques in patients with spondylolisthesis.

Materials and Methods: This is a prospective study conducted on 30 patients who underwent surgical treatment for spondylolisthesis with posterior trans-pedicular screw fixation with conventional or reduction screws and fusion. Meyerding's grade of listhesis, Japanese Orthopaedic Association (JOA) score, Oswestry disability index (ODI) score and pain scores such as visual analog scale (VAS), numerical rating scale 11 (NRS-11), and pain relief rate were used to analyze the functional outcome.

Results: Postoperatively, Meyerding's grade of listhesis and the JOA score had improved significantly. The ODI score and pain scores such as VAS, NRS-11, and pain relief rate were better after surgical interventions. There was full motor recovery in 13 patients and 14 patients had full sensory recovery, while six patients had sensory blunting at the time of the time of the last follow-up. Twenty-six (80.7%) patients had clinically successful results and radiological/clinical fusion while four of the patients did not achieve a clinically successful result and radiological/clinical fusion. The average time for bony fusion was 5.58 months with the earliest being 4 months and the latest 12 months. Intraoperatively, one patient had screw slippage and one had a dural tear. Postoperatively, four patients had infection, two patients were presented with deep infection, and the instrumentation had been removed.

Conclusion: This study demonstrated favorable functional outcomes and improvements in pain, disability, and quality of life measures following surgical intervention.

Keywords: Low back pain, spondylolisthesis, posterior stabilization and fusion, functional outcome.

INTRODUCTION

Low back pain is among the most common reasons for patients presenting to orthopedic outpatient clinics in our country. In approximately 5–10% of cases, a specific underlying cause can be identified, such as degenerative conditions, inflammatory or infectious processes, neoplasms, metabolic bone diseases, referred pain, psychogenic factors, trauma, or congenital anomalies. However, the majority of cases are attributed to non-specific musculoskeletal disorders. The principal causes of mechanical back pain include lumbar strain, intervertebral disc herniation, spondylosis, spondylolisthesis, spinal stenosis, and vertebral fractures.

Spondylolisthesis is a relatively common spinal pathology characterized by the anterior displacement of one vertebral body relative to the adjacent

vertebra. This condition may lead to spinal instability, nerve root compression, and disabling symptoms such as chronic back pain, radiculopathy, and neurogenic claudication. The degenerative and spondylolytic types represent the most prevalent forms, with reported prevalence rates ranging from 19.1–43.1% and 3.7–11.5%, respectively.[1]

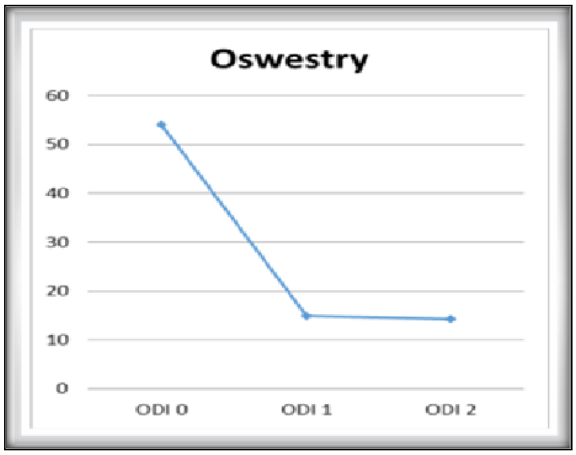
When conservative management fails to achieve satisfactory symptom relief, surgical intervention becomes necessary to address spinal instability and mitigate neurological compromise. The importance of surgical management in degenerative spondylolisthesis has been well documented in the literature.[2-4] While decompression alone has shown favorable outcomes in select cases, spinal fusion remains a cornerstone in the surgical treatment of this condition. Posterior stabilization and fusion techniques are among the most frequently employed surgical modalities for spondylolisthesis.[5-7]

Evaluating the long-term functional outcomes of these surgical procedures is essential for determining the durability and sustained benefits of posterior stabilization and fusion. Such studies contribute valuable insights into the comparative advantages and limitations of these techniques relative to other surgical options. Furthermore, assessing functional outcomes enables the identification and analysis of postoperative complications, which is critical for refining surgical strategies, reducing complication rates, and enhancing overall patient safety.

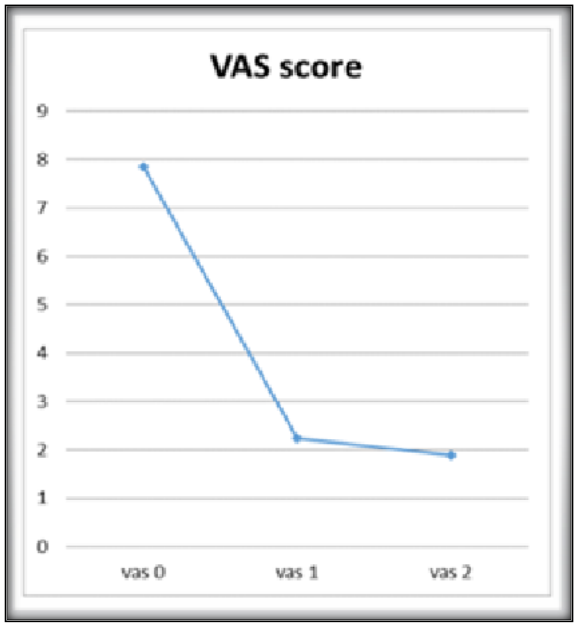
The present study aims to evaluate the functional outcomes of patients undergoing surgical management of spondylolisthesis with posterior stabilization, thereby contributing to the existing body of evidence on the efficacy and safety of these interventions.

MATERIALS AND METHODS

This descriptive study was conducted on 30 patients who underwent surgical treatment for spondylolisthesis with posterior transpedicular screw fixation with conventional or reduction screws and fusion. The patients included in the study were based on following inclusion and Exclusion criteria.



Graph 1: Improvement in Oswestry disability index



Graph 2: Improvement in visual analog scale score

Inclusion Criteria

The following criteria were included in the study:

1. All the spondylolisthesis patients aged above 35 years undergoing posterior surgical fixation with instrumentation and fusion with bone grafting during the period of study in our hospital.

Exclusion Criteria

The following criteria were excluded from the study:

1. Patients with any other spinal pathologies.
2. Patients who have had earlier surgeries on their spine.
3. Patients who did not have a regular follow-up for a period of minimum 6 months.
4. Patient details, including demographic information, pre-operative symptoms, radiographic data, surgical details, and follow-up assessments, were recorded. All the patients had the routine blood investigations done that are required for surgery. They all had X-rays of the lumbosacral spine – anteroposterior, lateral, oblique as well as the flexion and extension views. All the patients had an MRI of the spine. All the patients had undergone posterior decompression with fusion and bone grafting.

Figure 1: PRE-OP X-RAY

Figure 2: PRE-OP MRI

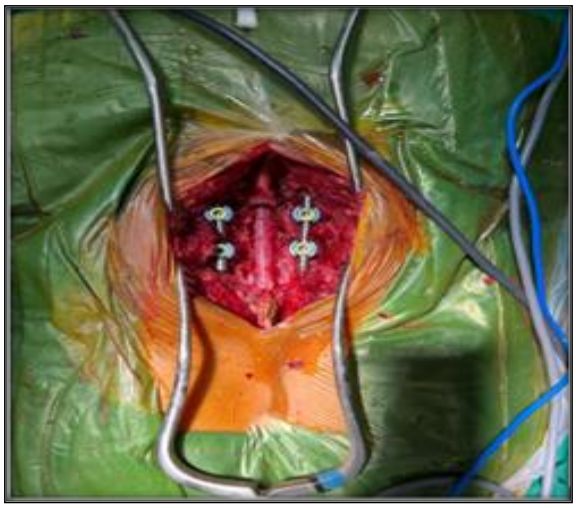


Figure 3: INTRA-OP

Figure 4: POST-OP

Analysis of results

The results of the surgical procedures were analyzed based on improvement in Japanese Orthopaedic Association (JOA) Score and Meyerding's grade of listhesis.

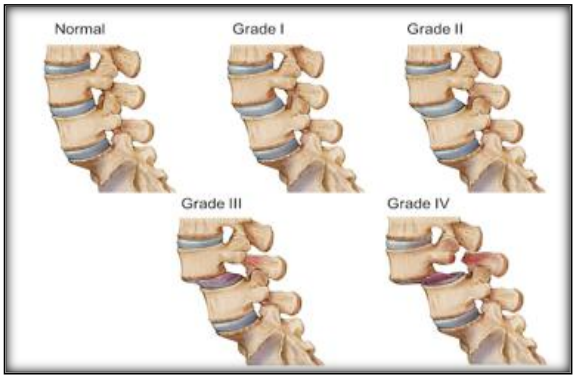


Figure 5: MEYERDING'S GRADE

Table 1

Meyerding classification	Percentage of slip
Grade I	0-25
Grade II	25-50
Grade III	50-75
Grade IV	75-100
Grade V	>100 (Spondyloptosis)

Table 2

Criterion	Points
Motor Function	1
Upper extremity	
Fine motor function massively decreased	2
Fine motor function decelerated	3
Discreet weakness in hands or proximal arm	4
Normal function	5
Motor Function	
Unable to walk	1
Lower extremity	
Need walking aid on flat floor	2
Need handrail on stairs	3
Able to walk without walking aid, but inadequate	4
Normal function	5
Sensory	
Upper extremity/ lower extremity/ trunk	
Apparent sensory loss	1
Minimal sensory loss	2
Normal Function	3
Bladder Funcion	

Urinary retention	1
Servere dysfunction	2
Mild dysfunction	3
Normal Function	4
Total score	0-17

The lower the score the more severe the deficits. Normal function 16+17, Grade 1:12-15, Grade 2: 8-11, Grade 3: 0-7. Weight of the criterion in percentage of 17 Points: upper extremity 23.5%; Lower extremity 23.5%: sensory 3x11.8% (total: 35.4%); bladder and bowel function 17.6%

Japanese Orthopaedic Association (JOA) Score

The results of JOA score were classified as having achieved clinical success or not. They were mainly assessed for low back pain, leg pain, gait, Straight leg raising test, motor, and sensory disturbances. Patients who had JOA score of more than 12 out of 15 were classified as having achieved clinical success. Neurological outcomes were noted in all patients. Pre-operative and post-operative scores were compared to evaluate the effectiveness of the surgical intervention. The disability index was scored for individual patients using an Oswestry Disability Index (ODI) Assessment Questionnaire. The patient's pain perception was noted on visual analog scale (VAS) and numerical rating scale (NRS) scores, and the degree of pain relief was assessed by the PRR score. VAS is a 10 cm scale (scored as "10" = worst pain imaginable and "0" = no pain), NRS has endpoints "0" (no pain), and "10" (worst pain imaginable). Pain Relief Rate: "< 25%" = unrelieved, "25–49%" = mere relief, "50–74%" = moderate relief, "75–99%" = significant relief, and "100%" = complete relief) was also assessed. VAS score, NRS score, and ODI score were assessed preoperatively, 3 months, and 12 months postoperatively, and PRR was assessed at 3 months and 12 months postoperatively.

Table 3: Pre-operative and post operative VAS, NRS-11, ODI, and PRR scores.

Score	Visit 0	Visit 1	Visit 2
VAS	7.86±0.7	1.86 ±0.9	1.4±0.7
NRS	7.80±0.8	1.74 ± 0.9	1.44 ±0.7
ODI	54±5.4	11.76 ±6.4	10.64 ±4.96
PRR	-	80.1±12.27	84.0±10.4

VAS: Visual analog scale. NRS: Numerical rating scale, ODI: Oswestry disability index

Surgical procedure: Under general anaesthesia, the patient was positioned prone on a spinal frame with intraoperative fluoroscopic (C-arm) guidance. A standard posterior midline incision was made, followed by subperiosteal dissection to expose the paraspinal musculature up to the lateral margins of the transverse processes. When indicated, extensive decompression and laminectomy were performed at single or multiple levels, with meticulous care to avoid injury to the underlying dura and nerve roots. Each affected nerve root was identified and adequately decompressed, including osteotomy of the facet joints as necessary.

Under direct visualization and C-arm guidance, the pedicles of the vertebrae were localized. A small awl was used to create a pilot tract through each pedicle into the vertebral body. Pedicle screws were then inserted, ensuring that the screws remained perpendicular to the longitudinal axis of the spine to achieve optimal biomechanical stability. Remaining pedicles were instrumented in a similar fashion, with screw placement verified under fluoroscopy.

Particular attention was given to sacral fixation. The first sacral pedicle was identified just caudal to the superior sacral facet, and the S1 screw was placed accordingly. The S2 pedicle screw was inserted at an approximate 45° lateral inclination into the sacral ala to achieve secure anchorage.

Mass Miami rods were contoured to restore physiological lumbar lordosis. Prior to rod placement, autologous bone graft was applied over the decorticated transverse processes, pedicles, and facet joints to promote fusion. The rods were then seated into the pedicle screws and secured with posterior tapered nuts, which were further tightened using a wrench to ensure rigid construct stability. The surgical wound was closed in layers over a suction drain.

The average operative duration was approximately 3 hours. Postoperatively, antibiotic prophylaxis was continued. Patients were maintained in a supine position with adequate analgesia for the first 48 hours. The drain was typically removed on postoperative day 2. Intravenous antibiotics were administered for three days, followed by oral antibiotics for an additional three days. Patients were encouraged to sit and ambulate starting the first postoperative day, without the need for external bracing. Routine dressing changes were performed, and sutures were removed on day 14. Upon discharge, patients were advised to avoid heavy lifting and strenuous activities for at least six months.

Table 4: Meyerding classification of spondylolisthesis in study population

Meyerding classification	Normal	Grade I	Grade II	Grade III
Pre-operative	-	2(6%)	8(27%)	20(67%)
Post-operative	13(43%)	12(40%)	5(17%)	-

RESULTS

This study encompassed 30 patients, comprising 22 females (73%) and 8 males (27%). The patients' ages ranged from 35 to 65 years, with a mean age at the time of surgery of 56.13 ± 6.02 years. The duration of symptoms prior to intervention spanned from 1 month to 10 years, with a mean duration of 25.7 months.

Occupationally, the majority of patients were housewives, followed by individuals engaged in heavy manual labor. All patients presented with complaints of low back pain. Additional clinical manifestations included radicular pain in 20 patients (67%), an antalgic gait or limp in 18 patients (60%), sensory disturbances such as numbness in 13 patients (43%), motor weakness in 10 patients (33%), and bladder or bowel dysfunction in 2 patients (6%).

Prior to surgical management, most patients had received conservative treatment modalities. The predominant intervention consisted of nonsteroidal anti-inflammatory drugs (NSAIDs), supplemented by periods of hospitalization involving bed rest, skeletal traction, and structured physiotherapy.

Pre-operative observations

The predominant site of spondylolisthesis among patients in this cohort was the L5-S1 level (70%), followed by the L4-L5 level (30%). Degenerative spondylolisthesis accounted for 80% of cases. Clinical examination revealed that all patients exhibited paraspinal muscle spasm, with 26 patients (87%) demonstrating spinal tenderness. Additional findings included scoliosis in 27%, kyphosis in 20%, transverse furrow in 13%, and a palpable vertebral step in 70% of cases. All patients experienced restricted spinal mobility.

Motor deficits were present in 23 patients, with an almost equal distribution between the left and right lower limbs. Sensory deficits were identified in 24 patients, with involvement of the L5 (36%), L4/L5 (23%), L5/S1 (6%), S1 (6%), and L4 (6%) dermatomes. Eleven patients presented with diminished ankle reflexes. Universally, patients tested positive on the straight leg raise, bowstring, and Lasegue tests.

According to Meyerding's classification, 20 patients (67%) had Grade III, 8 (27%) had Grade II, and 2 (6%) had Grade I spondylolisthesis. The average duration of follow-up was 12 months. Preoperatively, the mean Japanese Orthopaedic Association (JOA) score was 7.65 (range 6–9). Notably, there was significant improvement in functional outcomes following surgical intervention.

Post-operative Observations

Following surgical intervention, there was a marked improvement in the Meyerding grade of spondylolisthesis among patients. Thirteen individuals (43%) demonstrated complete normalization, while twelve (40%) were classified as Grade I and five (17%) as Grade II; notably, no patients remained in Grade III (see Table 2). The mean Japanese Orthopaedic Association (JOA) score improved from a preoperative range of 6–9 to a postoperative range of 7–15, with an average score of 13.11. Additionally, the mean preoperative Oswestry Disability Index (ODI) score decreased significantly from 54 ± 5.4 to 10.64 ± 4.96 at final follow-up ($P < 0.001$; see Table 1 and Figure 1). Visual Analog Scale (VAS) pain scores were reduced from a preoperative mean of 7.86 ± 0.7 to 1.4 ± 0.7 postoperatively ($P < 0.001$; see Table 1 and Figure 2), while Numeric Rating Scale (NRS-11) pain scores improved from 7.80 ± 0.8 to 1.44 ± 0.7 ($P < 0.001$). The overall pain relief rate showed substantial improvement, with scores of 80.1 ± 12.27 and 84.0 ± 10.4, respectively. Figure 3 presents an illustrative case of Grade 2 degenerative spondylolisthesis treated with transforaminal lumbar interbody fusion and pedicle screw stabilization.

At the final follow-up, eight patients reported residual low back pain, four experienced radiculopathy, and three continued to have a limp. Complete motor recovery was achieved in thirteen patients, while eight exhibited partial improvement. Three patients maintained their baseline motor function, and one patient experienced deterioration. Sensory function was fully restored in fourteen patients, with an additional six exhibiting residual sensory blunting. Overall, twenty-six patients (80.7%) achieved both clinically and radiologically successful outcomes, including spinal fusion, whereas four did not meet these criteria. The mean time to bony fusion was 5.58 months, with fusion observed as early as four months and as late as twelve months postoperatively.

Complications

Complications were observed in 4 out of 30 patients (13.3%) in this study. Intraoperative complications included one case of screw slippage and one case of dural tear. Postoperatively, three patients developed deep infections, while one patient experienced a superficial infection.

DISCUSSION

Spondylolisthesis is a spinal disorder characterized by significant pain and disability, often restricting patients' daily activities and overall quality of life. When conservative treatments fail to achieve adequate symptom relief, surgical intervention becomes necessary. The primary objective of this study was to evaluate the functional outcomes of surgical management of spondylolisthesis utilizing posterior stabilization and fusion techniques.

Epidemiological studies estimate the prevalence of spondylolisthesis at approximately 6% in adults, with 25% of affected individuals experiencing significant back pain during their lifetime. Consistent with these findings, nearly all patients in this study reported back pain, with 20 experiencing severe and intolerable symptoms.

Meyerding's classification was employed to grade spondylolisthesis severity, which is determined by the degree of vertebral slippage visualized on radiographs. The classification is as follows: less than 25% slippage (Grade I), 26–50% (Grade II), 51–75% (Grade III), 76–100% (Grade IV), and over 100% (Grade V). Notably, no patients in this series exhibited more than 75% slippage. Typically, Grades I and II are managed conservatively, whereas Grades III–V are considered candidates for surgical intervention. However, previous studies by Harris and Weinstein as well as Lundine et al. have demonstrated no significant difference in outcomes between surgical and conservative management for patients with Grades III–V spondylolisthesis.

Zdeblick's prospective study of 124 patients undergoing lumbar fusion for degenerative disorders reported an overall fusion rate of 86% with rigid instrumentation, compared to 65% with non-instrumented fusion. Furthermore, rigid instrumentation was associated with a higher rate of good-to-excellent outcomes (95% vs. 71%) and a lower rate of revision surgery (0% vs. 8%). These findings support the use of rigid pedicle screw fixation in patients requiring fusion for degenerative spondylolisthesis.

The results of the present study align with previous literature, demonstrating that surgical intervention employing posterior stabilization and fusion yields favorable functional outcomes, with significant improvements in pain, disability, and quality of life measures. Mochida et al. also reported a high success rate for bony fusion (91%) and a 40% reduction in vertebral slippage with instrumentation in patients with single-level degenerative spondylolisthesis. In the present series, the fusion rate was 80%, with an 80% overall clinical success rate.

The choice of posterior stabilization and fusion in this study is justified by its capacity to restore segmental spinal stability. The use of pedicle screw fixation combined with interbody fusion facilitates spinal alignment, neural decompression, pain reduction, and functional improvement.

Several factors influencing surgical outcomes were considered, including the anatomical level of spondylolisthesis. The distribution of cases, with the majority at L5–S1 (isthmic type) and L4–L5 (degenerative type), corroborates established patterns reported in the literature, such as those found in the study by Elmorsy et al.

It is important to acknowledge the limitations of this study. The small sample size and retrospective design restrict the strength of the conclusions. Additionally, the absence of a comparison group limits the ability to directly contrast outcomes with alternative surgical or nonsurgical interventions. While significant improvements were observed in functional outcomes, potential complications of surgical management—including infection, hardware failure, adjacent segment degeneration, and persistent or recurrent symptoms—should be carefully considered. Future long-term, prospective studies with larger cohorts are warranted to clarify the durability of surgical outcomes and to further evaluate the incidence and management of complications.

Recent evidence supports the efficacy of transforaminal lumbar interbody fusion (TLIF) in achieving successful fusion in patients with spondylolisthesis. Posterior decompression and spinal fusion have also been validated as effective strategies in the management of lumbosacral listhesis.

CONCLUSION

The outcomes of this study reinforce the efficacy of surgical management employing posterior stabilization and fusion for patients with spondylolisthesis. Marked improvements in functional status, pain control, and quality of life underscore the value of this surgical strategy. Nevertheless, further research is warranted—particularly well-designed, prospective studies with larger cohorts and extended follow-up—to validate these findings and inform optimal management. Long-term evaluation of treatment durability and complication rates will be essential in refining patient care strategies for spondylolisthesis.

Clinical Message: These findings further substantiate the beneficial functional outcomes associated with surgical intervention utilizing posterior stabilization and fusion for spondylolisthesis, underscoring its value as a viable treatment modality to improve patient quality of life and mitigate symptom burden.

REFERENCES

1. Wang YX, Zoltán K, Deng M, Leung JC. Lumbar degenerative spondylolisthesis epidemiology: A systematic review with a focus on gender-specific and age-specific prevalence. J Orthop Translat 2017;11:39-52. [Google Scholar]
2. Weinstein JN, Lurie JD, Tosteson TD, Hanscom B, Tosteson AN, Blood EA, et al. Surgical versus nonsurgical treatment for lumbar degenerative spondylolisthesis. N Engl J Med 2007;356:2257-70. [Google Scholar]
3. Eismont FJ, Norton RP, Hirsch BP. Surgical management of lumbar degenerative spondylolisthesis. J Am Acad Orthop Surg 2014;22:203-13. [Google Scholar]
4. Inui T, Murakami M, Nagao N, Miyazaki K, Matsuda K, Tominaga Y, et al. Lumbar degenerative spondylolisthesis: Changes in surgical indications and comparison of instrumented fusion with two surgical decompression procedures. Spine 2017;42:E15-24. [Google Scholar]
5. Matz PG, Meagher RJ, Lamer T, Tontz WL Jr., Annaswamy TM, Cassidy RC, et al. Guideline summary review: An evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spondylolisthesis. Spine J 2016;16:439-48. [Google Scholar]
6. Herkowitz HN. Spine update. Degenerative lumbar spondylolisthesis. Spine (Phila Pa 1976) 1995;20:1084-90. [Google Scholar]
7. Ghogawala Z, Dziura J, Butler WE, Dai F, Terrin N, Magge SN, et al. Laminectomy plus fusion versus laminectomy alone for lumbar spondylolisthesis. N Engl J Med 2016;374:1424-34. [Google Scholar]
8. Fredrickson BE, Baker D, McHolick WJ, Yuan HA, Lubicky JP. The natural history of spondylolysis and spondylolisthesis. J Bone Joint Surg Am 1984;66:699-707. [Google Scholar]

9. Virta L, Ro¨nnemaa T, Osterman K, Aalto T, Laakso M. Prevalence of isthmic lumbar spondylolisthesis in middle-aged subjects from eastern and western Finland. J Clin Epidemiol 1992;45:917-22. [Google Scholar]
10. Meyerding HW. Low backache and sciatic pain associated with spondylolisthesis and protruded intervertebral disc: Incidence, significant, and treatment. J Bone Jt Surg 1941;23:461-70. [Google Scholar]
11. Harris IE, Weinstein SL. Long-term follow-up of patients with grade III and IV spondylolisthesis. Treatment with and without posterior fusion. J Bone Jt Surg 1987;69:960-9. [Google Scholar]
12. Lundine KM, Lewis SJ, Al-Aubaidi Z, Alman B, Howard AW. Patient outcomes in the operative and nonoperative management of high-grade spondylolisthesis in children. J Pediatr Orthop 2014;34:483-9. [Google Scholar]
13. Zdeblick TA. A prospective, randomised study of lumbar fusion-priliminary results. Spine 1993;18:983-91. [Google Scholar]
14. Simmons EH, Capicotto WN. Posterior transpediculate instrumentation of the lumbar spine. Clin Orthop Relat Res 1988;236:180-91. [Google Scholar]
15. Mochida J, Suzuki K, Chiba M. How to stabilize a single level lesion of degenerative lumbar spondylolisthesis. Clin Orthop Relat Res 1999;368:126-34. [Google Scholar]
16. Elmorsy SE, Abulnasr HA, Hassan Y, Samra M, Eissa EM. Functional outcome of surgical management of low mid-grade lumbar spondylolisthesis when considering the sagittal balance parameters preoperatively: A prospective study. Chin Neurosurg J 2022;8:35. [Google Scholar]
17. Jambukeswaran PS, Somasundaram AK, Jeyaraman M. Does functional outcome mandate fusion in spondylolisthesis management? A retrospective analysis of 76 cases with one year follow-up. Indian J Orthop Surg 2021;7:1-8. [Google Scholar]
18. Angachekar D, Deshpande S, Gudhe M, Samal N, Khan S, Gupta S. Clinical and functional outcome analysis of posterior decompression and spinal fusion surgery in the management of lumbar and sacral listhesis: A prospective cohort study. J Datta Meghe Inst Med Sci Univ 2020;15:407-13. [Google Scholar]
19. Omidi-Kashani F, Hassankhani EG, Shiravani R, Mirkazemi M. Surgical outcome of reduction and instrumented fusion in lumbar degenerative spondylolisthesis. Iran J Med Sci 2016;41:13-8. [Google Scholar]