SURGICAL OUTCOMES OF POSTEROLATERAL FUSION IN PATIENTS WITH LUMBAR SPINAL STENOSIS AND OSTEOPOROSIS

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Our study focuses on patients who underwent posterolateral decompression, spinal fixation, and bone grafting from 1/2021 to 12/2023 at Hanoi Medical University Hospital. The study was conducted on 50 patients that matched the criteria, in which the mean age was 69.32 ± 8.24 years old, with a female-to-male ratio of 1.5:1. Ligamentum flavum hypertrophy was observed in 32%, and lumbar disc herniation in 60%. The most commonly affected level was L4–L5 (92%). Preoperative VAS scores for back and leg pain were 6.7 ± 2.1 and 6.5 ± 2.4, respectively. The mean preoperative ODI was 42.6 ± 13%. Mean operative time was 150 ± 33 minutes, and mean intraoperative blood loss was 169 ± 73ml. Intraoperative complications included one case of pedicle screw placement at the superior endplate and one cases of surgical site infection. The overall complication rate was 4%. Mean hospital stay was 6.3 ± 2.7 days, and mean time to ambulation postoperatively was 3.7 ± 1.4 days. Results after 6 months postoperative follow-up: Very good 32%, Good 38%, Medium 28%, Bad 2%. Results after 12 months postoperative: Very good 40%, Good 44%, Medium 16%. Osterolateral spinal decompression, fixation, and bone grafting are associated with lower complication rates, shorter operative times, and reduced intraoperative blood loss compared to interbody fusion techniques, especially in patients with lumbar spinal stenosis and osteoporosis.

Keywords: Lumbar spinal stenosis, osteoporosis, decompression, spinal fixation, posterolateral bone grafting.

I. INTRODUCTION

Lumbar spinal stenosis is a commonly encountered pathological condition, characterized by a narrowing of the spinal canal which leads to compression of neural and vascular structures. This compression manifests clinically as neurogenic claudication, paresthesia, and weakness in the lower extremities. The etiology is often multifactorial, including intervertebral disc herniation, facet joint hypertrophy, ligamentum flavum thickening, and hypertrophy of the posterior vertebral elements.[1] The prevalence of osteoporosis continues to rise in parallel with the aging of the global population.[2] Globally, the prevalence of osteoporosis is estimated at 18.3%, increasing to 21.7% in the elderly population.[3] There are two primary therapeutic approaches for lumbar spinal stenosis: conservative management and surgical intervention. Conservative treatment is generally indicated in cases without evidence of significant neural compression or where the symptoms are transient. Surgical intervention

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becomes necessary when conservative measures fail or when there is progressive neurological impairment due to persistent nerve compression. In patients undergoing decompressive surgery for spinal stenosis - particularly in cases involving extensive decompression with resection of facet joints - the risk of postoperative spinal instability increases significantly. There have been reports of iatrogenic spondylolisthesis following decompression alone.[4] As a result, the incorporation of spinal fixation and stabilization techniques has become increasingly common in surgical management, with the aim of reducing the risk of postoperative instability. However, the presence of osteoporosis poses a notable challenge to spinal fixation procedures. Reduced bone mineral density compromises the structural integrity of the vertebrae, making it more difficult to achieve successful bone fusion and increasing the likelihood of complications such as screw loosening or pseudarthrosis.[5] Given the above considerations, this study aims to evaluate the clinical efficacy of posterolateral spinal decompression, fixation, and bone graft fusion in the treatment of lumbar spinal stenosis in patients with concomitant osteoporosis.

II. MATERIALS AND METHODS

1. Subjects

A total of fifty patients with lumbar spinal stenosis and osteoporosis who met the inclusion criteria were selected for the study.

Inclusion criteria

Patients diagnosed with lumbar spinal stenosis and osteoporosis based on clinical evaluation and radiological imaging (X-ray and MRI) were included if they underwent posterolateral spinal fixation, decompression, and bone graft fusion.

Patients were followed intraoperatively and postoperatively for a minimum of 12 months and were assessed consistently using standardized evaluation checklists.

Exclusion criteria

Patients without osteoporosis (T-score greater than –2.5 at the affected spinal level); those with comorbid conditions that may affect treatment outcomes such as ankylosing spondylitis, spinal tuberculosis, neuromuscular disorders, or acute/chronic peripheral vascular disease; and those with incomplete medical records or lost to follow-up were excluded.

2. Methods

Study design: Retrospective case series.

Study period and setting: The study was conducted from January 2021 to December 2023 at the Department of Neurosurgery and Spine Surgery, Hanoi Medical University Hospital.

Research tools: The research questionnaire consisted of two sections:

Section 1: Basic information (This section includes: name, age, gender, occupation, preoperative diagnosis, duration of surgery, discharge time, surgical site, medical history, etc.). Surgical method: All patients underwent surgery using a standardized technique: posterolateral fusion.

Section 2: Preoperative and postoperative clinical assessment questionnaires.

Pain intensity was assessed using the Visual Analog Scale (VAS).

Functional limitation of the lumbar spine was evaluated using the Oswestry Disability Index (ODI).[6]

Spinal fusion status was assessed according to the Bridwell fusion grading system.[7]

Surgical outcomes and patient satisfaction were evaluated based on the Macnab criteria.[8]

Data analysis

Data were processed and analyzed using

SPSS software version 22. The normality of distribution was tested using the Kolmogorov–Smirnov test. Descriptive statistical methods such as frequency, mean, and percentage were applied where appropriate.

3. Research ethics

Participation in the study was voluntary and based on informed consent from all patients. Study subjects retained the full right to withdraw from the research at any time during the study period. All patient information was kept confidential and used solely for research purposes. The study was conducted in a manner that did not affect the quality of hospital care, nor did it compromise the patients' health, rights, or financial interests.

III. RESULTS

1. Characteristics of study subjects

Table 1. General characteristics of the study subjects (n = 50)

Characteristics		Number (n)	Percentage (%)
Age	Mean ± SD (Min - max)	69,32 ± 8,24 (53 - 88)	
Gender	Male	20	40
	Female	30	60
Duration of symptoms	≤ 2 years	28	56
	> 2 years	22	44
Symptoms	Neurogenic claudication	35	70
	Radicular pain	19	38
	Low back pain	40	80
	Sphincter dysfunction	1	2
	Muscle atrophy	4	8
Affected levels	L2 - L3	10	20
	L3 - L4	33	66
	L4 - L5	46	92
	L5 - S1	18	36
Degenerative lesions on lumbar spine MRI	Ligamentum flavum hypertrophy	16	32
	Facet joint hypertrophy	33	66
	Decreased disc height	15	30
	Modic changes	22	44
	Disc herniation	30	60
Number of affected levels	1 level	4	8
	2 levels	21	42
	3 levels	19	38
	4 levels	6	12

The number of female patients was higher than male patients, with a female-to-male ratio of 1.5. The majority of patients were elderly, with a mean age of 69.32 ± 8.24 years old (ranging from 53 to 88 years old). The average duration from symptom onset to hospital admission was 7.14 ± 8.61 (1 - 36) months. Most patients were admitted due to poor response to conservative treatment. The predominant clinical symptoms were low back pain (80%) and neurogenic claudication (70%). The most commonly affected spinal level was L4–L5 (92%), which is consistent with its high mobility and significant load-bearing function. The main degenerative lesions of the lumbar spine observed on MRI included ligamentum flavum hypertrophy (32%), disc herniation (60%), and facet joint hypertrophy (66%).

2. Surgical procedure and intraoperative course

The average operative time was 150 ± 33 (60 - 210) minutes, and the mean intraoperative blood loss was 169 ± 73 (100 - 400) ml. One intraoperative complication was recorded: a case of pedicle screw misplacement involving the superior endplate of the vertebral body. The mean duration of hospital stay was 6.3 ± 2.7 (5 - 32) days, and the average time to postoperative ambulation was 3.7 ± 1.4 (2 - 6) days.

3. Surgical outcomes

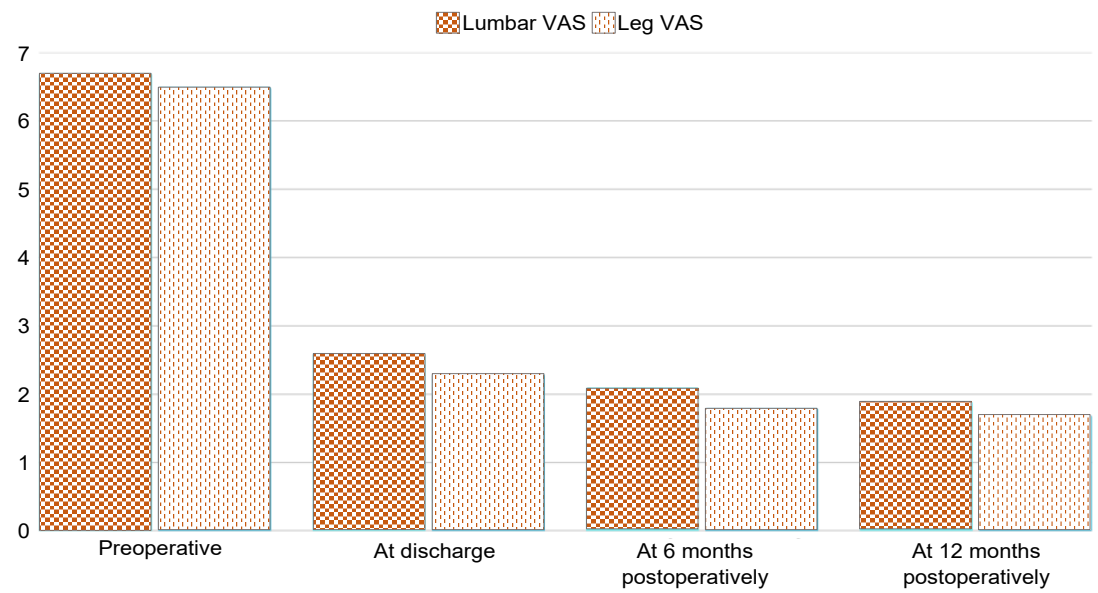

Chart 1. Pain levels before and after surgery according to the Visual Analog Scale (VAS)

Immediately after surgery, patients experienced a significant reduction in both low back pain and leg pain. The absence of interbody fusion helped minimize damage to the vertebral bodies, while allowing for direct decompression of the nerve roots, clear visualization of the ligamentum flavum, and precise control of neural structures. Wide decompression of the spinal canal contributed to back pain relief and notably improved leg pain. Postoperative X-ray imaging was performed in 100% of patients prior to discharge, and all pedicle screws were confirmed to be in the correct position.

Surgical outcomes at 6 months postoperatively

At 6 months postoperatively, in addition to pain assessment, we evaluated the degree of functional limitation of the lumbar spine

using the Oswestry Disability Index (ODI), and assessed spinal fusion status based on the Bridwell grading system through dynamic X-ray imaging.

Table 2. Assessment of fusion status (Bridwell), surgical outcomes (Macnab criteria), and functional limitation (ODI) at 6 months postoperatively (n = 50)

	Fusion grade	**Number (n)**	**Percentage (%)**
Fusion status (Bridwell classification)	Grade I	8	16
	Grade II	18	36
	Grade III	19	38
	Grade IV	5	10
	Total	50	100
	Grade	**Number (n)**	**Percentage (%)**
Surgical outcomes (Macnab criteria)	Very good	16	32
	Good	19	38
	Medium	14	28
	Bad	1	2
	Total	50	100
	Disability level	**Number (n)**	**Percentage (%)**
Preoperative ODI	Minimal	0	0
	Moderate	23	46
	Severe	22	44
	Crippled	5	10
	Bed-bound or exaggerating	0	0
Postoperative ODI (6 months)	Minimal	43	86
	Moderate	7	14
	Severe	0	0
	Crippled	0	0
	Bed-bound or exaggerating	0	0
Mean preoperative ODI		42,6 ± 13 (21 - 70)	
Mean postoperative ODI (6 months)		15,2 ± 6,2 (8 - 40)	

At 6 months postoperatively, 60% of patients demonstrated successful posterolateral fusion using a combination of autologous bone graft and synthetic bone substitute. Surgical outcomes assessed using the Macnab criteria showed that 70% of patients achieved good or excellent results. Most patients had returned to normal daily activities. One patient continued

to experience radicular pain and numbness, which was associated with a postoperative wound infection. Functional limitation of the lumbar spine also improved significantly, with the Oswestry Disability Index (ODI) decreasing from a preoperative value of 42.6 ± 13 (21 - 70) to 15.2 ± 6.2 (8 - 40) at 6 months after surgery.

Table 3. Correlation between change in ODI score at 6 months postoperatively and age, sex, and number of affected levels

Variable		ΔODI (Mean ± SD)	p-value
Age	< 75 years	28 ± 13,75	0,631
	≥ 75 years	26,67 ± 17,43	
Gender	Male	24 ± 16,73	0,136
	Female	30 ± 13,05	
Number of affected levels	≤ 2 levels	33,96 ± 11,62	0,002
	> 2 levels	21,24 ± 15,04	

Surgical outcomes at 12 months postoperatively

At 12 months postoperatively, follow-up evaluations were performed in 44 patients (88%), yielding the following results:

Table 4. Surgical outcomes at 12 months postoperatively according to Macnab criteria (n = 44)

Grade	Number (n)	Percentage (%)
Very good	19	43,2
Good	16	36,3
Medium	9	20,5
Bad	0	0
Total	44	100

At the 6-month follow-up, one patient continued to experience low back pain and radicular symptoms. However, by the 12-month evaluation, the patient had fully recovered through a combination of medication, physical rehabilitation, and modification of lifestyle habits that were previously detrimental to spinal health.

IV. DISCUSSION

The mean age in our study population was 69.32 ± 8.24 (53 - 88) years old corresponding to the elderly group at retiring age. At this stage, degenerative changes such as intervertebral disc degeneration, ligamentous hypertrophy, and facet joint degeneration frequently co-occur, consistent with previously reported findings regarding the typical onset age of lumbar spinal stenosis.[9] The proportion of female patients was higher than males, which may be related to the decline in estrogen levels after menopause, leading to osteoporosis

and thereby accelerating spinal degeneration. Among patients with lumbar spinal stenosis in our study, 60% presented with disc herniation, 32% with ligamentum flavum hypertrophy, and 66% with facet joint hypertrophy. These findings are in line with the pathophysiological mechanisms of lumbar spinal stenosis, as these degenerative changes are primary contributors to central canal narrowing and nerve root outlet stenosis.[10,11,12]

The mean operative time was 150 ± 33 (60 - 210) minutes, and the average intraoperative blood loss was 169 ± 73 (100 - 400) ml. Patients undergoing multilevel decompression had a higher risk of increased blood loss. The operative time in our study was comparable to that reported by international spine surgeons, typically ranging from 150 to 180 minutes. However, the blood loss observed in our study was significantly lower than that reported by Abdelaziz et al. (2020), which averaged 457 ± 193.8 (250 - 675) ml.[13,14] These findings suggest that posterolateral fusion may offer advantages over interbody fusion in terms of surgical efficiency, by reducing operative time and minimizing blood loss - primarily due to the avoidance of disc removal.

Intraoperative complications included one case of pedicle screw misplacement into the superior endplate of the vertebral body and one case of postoperative wound infection, resulting in an overall complication rate of 4%. No cases of dural tear or nerve root injury were observed, highlighting the advantages of this surgical approach. The technique provides wide exposure while avoiding disc removal, thereby minimizing the risk of damage to the spinal cord and nerve roots.

The mean hospital stay was 6.3 ± 2.7 (5 - 32) days, and the average time to ambulation after surgery was 3.7 ± 1.4 (2 - 6) days. Gruskay et al. (2015) reported that the length of hospital stay ranged from 3 to 7 days, depending on the number of decompressed spinal levels.[15] Early drain removal, combined with appropriate pain control and early rehabilitation, may contribute to a reduced length of stay without increasing the risk of complications.[16]

Lumbar spinal stenosis with nerve root compression leads to neurological impairment. In our study, 100% of patients presented with spinal syndrome, with preoperative VAS scores of 6.7 for low back pain and 6.5 for radicular leg pain, indicating the severe impact of the condition on spinal function. The mean preoperative Oswestry Disability Index was 42.6%, reflecting substantial functional limitation. Postoperatively, VAS scores improved significantly to 2.6 for back pain and 2.3 for leg pain, demonstrating marked symptom relief. These results are consistent with previous studies showing the effectiveness of decompression and spinal fixation in improving pain and neurological function.[17] In open surgery, extensive dissection of paraspinal muscles and soft tissues may lead to confusion in early postoperative assessments, as patients may misinterpret wound pain as instability-related pain. However, such differentiation is challenging to evaluate during the immediate hospitalization period.

At 6 months postoperatively, VAS scores for back and leg pain in our study were 2.1 and 1.8, respectively. The Oswestry Disability Index was 15.9, indicating substantial improvement in lumbar spine function. According to European studies, a reduction of 12–14 ODI points is considered clinically significant and corresponds to excellent functional outcomes.[18] Improvements in back pain, leg pain, and functional limitation were all statistically significant, with $p < 0.01$. Patient satisfaction,

assessed at 6 months using the Macnab classification, showed excellent outcomes in 32% of cases, good in 38%, fair in 28%, and poor in 2%. A study by Yang (2024) reported that at 24 months postoperatively, 90.6% of patients achieved excellent or good outcomes.[19]

At the 6-month follow-up, no significant differences were observed in ODI improvement across age groups. However, over time, patients aged ≥ 75 years old tended to have higher ODI scores, likely due to age-related factors such as reduced self-care ability, mobility limitations, and sleep disturbances.[20] Similarly, no significant correlation was found between postoperative ODI scores and sex, indicating that the degree of improvement was comparable between males and females, consistent with findings from several international studies.[21] Notably, the number of spinal levels involved in surgery significantly affected ODI improvement. Patients who underwent multilevel fusion had less favorable functional outcomes. This finding aligns with the results of Zhang (2024).[22] This may be attributed to the loss of spinal flexibility resulting from multilevel fusion. In addition, multilevel surgery may prolong recovery time due to more extensive soft tissue dissection, longer operative duration, and increased intraoperative blood loss, all of which can negatively impact early mobilization.

At 6 months postoperatively, the bone fusion rate as assessed on radiographs was 52%. This is comparable to findings by Faulks (2025), who reported a 6-month fusion rate of 55.7%. Posterolateral fusion has been shown to achieve high long-term fusion success rates, approximately 88–93% at 1 to 2 years, approaching the efficacy of interbody fusion techniques such as PLIF. Although the early fusion rate at 6 months remains relatively low (~55%), this figure is expected to improve significantly over time.[23]

At the 12-month follow-up, 44 patients (88%) were re-evaluated, with 79.5% achieving good or excellent outcomes. All patients demonstrated significant improvement in clinical symptoms. One patient who had persistent low back pain and radicular symptoms at 6 months showed full recovery by the 12-month mark through the use of medication, physical rehabilitation, and modification of lifestyle habits detrimental to spinal health.

V. CONCLUSION

Posterolateral fusion is an effective treatment method for lumbar spinal stenosis patients with osteoporosis, providing significant improvement in low back and leg pain immediately postoperatively with sustained long-term benefits. Posterolateral fusion using a combination of autologous posterior element cancellous bone and synthetic bone graft yields relatively satisfactory bone union results. In elderly osteoporotic patients, avoiding interbody fusion reduces operative time and intraoperative blood loss, while minimizing vertebral body injury as well as neural damage during discectomy.

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