

Lumbar Posterolateral Fusion With or Without Posterior Interbody Fusion in Degenerative Spondylolisthesis: Prognostic Factors and Clinical Outcome

MOHAMED EL HAWARY, M.D. and HANY EL NEMR, M.D.

The Department of Neurosurgery, Faculty of Medicine, Benha University

Abstract

Background: Spondylolisthesis primarily results from the gradual misalignment of vertebral bodies, particularly in the lumbar region. Degenerative and isthmic variants constitute approximately 90% of these vertebral displacements. This condition is prevalent in 20.7% of individuals aged 40 to 80 years, though only a subset of symptomatic patients necessitates surgical intervention. The preferred surgical approach for managing degenerative spondylolisthesis (DS) continues to be contentious. Typically, a strategy involving decompression along with posterolateral fusion (PLF), optionally complemented by lumbar interbody fusion, is widely adopted.

Aim of Study: This retrospective analysis was conducted to evaluate and contrast the outcomes between patients who underwent isolated PLF and those who received a combination of posterolateral fusion with interbody fusion (PLF + PLIF) for the management of degenerative spondylolisthesis.

Patients and Methods: The study was conducted over a period of 36 months from August 2020 to August 2023 on 58 patients having single level degenerative lumbar spondylolisthesis whom were operated in neurosurgery department in Banha University for decompression and posterolateral fusion with or without posterior interbody fusion.

Results: While individuals undergoing PLF displayed a more pronounced postoperative recovery in conditions such as radiculopathy, bowel/bladder dysfunction, sensory anomalies, motor impairments, and back pain when compared to their counterparts receiving PLF + PLIF, these variations failed to reach a level of statistical significance. Nonetheless, the frequency of pseudoarthrosis/instrumentation failure and the necessity for subsequent surgical interventions were significantly elevated within the PLF cohort. Radicular and neurological outcomes were statistically comparable between the two cohorts.

Conclusion: In cases of low-grade degenerative spondylolisthesis, posterolateral fusion tends to yield superior clinical outcomes; however, posterior lumbar interbody fusion offers a more reliable approach for sustaining alignment correction and achieving successful union. Thus, meticulous patient selection is critical for determining the appropriate surgical intervention.

Key Words: Spondylolisthesis – Lumbar interbody fusion – Posterolateral fusion.

Introduction

THE choice of surgical intervention for DS remains a subject of considerable debate. While simple posterior decompression initially offers favorable results, symptoms often reemerge over time. Consequently, a consensus has emerged among many experts advocating for the necessity of PLF to achieve more enduring outcomes.

In a 3-year prospective study involving 50 patients, Herkowitz and Kurz demonstrated that the addition of posterolateral intertransverse fusion yielded superior clinical outcomes compared to standalone laminectomy [1].

The introduction of pedicular screws has been associated with enhanced clinical outcomes. Bridwell et al., conducted a 2-year follow-up study of 44 patients with DS and reported that the use of pedicular screws not only improved the fusion rate but also resulted in better clinical outcomes. However, other researchers have observed that, despite the increased fusion rate and the benefit of early mobilization, there was no significant improvement in clinical results [2].

The recent development of PLIF, featuring an integrated containment system, represents a notable enhancement in spinal surgery techniques. The strategic application of autogenous bone grafts along-

Correspondence to: Dr. Mohamed El Hawary, The Department of Neurosurgery, Faculty of Medicine, Benha University

side pedicular screw fixation and PLF to reinforce the anterior column via PLIF has proven to elevate fusion rates and improve clinical results, especially in instances of isthmic spondylolisthesis.

Madan and Boeree [3] noted that PLF yielded superior clinical outcomes for individuals with low-grade isthmic spondylolisthesis [7], whereas PLIF was more effective in sustaining correction and achieving successful union. The purpose of this study was to investigate the effects of integrating PLIF into surgical procedures for DS [8,9].

Patients and Methods

In this retrospective analysis, 58 patients diagnosed with lumbar spondylolisthesis underwent surgical intervention in the Neurosurgery Department at Banha University over a period of 36 months from August 2020 to August 2023, receiving either posterolateral fusion alone or a combination of posterolateral fusion with interbody fusion. The inclusion criteria were degenerative spondylolisthesis on a single level, grade one or two and at any level, low back pain with or without sciatica, and age 35 to 60 years. The exclusion criteria were previous spine surgery, history of trauma and drug abuse.

All patients underwent evaluation using dynamic X-rays and MRI to document instability and nerve root compression. The study compared 32 patients who received combined PLF + PLIF with 26 patients who underwent PLF alone.

The PLIF technique involved the meticulous clearing of the disc space using shavers, followed by the insertion of a carbon lumbar cage into the prepared disc space. Autologous bone graft, harvested from the excised loose lamina, was strategically placed both between and lateral to the cage. Additionally, all patients underwent posterolateral fusion utilizing laminar bone grafts. The PLIF procedures were consistently performed at the specific level of vertebral slippage. The first group, comprising 26 patients, was treated with PLF using pedicle screws combined with posterolateral bone grafting. The second group, consisting of 32 patients, received PLIF with pedicle screws, interbody fusion using a cage, and bone grafting.

A single-level PLF was performed in every case. Within the PLF group, decompressive laminectomy and nerve root release were conducted in all patients presenting with sciatica (73%). No decompression was carried out in patients without sciatica. Conversely, in the PLIF group, decompression was inherent to the procedure, involving the removal of the loose lamina and nerve root release, following the same technique applied in the PLF group. In a previous report from our study, we observed that outcomes were comparable between the groups, regardless of the inclusion of interbody fusion.

Every patient underwent comprehensive evaluations concerning functional disability, pain, and occupational status before initiating treatment, followed by subsequent assessments at one-year and two-year intervals during outpatient visits. To maintain impartiality, these evaluations at the two-year follow-up were conducted by an independent observer.

Surgical technique: The PLF technique utilized a midline subperiosteal approach, incorporating the excision of loose fragments, laminectomy, medial facetectomy, and foraminotomy. Following adequate decompression, a graft bed was established via subperiosteal dissection between the transverse processes and lateral facets. Bone autograft was then placed into this prepared space subsequent to stabilization with pedicle screws and rods. In the PLIF group, this protocol was extended to include additional steps: bilateral incisions over the disc and retraction of nerve roots. The end plates were meticulously curetted to the bleeding cancellous bone, and the disc nucleus was entirely removed. A carbon cage, positioned next to the autologous cancellous bone harvested during the laminectomy, was implanted within the disc space. The remainder of the procedure mirrored the steps detailed for the PLF group.

Postoperative care: All patients underwent clinical evaluation immediately after recovering from anesthesia, with assessments conducted daily until discharge. Follow-up evaluations were then carried out at 1, 3 and 6-months post-discharge, and subsequently on an annual basis for two years. During each follow-up visit, plain radiographs were obtained to evaluate the positioning of the cage and spinal alignment. Additionally, patients were clinically examined during each visit for pain, motor function, sphincter control, and the presence of any new symptoms.

Radiologic evaluation: Union was categorized as solid when there was evidence of continuous bony trabeculae and movement between segments remained below 4° on flexion-extension radiographs. Conversely, nonunion was identified by the presence of visible defects, graft collapse, or segmental movement surpassing 4°.

Results

The analysis included data from 58 surgically treated spondylolisthesis cases, which were categorized into two groups. The first group comprised 26 patients who underwent PLF with pedicle screw fixation and posterolateral bone grafting. The second group included 32 patients who received PLIF, incorporating pedicle screws, interbody fusion with a cage, and bone grafting.

An evaluation of the 2 groups and their comparison was concluded.

Table (1): Comparison of patients groups as regard mean age.

	Group A (n=26)	Group B (n=32)
Mean age (years)	49 years	45 years

This table shows that group A had higher mean age than group B which means interbody fusion was used more in younger patients.

In Group A, patient ages ranged from 38 to 60 years. In Group B, the age range was between 35 and 55 years.

Table (2): Comparison of patients groups as regard sex.

	Group A		Group B	
	N	%	N	%
Male	15	58	13	40
Female	11	42	19	60

The data indicates that there were 30 female and 28 male cases. Additionally, 58% of the participants in Group A were male, while 60% of those in Group B were female.

This indicates that the necessity for interbody fusion with a lumbar cage and bone graft was more prevalent among females, likely due to factors such as generalized joint laxity influenced by hormonal variations, weakened back muscles, and obesity [4].

Table (3): Clinical presentation among the two groups.

Clinical findings	Group A		Group B	
	N	%	N	%
Low Back pain	19	73%	28	88%
Sciatica	15	58%	23	70%
Numbness	13	50%	16	50%
Motor weakness	3	12%	2	6%

- The majority of cases in both groups presented with low back pain and sciatica.
- Group B exhibited a greater proportion of cases manifesting sciatica, at 70%, in contrast to 58% within Group A.

Postoperative improvement:

The number of patients experiencing postoperative symptoms in the PLF group showed a statistically significant reduction when compared to their preoperative status, with marked decreases in back pain (73% to 8%), radiculopathy (58% to 15%), and sensory deficits (50% to 12%). Although there

was a postoperative reduction in motor weakness, the change was not statistically significant (12% to 9%). Similarly, in the PLF + PLIF group, there was a statistically significant decrease in the number of patients with postoperative back pain (88% to 6%) and radiculopathy (70% to 22%) (Table 4). Although reductions in sensory deficits and motor weakness were noted, these changes did not achieve statistical significance. Comparative analysis between the two groups revealed no statistically significant difference in the proportion of patients reporting symptomatic improvement postoperatively. In the PLF group, 65% of patients reported alleviation of back pain, while 81% of those in the PLIF group experienced comparable relief. Regarding radiculopathy, 42% of patients in the non-interbody fusion group reported symptomatic improvement, as opposed to 50% in the interbody fusion group.

Our analysis of surgical outcomes revealed that the reoperation rate for degenerative disease was statistically significantly higher after PLF compared to PLIF. Specifically, pseudoarthrosis and instrumentation failure were notably more prevalent following PLF, warranting a higher rate of reoperations. When comparing the two groups, the proportion of patients experiencing postoperative symptomatic improvement in the PLF group did not statistically differ from that in the PLF + PLIF group.

Table (4): Comparison of post-operative improvement among both groups.

Post-operative complaint	Group A		Group B	
	N	%	N	%
Low back pain	2	8%	2	6%
Sciatica	4	16%	7	22%
Numbness	3	12%	2	6%
Motor weakness	1	4%	1	3%

Postoperative fusion:

Postoperatively, the rates of fusion were 92% in group A and 100% in group B. This means better fusion rates with using of interbody fusion.

Case no. (1):

A 40-year-old woman presented with a 5-month history of low back pain accompanied by bilateral lower limb pain, with the right side being more affected. Neurological examination showed full motor power with normotonia of both lower limbs. Positive SLRT on right lower limb at 35 degrees with parasthesia in both lower limbs. MRI images (Fig. 3) showed L4-5 degenerative spondylolisthesis with right para central ruptured disc at level of L 4-5 and posterior approach for lumbar discectomy and fusion with transpedicular screws with posterolateral bone graft were achieved. She showed an early improvement of the symptoms and signs.

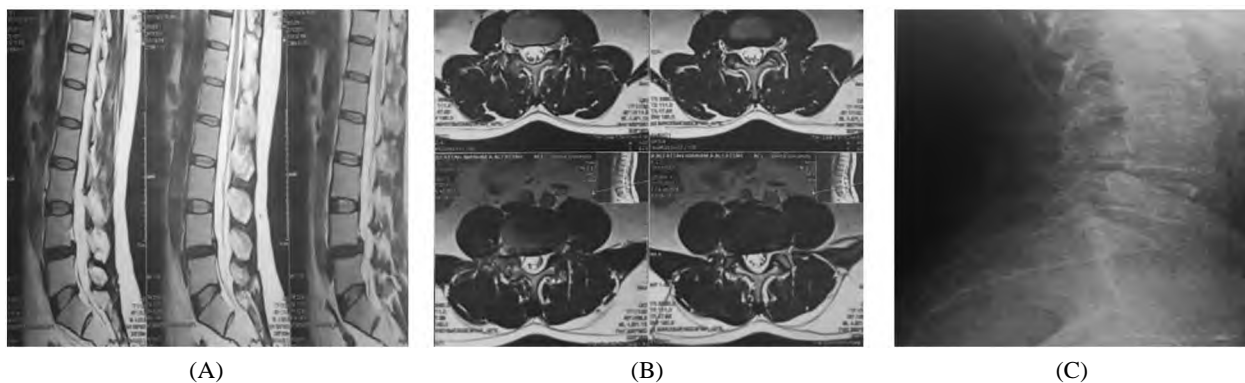


Fig. (1): Case (1): MRI lumbar spine sagittal (A) and Axial (B) Views showing L4-5 degenerative spondylolisthesis with right para central ruptured disc at level of L 4-5, and preoperative X-ray lateral view (C).

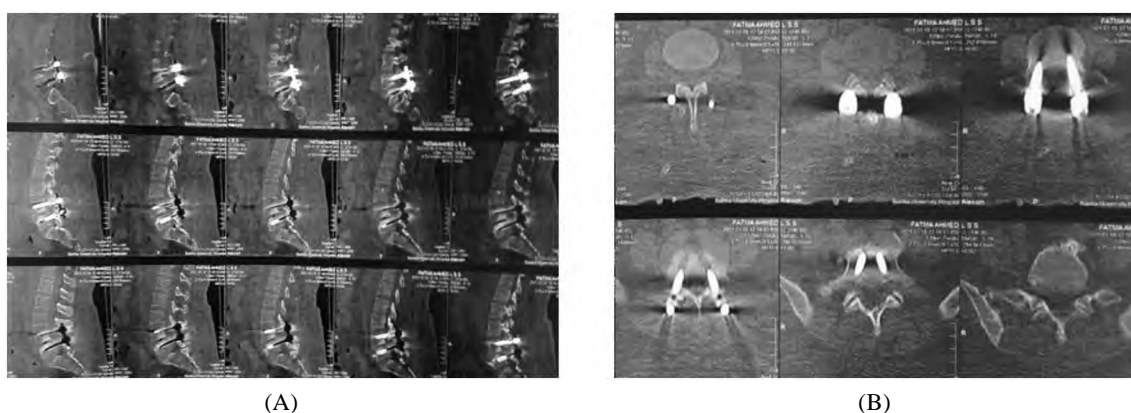


Fig. (2): Case (1): Postoperative CT lumbosacral spine showing transpedicular fixation by screws with posterolateral bony fusion sagittal view (A) Axial view (B).

Case no. (2):

A 45 years old woman suffered from severe low back pain with bilateral lower limbs claudications and numbness. Neurological examination showed paresthesia in both lower limbs with sever tenderness on lumbar spine. MRI images (Fig. 5) showed

L4-5 degenerative spondylolisthesis with canal stenosis and posterior approach for laminectomy ,discectomy and fusion with transpedicular screws and interbody fusion by lumbar cage and bone graft.

She showed excellent improvement of the back pain and claudications after the surgery.

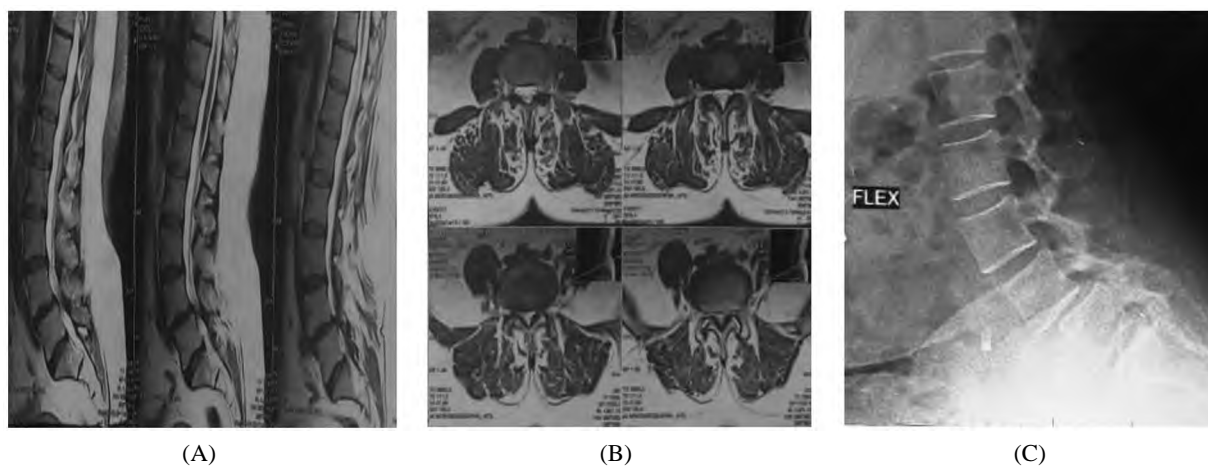


Fig. (3): MRI lumbar spine sagittal (a) and axial (b) views showing L4-5 degenerative spondylolisthesis with spinal canal stenosis at level of L 4-5, and preoperative X-ray lateral view (c).

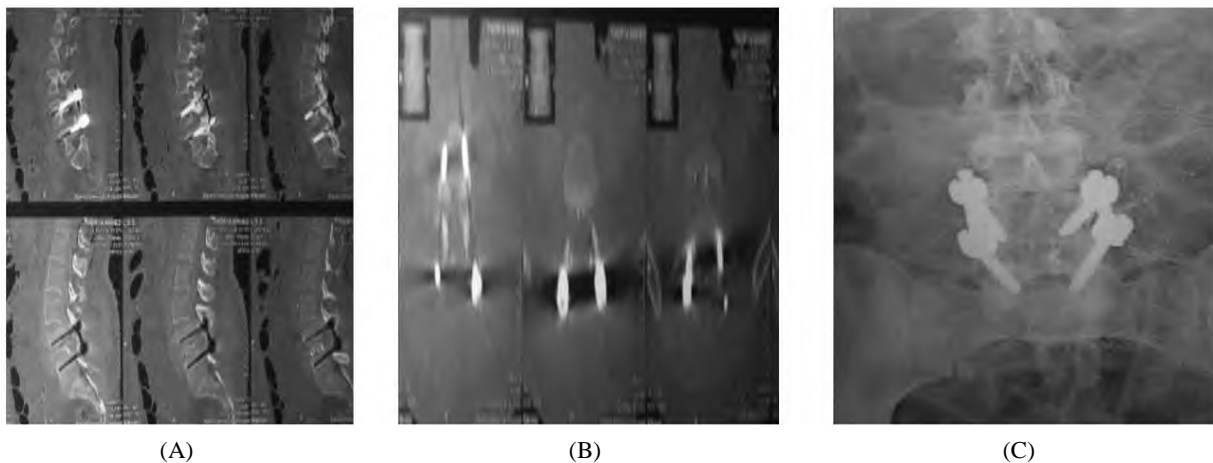


Fig. (4): Case (2): Postoperative CT lumbosacral spine showing transpedicular fixation by screws with interbody fusion with lumbar cage and bone graft sagittal view (A) Axial view (B) Postoperative lumbar X-ray anteroposterior view (C).

Discussion

Patients with a lumbar motion segment causing persistent pain, unresponsive to conservative treatment, may derive significant relief from lumbar spinal fusion. The decision between opting for posterolateral fusion versus posterior interbody fusion is contingent upon a multitude of factors. Each approach offers distinct benefits and drawbacks, necessitating a careful assessment of the patient's unique clinical profile to determine the most suitable surgical strategy. The landscape of spinal fusion is continuously advancing with innovations in instrumentation, minimally invasive techniques, and interbody grafting options. Further research is essential to ascertain whether the advantages of more invasive or costlier techniques justify their inherent risks and potential downsides.

In our study, Group A exhibited a higher mean age compared to Group B, indicating that interbody fusion was more frequently employed in the younger patient cohort.

In Group A, the patient age range spanned from 38 to 60 years, while in Group B, it ranged from 35 to 55 years. The study cohort comprised 30 females and 28 males. Notably, Group A had a predominance of male patients, accounting for 58% of the cases, whereas Group B was predominantly female, with 60% of the cases being women.

This suggests that the demand for interbody fusion with lumbar cage and bone graft was notably higher in female patients, potentially attributable to factors such as generalized joint laxity influenced by hormonal variations, weakened paraspinal musculature, and obesity, which may serve as contributing risk factors. These findings are consistent with those reported by Jacobsen et al. [14]. This study revealed a statistically significant diminution in postoperative symptoms within the PLF group relative to their

preoperative condition, with marked improvements observed in back pain (73% vs 8%), radiculopathy (58% vs 15%), and sensory deficits (50% vs 12%) [10,11].

In our study, a statistically significant reduction in postoperative symptoms was observed in the PLF + PLIF group when compared to their preoperative status, particularly with respect to back pain (88% vs 6%) and radiculopathy (70% vs 22%).

Videbaek et al. [5] documented those individuals undergoing interbody fusion experienced a statistically significant alleviation of back pain in contrast to those in the PLF group; however, the variations in leg pain between the two cohorts did not attain statistical significance [12].

In our study, the rates of fusion were 92% in group A and 100% in group B. This means better fusion rates with using of interbody fusion.

Suk et al. [6] identified an association between the use of pedicle screws in posterolateral fusion and the occurrence of graft-bending nonunion, leading to a loss of correction [13]. The present study similarly underscores the critical role of PLIF in fortifying the anterior column, thereby achieving both successful fusion and adequate correction. Consistent with Suk et al.'s findings, this investigation also documented a 100% fusion rate within the PLIF (circumferential fusion) group [14].

Conclusion:

Radiographic analysis demonstrated a statistically significant enhancement in spondylolisthesis correction following interbody fusion. Despite this, patients treated with PLF alone exhibited higher rates of postoperative clinical improvement. Additionally, interbody fusion was statistically associated with a significantly lower rate of reoperation due to the progression of degenerative disease.

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الانصهار الخلفي القطنى مع أو بدون الانصهار الداخلى الخلفى فى الانزلاق الفقارى التنكسية: العوامل النذيرية والنتائج السريرية

النهج الجراحى الذى يجب استخدامه لعلاج الانزلاق الفقارى التنكسية هو قضية مثيرة للجدل. تخفيف الضغط الخلفى البسيط له نتيجة فورية جيدة، ولكن الأعراض تتكرر فى كثير من الأحيان فى غضون عدة سنوات. وبالتالي، يتفق العديد من المؤلفين على أن هناك حاجة إلى الانصهار الخلفى.

فى الآونة الأخيرة، تم تطوير الانصهار القطنى الخلفى باستخدام طعم عظمى ذاتى المنشأ بالإضافة إلى تكبير العمود الأمامى باستخدام مسامير ونظام القفص القطنى.

فى هذه الدراسة بأثر رجعى، تم إجراء ٥٨ مريضاً يعانون من الانزلاق الفقارى القطنى فى قسم جراحة المخ والأعصاب فى جامعة بنها.

للاندماج الخلفى الجانبي فقط أو الاندماج الخلفى الجانبي مع استخدام مسامير ونظام الاقفاص القطنية.

الخلاصة: فى حالات الانزلاق الفقارى التنكسى المنخفض الدرجة، يميل الدمج الخلفى الجانبي إلى تحقيق نتائج سريرية متفوقة. ومع ذلك، فإن دمج الأجزاء القطنية الخلفية باستخدام الاقفاص القطنية يوفر نهجاً أكثر ثباتاً للحفاظ على تصحيح المحاذاة وتحقيق الاندماج الخلفى الجانبي الناجح. وبالتالي، فإن الاختيار الدقيق للمريض أمر بالغ الأهمية لتحديد التدخل الجراحى المناسب.