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Original Research Article

FUNCTIONAL OUTCOMES OF POSTERIOR DECOMPRESSION WITH OR WITHOUT INSTRUMENTATION FOR LUMBAR SPINAL CANAL STENOSIS: A SINGLE-CENTRE OBSERVATIONAL STUDY

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ABSTRACT

Background: Lumbar spinal canal stenosis can cause disabling back pain, radiculopathy, neurogenic claudication, and neurological impairment. Posterior decompression is commonly performed when symptoms persist despite conservative treatment. **Objective:** To evaluate the clinical and functional outcomes of posterior decompression, with or without instrumentation, in patients with lumbar spinal canal stenosis.
Materials and Methods: This single-centre observational cohort study included 26 adults treated surgically between December 2018 and September 2020. Patients underwent clinical examination, radiography, and magnetic resonance imaging. Functional recovery was assessed using the 29-point Japanese Orthopaedic Association (JOA) score. The minimum follow-up was six months. Data were analysed descriptively.
Results: The mean age was 48.6 years, and 15 patients (57.7%) were male. Severe back pain was present in 22 patients (84.6%), radiculopathy in 25 (96.2%), and neurological deficits in 11 (42.3%). Multilevel stenosis was identified in 19 patients (73.1%). Twenty-three patients underwent laminectomy with posterior instrumentation, two underwent laminectomy with fusion, and one underwent laminectomy alone. At final follow-up, 24 patients (92.3%) had a JOA score of 21–29. JOA recovery was excellent in 18 patients (69.2%) and good in eight (30.8%). Back pain and radiculopathy were absent in 25 patients (96.2%), while 23 (88.5%) were satisfied. Two dural tears and one superficial infection were recorded.
Conclusion: Posterior decompression was associated with favourable short-term outcomes. However, the small uncontrolled cohort precluded assessment of the additional benefit of instrumentation.
Keywords: lumbar spinal canal stenosis; posterior decompression; laminectomy; instrumentation; JOA score; functional outcome.

INTRODUCTION

Lumbar spinal canal stenosis is characterised by narrowing of the central spinal canal, lateral recess, or neural foramen, resulting in compression of the cauda equina or lumbar nerve roots. Degenerative changes involving the intervertebral discs, facet joints, ligamentum flavum, and vertebral margins are the principal causes of acquired lumbar stenosis. The condition commonly presents with low back pain, radiculopathy, neurogenic claudication, reduced walking tolerance, and symptoms aggravated by standing or lumbar extension. These manifestations can progressively restrict activities of daily living, occupational functioning, and quality of life.[1,2]

Clinical evaluation remains fundamental to diagnosis. Neurogenic claudication is typically characterised by lower-limb pain, numbness, heaviness, or weakness precipitated by standing or walking and relieved by sitting or forward flexion.[1-3] However, the severity of radiological stenosis does not always correspond directly to the intensity of symptoms; imaging findings must therefore be interpreted in conjunction with the patient's clinical presentation.[4,5] Magnetic resonance imaging is the preferred non-invasive investigation for identifying the level, extent, and anatomical subtype of stenosis, while dynamic flexion–extension radiographs can assist in detecting associated segmental instability.[3,4]

Initial management may include activity modification, analgesic medication, physiotherapy, muscle-strengthening exercises, and epidural injections.[2,3] Surgical intervention is generally considered when disabling symptoms persist despite adequate conservative treatment, walking capacity becomes substantially restricted, or progressive neurological impairment develops.[2,3,6,7] Posterior decompression relieves neural compression by enlarging the available space within the spinal canal. Fusion and posterior instrumentation may be added when pre-existing instability, spondylolisthesis, extensive decompression, or anticipated postoperative instability is present.[3,8-10]

Although decompressive surgery is widely used for symptomatic lumbar spinal canal stenosis, the indications for additional fusion and instrumentation remain debated. Decompression alone may preserve spinal motion and reduce operative morbidity, whereas fusion or instrumentation may provide stability in appropriately selected patients.[3,8-10] Variations in patient selection, anatomical disease patterns, surgical techniques, outcome measures, and duration of follow-up have contributed to differences among published results.[6-9] Consequently, evaluation of functional recovery and procedure-related complications remains important for guiding surgical decision-making.

The present study was undertaken to assess the functional outcomes of posterior decompression, with or without instrumentation, in patients with lumbar spinal canal stenosis. Functional recovery was evaluated using the Japanese Orthopaedic Association score,[11] together with changes in back pain, radiculopathy, walking distance, standing tolerance, neurological status, patient satisfaction, return to occupation, and postoperative complications.

MATERIALS AND METHODS

Study design and setting

This single-centre observational cohort study included patients with lumbar spinal canal stenosis who underwent posterior decompression, with or without instrumentation, in the Department of Orthopaedics at Dhiraj Hospital, SBKS Medical Institute and Research Centre, Sumandeep Vidyapeeth, Piparia, Vadodara, India. Patients were enrolled between December 2018 and September 2020. The study included 26 patients who completed a minimum postoperative follow-up of six months.

Eligibility criteria

Patients were eligible if they were 18 years of age or older, had symptomatic lumbar spinal canal stenosis confirmed by clinical and radiological evaluation, and were considered suitable for surgical treatment. Operative management was considered for patients with persistent or progressive symptoms despite conservative treatment, substantial restriction of daily activities, reduced walking or standing tolerance, or neurological impairment. These clinical indications are consistent with established recommendations for managing symptomatic lumbar spinal stenosis.[2,3]

Patients were excluded if they were younger than 18 years, declined participation, were medically unfit for surgery, or failed to complete at least six months of postoperative follow-up.

Preoperative clinical assessment

A detailed history was obtained from every patient, including the duration and severity of low back pain, distribution of radicular pain, symptoms of neurogenic claudication, walking distance, standing tolerance, and the effect of forward flexion or lumbar extension on symptoms. Neurogenic claudication was defined clinically as lower-limb pain, numbness, heaviness, or weakness precipitated by standing or walking and relieved by sitting or lumbar flexion.[1-3]

Physical examination included assessment of posture, spinal tenderness, lumbar movements, straight-leg raising, lower-limb sensation, reflexes, and motor power. Motor strength was graded for the hip flexors and adductors, hip extensors and abductors, knee flexors and extensors, ankle dorsiflexors and plantar flexors, and toe extensors and flexors.

Functional status was evaluated using the 29-point Japanese Orthopaedic Association (JOA) score for lumbar spinal disorders.[11] The score assessed subjective symptoms, clinical signs, restriction of activities of daily living, and bladder function. A lower score represented greater functional impairment.

Radiological assessment

All patients underwent anteroposterior and lateral radiographs of the thoracolumbar or lumbosacral spine. Flexion and extension radiographs were obtained to identify abnormal vertebral translation or angular movement. Lumbar segmental instability was evaluated using established radiological and clinical principles.[3,8-10]

Magnetic resonance imaging was performed in every patient to confirm the diagnosis, determine the number and levels of stenotic segments, and classify stenosis as central, lateral-recess, foraminal, or far-out stenosis.[3,4] The anteroposterior diameter of the spinal canal was measured on MRI. A canal diameter of less than 7 mm was classified as severe narrowing, whereas a diameter of 7–11 mm was considered relative narrowing.[12] MRI findings were interpreted in conjunction with clinical symptoms because the anatomical severity of stenosis does not always correspond directly to functional impairment.[4,5]

Surgical procedures

The operative procedure was selected according to the location and extent of neural compression, number of affected levels, presence of spondylolisthesis or radiological instability, severity of symptoms, and anticipated risk of postoperative instability. Surgical procedures included laminectomy alone, laminectomy with posterior instrumentation, and laminectomy with fusion.

Posterior decompression was performed to relieve compression of the cauda equina and lumbar nerve roots. The lamina and hypertrophied ligamentum flavum were removed as required, and the lateral recesses and affected nerve roots were adequately decompressed. Partial facetectomy or discectomy was performed when clinically indicated. Adequate decompression was confirmed by ensuring that the affected nerve roots were visibly free of compression.

Posterior instrumentation was added when instability was identified preoperatively or was anticipated following decompression. Instrumented stabilisation was also considered in patients with spondylolisthesis, multilevel disease, or extensive removal of stabilising posterior structures. Fusion was performed when maintenance of segmental stability was considered necessary. These principles are consistent with contemporary guidelines and comparative evidence concerning decompression, fusion, and prevention of postoperative instability.[3,8-10]

Postoperative management and follow-up

Postoperative care included wound monitoring, analgesia, mobilisation, activity modification, and physiotherapy. Patients were advised to avoid heavy lifting, twisting movements, and repeated forward bending during the early recovery period. Rehabilitation included abdominal and paraspinal muscle-strengthening exercises, aerobic conditioning, posture training, and progressive walking. A lumbosacral support was prescribed when considered clinically appropriate.

Patients were followed for a minimum of six months. The final follow-up period ranged from six to 15 months. Clinical evaluation at follow-up included back pain, radiculopathy, walking distance, standing tolerance, forward bending, pain during lumbar extension, straight-leg raising, sensory findings, motor power, return to occupation, patient satisfaction, and procedure-related complications.

Outcome measures

The primary outcome was functional recovery according to the JOA score at final follow-up. Percentage recovery was calculated using the JOA recovery-rate formula:

JOA Recovery Rate (%) = (Final JOA score − Preoperative JOA score) ÷ (29 − Preoperative JOA score) × 100

The functional outcome was classified as excellent when the recovery rate was at least 75%, good when it was 45%–74%, fair when it was 25%–44%, and poor when it was less than 25%.[11]

Secondary outcomes included improvement in back pain, radiculopathy, walking distance, standing time, straight-leg raising, sensory and motor deficits, patient satisfaction, return to occupation, and postoperative complications. Recorded complications included dural tear, superficial or deep infection, implant loosening, and neurological deterioration.

Statistical analysis

Data were entered into a master chart and analysed descriptively. Categorical variables were presented as frequencies and percentages. Continuous variables were reported as means and ranges when these values were available. Because the study involved a small cohort, heterogeneous surgical procedures, and no control group, no comparative treatment-effect analysis was performed.

Ethical Considerations

The Institutional Ethics Committee reviewed and approved the study protocol before the commencement of the study. Written informed consent was obtained from all participants after the study objectives and procedures had been explained in their preferred language. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and its subsequent amendments.[13]

RESULTS

Participant Characteristics

A total of 26 patients with lumbar spinal canal stenosis underwent surgical treatment and completed a minimum postoperative follow-up of six months. The progression of patients from inclusion through surgical treatment and final analysis is presented in the participant-flow diagram (Figure 1).

The mean age was 48.6 years, with a range of 30–70 years. Twelve patients (46.2%) were aged 41–50 years, representing the largest age group. Fifteen patients (57.7%) were male. Twenty-two patients (84.6%) performed moderate or strenuous work, and 16 (61.5%) had experienced symptoms for more than 12 months. Acquired degenerative stenosis was present in 21 patients (80.8%). [Table 1]

Table 1: Baseline demographic and clinical characteristics

Characteristic	**n (%)**
Age 41–50 years	12 (46.2)
Age 51–60 years	8 (30.8)
Male sex	15 (57.7)
Moderate or strenuous work	22 (84.6)
Acquired degenerative stenosis	21 (80.8)
Symptoms lasting >12 months	16 (61.5)

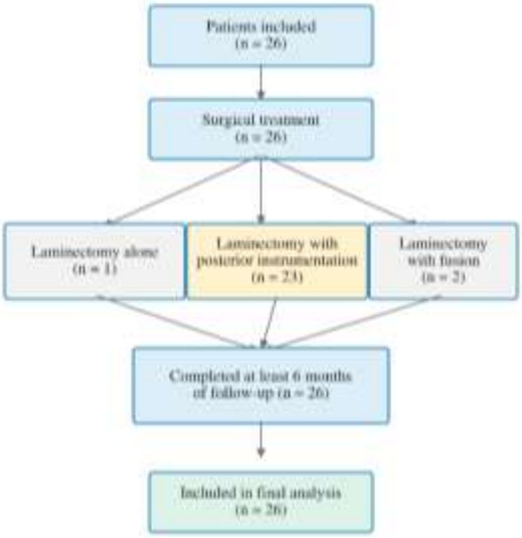

Figure 1: Participant flow through study inclusion, surgical treatment and final follow-up

Preoperative Clinical Findings

Severe low back pain was present in 22 patients (84.6%), while four (15.4%) had moderate pain. Radiculopathy was present in 25 patients (96.2%), including bilateral radiculopathy in 13 (50.0%). All patients had restricted walking capacity: 19 (73.1%) could walk only 100–200 m, and seven (26.9%) could walk less than 100 m. Standing tolerance was limited to 15 minutes or less in all patients.

Eleven patients (42.3%) had a neurological deficit at presentation. Seven patients had sensory impairment alone, and four had combined sensory and motor deficits. Twenty-two patients (84.6%) had a preoperative JOA score of 0–10, while four (15.4%) had a score of 11–20 (Table 2). A comparison of JOA score categories before surgery and at final follow-up is shown in Figure 2.

Table 2: Principal preoperative clinical findings

Clinical finding	**n (%)**
Severe back pain	22 (84.6)
Any radiculopathy	25 (96.2)
Bilateral radiculopathy	13 (50.0)
Walking distance ≤200 m	26 (100.0)
Standing tolerance ≤15 min	26 (100.0)
Neurological deficit	11 (42.3)
JOA score 0–10	22 (84.6)

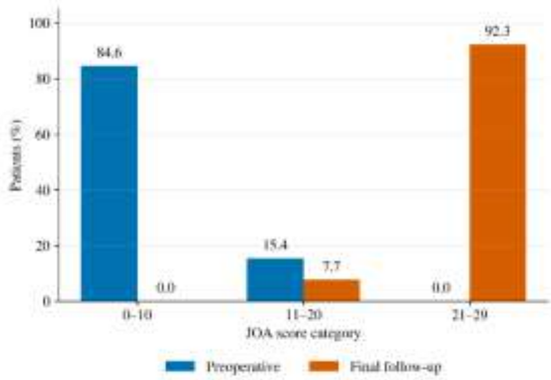

Figure 2: Comparison of preoperative and final follow-up JOA score categories

Radiological and Operative Findings

MRI demonstrated central stenosis in 22 patients (84.6%), lateral-recess stenosis in 14 (53.8%), and foraminal stenosis in 12 (46.2%). The MRI categories were not mutually exclusive because some patients had more than one anatomical subtype. The distribution of MRI-defined stenosis is illustrated in Figure 3.

L4–L5 was the most frequently affected level. Multilevel stenosis was present in 19 patients (73.1%), including 17 with two-level involvement and two with more than two affected levels. The anteroposterior canal diameter was less than 7 mm in nine patients (34.6%) and 7–11 mm in 17 (65.4%).

Laminectomy with posterior instrumentation was performed in 23 patients (88.5%). Two patients (7.7%) underwent laminectomy with fusion, and one (3.8%) underwent laminectomy alone. [Table 3]

Table 3: Radiological and operative characteristics

Characteristic	n (%)
Central stenosis	22 (84.6)
Lateral-recess stenosis	14 (53.8)
Foraminal stenosis	12 (46.2)
Multilevel stenosis	19 (73.1)
AP canal diameter <7 mm	9 (34.6)
Laminectomy with instrumentation	23 (88.5)
Laminectomy with fusion	2 (7.7)
Laminectomy alone	1 (3.8)

AP: anteroposterior. MRI stenosis categories were not mutually exclusive.

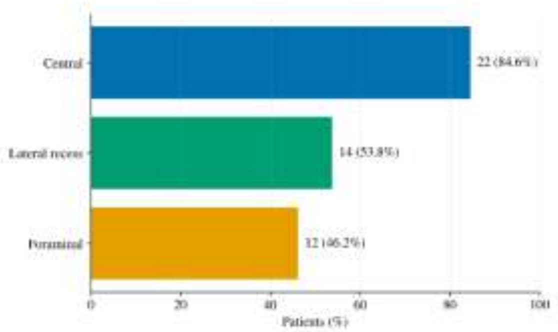

Figure 3: Distribution of anatomical subtypes of lumbar spinal canal stenosis on MRI

Functional Outcomes

The mean postoperative follow-up was nine months, with a range of six to 15 months. At final follow-up, 24 patients (92.3%) had a JOA score of 21–29, whereas two (7.7%) had a score of 11–20. No patient remained in the JOA score category of 0–10. The change in JOA score distribution between the preoperative and final assessments is presented in Figure 2.

Back pain was absent in 25 patients (96.2%), and radiculopathy was absent in 25 (96.2%). Twenty-one patients (80.8%) could walk more than 500 m, while five (19.2%) could walk 300–400 m. Eighteen patients (69.2%) could stand for 20–30 minutes, and eight (30.8%) could stand for 15–20 minutes.

Forward bending was performed without difficulty by 24 patients (92.3%). None of the patients experienced pain during lumbar extension. Straight-leg raising improved to 70°–80° in 25 patients (96.2%), and no residual sensory deficit was recorded at final follow-up (Table 4).

According to the JOA recovery classification, 18 patients (69.2%) achieved an excellent outcome, and eight (30.8%) achieved a good outcome. No fair or poor outcomes were recorded. Twenty-three patients (88.5%) reported satisfaction with their postoperative outcome. The principal functional outcomes and JOA recovery categories are shown graphically in Figure 4.

Table 4: Clinical and functional outcomes at final follow-up

Outcome	n (%)
JOA score 21–29	24 (92.3)
No back pain	25 (96.2)
No radiculopathy	25 (96.2)
Walking distance >500 m	21 (80.8)
Standing time 20–30 min	18 (69.2)
No sensory deficit	26 (100.0)
Excellent JOA recovery	18 (69.2)
Good JOA recovery	8 (30.8)
Patient satisfaction	23 (88.5)

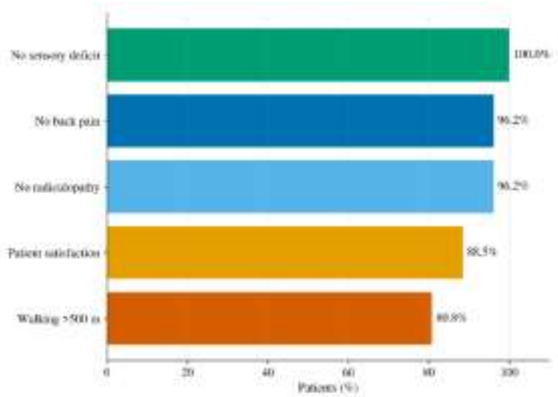

Figure 4: Functional outcomes and JOA recovery at final follow-up

Complications

Two intraoperative dural tears (7.7%) and one superficial surgical-site infection (3.8%) were recorded. The superficial infection was treated successfully with dressings and antibiotics. No deep infection, implant loosening, or postoperative neurological deterioration occurred during the follow-up period. [Table 5]

Table 5: Surgical complications

Complication	n (%)
Dural tear	2 (7.7)
Superficial infection	1 (3.8)
Deep infection	0 (0.0)
Implant loosening	0 (0.0)
Neurological deterioration	0 (0.0)

DISCUSSION

Lumbar spinal canal stenosis is a progressive degenerative condition that can substantially restrict mobility, occupational performance, activities of daily living, and quality of life.[1,2] Surgical treatment is primarily intended to relieve neural compression, improve functional capacity, and prevent further neurological deterioration when disabling symptoms persist despite conservative care.[2,3,6,7] The present study demonstrated favourable short-term functional outcomes following posterior decompression, with or without instrumentation, in such patients.

The mean age of the patients in the present study was 48.6 years, with the largest proportion belonging to the 41–50-year age group. Nath et al. reported a comparable mean age of 45.1 years,[11] whereas Weinstein et al. studied an older population with a mean age of approximately 65 years.[6] Differences in age distribution may reflect variations in occupation, referral patterns, lifestyle, diagnostic practices, and criteria for surgical selection. The relatively younger age observed in the present cohort may also be associated with the high proportion of patients engaged in moderate or strenuous occupations. However, because the study did not evaluate occupational exposure quantitatively, a causal association between occupation and the development of stenosis cannot be established.

A slight male predominance was observed in the present study. Similar male predominance was reported by Nath et al. and Weinstein et al., although the proportions differed between studies.[6,11] The higher representation of men in the present cohort may partly reflect occupational and healthcare-seeking patterns. Nevertheless, the small sample size limits meaningful conclusions regarding sex-related susceptibility to lumbar stenosis.

Most patients had experienced symptoms for more than 12 months before undergoing surgery. The prolonged duration of symptoms suggests that patients were initially treated conservatively or sought specialist care only after their functional limitations became severe. Conservative management remains appropriate for patients with mild or tolerable symptoms; however, persistent neurogenic claudication, progressive neurological deficit, and substantial restriction of daily activities are recognised indications for surgical evaluation.[2,3] Delayed presentation may prolong disability and could potentially influence the extent of neurological recovery.

Severe back pain and radiculopathy were the predominant clinical manifestations. Bilateral radicular symptoms were more common than unilateral symptoms, and all patients had restricted walking distance and standing tolerance. These findings are consistent with the characteristic presentation of lumbar spinal canal stenosis, in which standing and walking increase lumbar extension and further reduce the dimensions of an already narrowed canal. Sitting or forward flexion increases the available canal space and usually relieves neurogenic claudication.[1-3]

Neurological impairment was present in a substantial proportion of patients. Sensory abnormalities mainly involved the L4, L5, and S1 dermatomes, while motor weakness predominantly affected ankle and toe movements. Nath et al. similarly reported sensory and motor deficits among patients undergoing surgical treatment for degenerative lumbar canal stenosis.[11] The presence of objective neurological impairment, particularly when progressive, strengthens the indication for decompression because prolonged neural compression may reduce the likelihood of complete neurological recovery.[2,3]

MRI demonstrated central stenosis as the most frequent anatomical pattern, followed by lateral-recess and foraminal stenosis. Several patients had more than one subtype of stenosis. L4–L5 was the most frequently affected level, and multilevel involvement was more common than single-level disease. This pattern is consistent with the greater mobility and mechanical loading of the lower lumbar segments and with progressive degenerative changes involving the intervertebral discs, facet joints, ligamentum flavum, and vertebral margins.[1,2] MRI was valuable for defining the anatomical level and extent of stenosis; however, imaging findings must be correlated with symptoms and neurological examination because radiological narrowing alone does not determine the need for surgery.[4,5]

The marked postoperative shift towards higher JOA score categories indicates substantial improvement in functional status. Previous studies have also reported favourable outcomes following decompressive surgery for symptomatic lumbar stenosis. Weinstein et al. demonstrated greater improvement in pain and physical function among surgically treated patients than among those receiving non-operative care.[6] Delitto et al. also compared surgical and nonsurgical management in a randomised trial.[7] Nath et al. reported improvement in pain, walking ability, neurological function, and

JOA-based outcomes after decompression for degenerative lumbar canal stenosis.[11] A systematic review by Fritsch et al. found clinically important postoperative improvement in pain and disability.[14] The findings of the present study are therefore broadly consistent with the published literature.

Improvement in walking distance and standing tolerance is particularly relevant because neurogenic claudication is one of the principal causes of disability in lumbar stenosis. Most patients regained the ability to walk more than 500 m, and standing tolerance improved considerably following surgery. These improvements are clinically meaningful because they influence independence, occupational activity, and quality of life. Relief of back pain and radiculopathy, together with recovery of sensory and motor function, likely contributed to the high level of patient satisfaction.

Although all patients were classified as having good or excellent JOA recovery, this finding should be interpreted cautiously. The study reported categorical JOA scores rather than individual preoperative and postoperative values with measures of variability. Consequently, the mean change in JOA score, confidence intervals, and statistical significance could not be evaluated. The favourable recovery classifications should be verified using the patient-level master chart and the prespecified JOA recovery-rate formula before submission.

Most patients underwent decompression with posterior instrumentation. Fusion or instrumentation may be considered in patients with pre-existing instability, spondylolisthesis, extensive facet-joint removal, multilevel decompression, or an anticipated risk of postoperative instability.[3,8-10] However, randomised studies have not shown a uniform benefit from adding fusion to decompression for all patients with lumbar stenosis, emphasising the importance of careful selection.[8,9] The present study was not designed to compare decompression alone with decompression plus instrumentation. Only one patient underwent laminectomy alone, making a meaningful comparison impossible. Therefore, the results demonstrate the outcome of the overall surgical strategy used in this cohort but do not establish that instrumentation is superior to decompression alone.

Dural tear was the most frequent intraoperative complication, while one patient developed a superficial surgical-site infection. No deep infection, implant loosening, or postoperative neurological deterioration was reported. Dural tear is a recognised complication of operative decompression for lumbar stenosis.[2,3] The absence of implant-related complications is encouraging, but the relatively short follow-up period was insufficient to evaluate delayed implant failure, adjacent-segment degeneration, recurrent stenosis, pseudarthrosis, or postoperative instability.

The principal strengths of this study were the use of systematic clinical and MRI assessment, application of the recognised JOA functional score,[11] evaluation of several patient-centred outcomes, and completion of at least six months of follow-up by all included patients. The study also documented neurological recovery, patient satisfaction, return to occupation, and surgical complications.

Several limitations must be acknowledged. The study had a small sample size and was conducted at a single institution. It lacked a non-operative control group and an adequately sized decompression-alone group. The surgical procedures were heterogeneous, and the criteria for choosing instrumentation or fusion were not fully standardised. The follow-up period was short and varied between patients. The analysis was descriptive and did not include confidence intervals, hypothesis testing, or adjustment for potential confounders. In addition, excluding patients who did not complete the minimum follow-up could have introduced attrition bias. These limitations reduce the generalisability of the findings and prevent conclusions regarding the comparative effectiveness of the surgical procedures.

Larger prospective studies are required to confirm these findings. Future research should use standardised surgical indications, clearly defined operative techniques, patient-level JOA data, validated patient-reported outcome measures, and longer follow-up. Direct comparison of decompression alone with decompression plus fusion or instrumentation would help identify the patients who derive an additional benefit from stabilisation.

CONCLUSION

Posterior decompression, with or without instrumentation, produced favourable short-term functional outcomes in patients with symptomatic lumbar spinal canal stenosis. Patients demonstrated substantial improvement in JOA-based functional status, back pain, radiculopathy, walking capacity, standing tolerance, and neurological function. Most patients were satisfied with the surgical outcome, and relatively few perioperative complications were recorded.

Adequate decompression should be considered in carefully selected patients with persistent disabling symptoms, restricted mobility, or progressive neurological impairment despite conservative management. Instrumentation should be selected according to documented or anticipated spinal instability rather than used routinely.

Because this study included a small heterogeneous cohort without a control group, it cannot determine the additional benefit of instrumentation over decompression alone. Larger prospective comparative studies with standardised treatment criteria and longer follow-up are required to confirm the durability of the observed outcomes.

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