DOI: 10.21608/pajn.2025.321568.1146

Original Article

Spinous Process Splitting Approach in Microscopic Decompression of Lumber Canal Stenosis

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Received: 17 September 2024 / **Accepted:** 3 January 2025 / **Published online:** 15 June 2025

BACKGROUND: Conventional laminectomy (CL) is the gold standard treatment for surgical management of lumbar canal stenosis (LCS). Despite being effective in neural decompression, yet, this approach entails aggressive muscle retraction, bony and ligamentous disruption of posterior midline structures. The spinous process (SP) splitting is a minimally invasive approach for LCS surgical management, affording effective central and lateral recess decompression, yet with less morbidity and better postoperative rehabilitation than CL.

OBJECTIVE: This study aimed to evaluate the safety and efficacy of the SP splitting approach in LCS management representing a single center experience.

METHODS: This retrospective study involved 120 patients with LCS that failed to respond to conservative treatment, who presented to a single center between March 2014 and July 2022, with a minimum follow up period of 12 months. These participants underwent a single-level microscopic trans-spinous lumbar decompression via the SP splitting approach. Preoperative and postoperative clinical, functional and radiological status were evaluated. Operative findings and complications were also evaluated. Preoperative and postoperative creatine phosphokinase (CPK) and C-reactive protein (CRP) levels were also reviewed.

RESULTS: Compared to preoperative values, the Oswestry disability index (ODI) and visual analogue scale (VAS) scores for back and leg pain significantly improved at 1 month and 1 year postoperatively. The mean maximum walking distance improved significantly after surgery. The CRP and CPK levels were not significantly different at 2 weeks postoperative compared to preoperative values. The mean antero-posterior (A-P) diameter of spinal canal significantly increased postoperatively. Intraoperative complications included accidental durotomy in one (0.83%) patient. Postoperative complications included superficial infection in one (0.83%) patient, muscle atrophy in 3 (2.5%) patients, and need for reoperation in 2 (1.7%) patients.

CONCLUSION: The SP splitting approach is a safe and effective minimally invasive technique for LCS surgical management that achieves favorable clinical and radiological outcomes, yet with minimal surgical morbidity, better postoperative rehabilitation and with relatively low complication rate.

KEYWORDS: Lumbar canal stenosis, Microscopic decompression, Minimally invasive, Multifidus muscle, Spinous process splitting.

INTRODUCTION

Lumbar canal stenosis (LCS), a prevalent condition, is characterized by a gradual degenerative process that reduces the surface area of the spinal canal causing compression of neural tissues. Lumbar canal stenosis is the most common indication of spinal surgery in elderly patients above 65 years. This compression is usually related to degenerative disc prolapse, zygapophyseal facet joint osteoarthropathy, ligamentum flavum hypertrophy and buckling, osteophytes formation, and/or degenerative spondylolisthesis. The most affected levels are between fourth and fifth and between third and fourth lumbar vertebrae. Anatomically, it is classified into central, lateral recess, and foraminal LCS.[1,2]

Many patients with LCS can be asymptomatic. Central canal stenosis usually results in neurogenic claudication where patients suffer from progressive leg pain associated with walking with decreasing pain free distance over time. Lateral canal stenosis and foraminal stenosis usually result in radiculopathy. Low back pain may be related to associated muscle spasm, facet arthropathy, degenerative scoliosis, and /or dynamic instability. If there is severe neural compression, LCS may be associated with neurological deficit.[3]

Patients with manifestations of lumbar canal stenosis are usually managed conservatively. Medical treatment, injections, lifestyle modifications, and physiotherapy are usually effective in most of the patients. Surgery is indicated in about 15% of patients with LCS when there are incapacitating symptoms interfering with daily activity despite medical treatment for at least 4-6 weeks and/or neurological deficit.[1-3]

Surgical intervention for symptomatic LCS aims to alleviate the patients' symptoms by providing adequate decompression of the affected neural structures. Traditionally, surgical treatment for LCS involved extensive removal of posterior midline structures.[4]

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Conventional laminectomy (CL), while effective in decompressing neural elements, often results in significant tissue damage, prolonged recovery times, and potential postoperative instability.[5]

Concurrently, efforts are made to save the lumbar spine anatomical integrity and biomechanical functionality as much as possible.[6] Thus, various minimally invasive surgical techniques are developed. These minimally invasive spine surgeries (MISS) benefit from innovations in microsurgical and endoscopic spine techniques. These techniques allow minimal muscular trauma, minimal bony resection and minimal ligamentous disruption, yet, achieving effective neural decompression with less blood loss, less hospital stay, less infection rates and less incidence of iatrogenic post decompression mechanical instability and failed back syndrome. These MISS to be effectively used need a learning curve to afford the desired adequate decompression in a minimally invasive way. Mastering these MISS techniques will decrease the need to reoperate after initial surgery through facet preserving laminectomy.[7] One widely used approach is minimally invasive microscopic lumbar decompression, which includes procedures like lumbar spinous process (SP) splitting laminectomy.[8,9]

Multifidus muscle preservation is crucial, as it enables complex, coordinated movements of the trunk and serves as a dynamic stabilizer. Multifidus muscle helps in lumbar extension, rotation and lateral bending. The SP splitting approach allows minimally invasive decompression of the central lumbar canal and bilateral lateral recesses and microdiscectomies while preserving the SP, interspinous and supra spinous ligaments, and the segmental multifidus muscle.[7]

The SP splitting approach is a valuable surgical technique for LCS. The SP splitting approach provides posterior midline access to the spinal canal, facilitating surgical interventions.[10] It involves splitting the SP and preserving muscle attachments.[6] The SP splitting approach allows for bilateral decompression through a unilateral approach, potentially reducing operative time, blood loss and accelerating recovery compared to CL.[11]

This work aimed to assess the clinical and radiological outcomes and complications of the SP splitting approach in LCS management.

PATIENTS AND METHODS

This is a retrospective study of 120 patients with surgical LCS who had a single level microscopic trans-spinous lumbar decompression using the SP splitting approach. This study was conducted at a single tertiary referral center between March 2014 and July 2022 with a minimum follow up period of 12 months.

Patients included in the study suffered from single level LCS and their manifestations failed to respond to at least 4-6 weeks of conservative treatment with incapacitating or progressive neurogenic claudication and/or neurological deficit. Patients who had previous posterior lumbar surgery, morbid obesity (body mass index more than 40), mechanical instability, degenerative spondylolisthesis, multiple level stenosis or had follow up period less than 12 months were excluded.

All patients were subjected to complete history taking and thorough clinical examination was conducted. Preoperative functional assessment was conducted using Oswestry disability index (ODI) questionnaire and visual analogue scale (VAS) to assess the impact of back or leg pain on daily activities. These scores were assessed postoperatively after 1 month and 1 year to assess the functional outcome of this approach in addition to follow up of progress in walking distance.

Preoperative radiological assessment included dynamic X ray of lumbosacral spine to identify possible dynamic instability, computerized tomography (CT), and magnetic resonance imaging (MRI) that were performed to assess spinal canal anteroposterior diameter. Postoperative dynamic X ray and CT was done 1 day after operation to assess spinal canal A-P diameter change and identify any possible postoperative instability.

Laboratory investigations involved preoperative and 2 weeks postoperative assessments of creatine phosphokinase (CPK) and C-reactive protein (CRP) levels as biochemical markers to assess paraspinal muscle damage.

Operative data collected included operative time, wound size, blood loss, length of hospital stay, time to return to normal daily activities, number of patients who had simultaneous microdiscectomy, fusion rates and complications, whether intraoperative or postoperative.

Spinous Process Splitting Approach

Before the procedure, the SP length was ascertained through CT scans. Also, the width of spinous process was measured to make sure there was enough width of cancellous bone to split through. After administering anesthesia, patients were positioned prone, and the SP levels were identified using fluoroscopic lateral X-rays. The operative site was equipped and dressed in accordance with standard protocols. The proper SP was identified, skin was infiltrated with a local anesthetic. A scalpel (number 15) was used to make an incision extending one level above and one below the targeted area and deepened to the spinous processes tip. The spinous processes were longitudinally split in the midline and then divided at its base from the posterior arch using different sizes of curved osteotomes. The multifidus muscle was dissected subperiosteally off the lamina using Cobb Elevator. Ample working space for laminotomy was gained via retracting each split half laterally together with its attached para-spinal muscle. So, the entire muscle group, including the multifidus, erector spinae, and other para-spinal muscles, were retracted laterally using a Galbi retractor, Cloward cervical Retractor, Casper's retractor or tubular retractor. Splitting of the SP was continued until the anterior periosteal surface of the lamina (cutting the base of the SP transversely). The supraspinous ligament and interspinous ligament were cut vertically in midline. Decompression was done starting with laminectomy with or without medial facetectomy and the ligamentum flavum was resected with undercutting of medial part of facet, so that the thecal sac opposite the articular segment was adequately decompressed. The two split halves were reapproximated by absorbable sutures. The supraspinous and interspinous ligaments were also reapproximated. A surgical microscope was used in all cases. Patients were encouraged to start walking as early as possible.

Fig 1: Preoperative CT image to ascertain the length of the spinous process to be splitted.

Statistical analysis

Statistical package for social sciences (SPSS) version 27 (IBM©, Chicago, IL, USA) was employed to perform the statistical analysis. Regarding the statistical analysis of the collected data, we expressed numerical data as mean (with ranges), whereas categorical data were presented as numbers and percentages. Statistical significance was defined as a two-tailed P value less than 0.05.

Ethical Approval

All patients had signed informed consent before surgery and for active participation in this study. The study was reviewed and approved by the ethics committee of the Faculty of Medicine of Alexandria University (Institutional review board (IRB) regarding human subjects).

RESULTS

This is a retrospective study of 120 patients with surgical LCS who had a single level microscopic trans-spinous lumbar decompression using the SP splitting approach, with a minimum follow up period of 12 months (range: 12-60 months).

The age of the studied group ranged between 42-64 years with a mean age of 56.2 ± 6.71 years. There were 83 (69.17%) males and 37 (30.83%) females. The most common presentation was neurogenic claudication and was present in 118 (98.3%) patients. The mean preoperative maximal walking distance was 150±65 meters with a range between 100-300 meters. Leg pain and/or numbness were present in 110 (91.7%) patients. Low back pain was present in 84 (70%) patients. None of the treated patients had a neurological deficit. All cases included in the study suffered from single level LCS. The most common level of stenosis in the current study was L3/4 in 74 (61.67%) patients, followed by L4/5 in 33 (27.5%) patients, and L5/S1 in 13 (10.83%) patients.

The mean operative time was 83.2±17.37 minutes, and the mean wound size was 3.2±0.98 cm. The mean intraoperative blood loss was 49.7±6.45 cc, and postoperative blood loss was 101.3±13.23 cc. Seventy-seven (64.2%) patients had simultaneous microdiscectomy. The mean length of hospital stay was 1.66 days with a range between 1-3 days. The mean time to return to normal daily activities was 12.8±1.99 days. Postoperative fusion occurred in 98 (81.67%) patients. Basic demographic, clinical, and perioperative surgical data of the study participants are illustrated in **(Table 1).**

Considering the preoperative functional status of patients who had trans-spinous decompression of LCS, the mean preoperative ODI was 48.5±9.47. The mean VAS for leg pain was 8.3 with a range between 6-9, while the VAS for back pain was 6.4 with a range between 5-7.

Revising the treatment outcome, functionally, the mean postoperative ODI became 10.5±7.77 at 1 month and 12.8±7.89 at 1 year. The mean VAS for back pain at 1 month was 4.2 with a range between 3-5 and was 2.1 with a range between 1-3 at 1 year. The mean VAS for leg pain was 2.2 with a range between 1-4 at 1 month postoperatively. After 1 year postoperatively, the mean VAS for leg pain was 1.2 with a range between 1-3. ODI and VAS for back pain and leg pain significantly improved at 1 month and 1 year than preoperative ones (p<0.001). Comparison of preoperative and postoperative functional status of the studied group at 1 month and 1 year postoperatively is illustrated in **(Table 2)**.

Clinically, the mean maximum walking distance improved from 150±65 meters with a range between 100-300 meters preoperatively, to a mean of 500±184.8 meters postoperatively, with a range between 400-1000 meters and this was statistically significant (P <0.001*).

Radiologically, preoperative mean A-P diameter of spinal canal was 10.82±1.69 cm with a range between 4-11.3 cm. This improved postoperatively to a mean diameter of 14.03±1.33 cm with a range between 12-16 cm. There was statistically significant difference as regards change in A-P diameter of spinal canal after trans-spinous decompression (P <0.001*).

Regarding the biochemical markers of muscle damage, the mean preoperative CRP level was 0.91±0.47 mg/, while at 2 weeks postoperatively, the mean CRP level was 0.92±0.47 mg/dl. The mean preoperative CPK was 90.69±31.69 U/L, meanwhile 2 weeks postoperatively, the mean CPK was 90.74±31.71 U/L. The values of CRP and CPK levels were not significantly different between preoperative and 2-weeks postoperatively indicating that there was minimal muscular damage using this decompression technique. Comparison of biochemical markers of paraspinal muscles damage of the studied group preoperatively and at 2 weeks postoperatively is illustrated in **(Table 3).**

Intraoperative complications included accidental durotomy in one (0.83%) patient which was minor and was managed conservatively. No iatrogenic nerve injury was documented. Postoperative complications included superficial infection in one (0.83%) patient which was managed conservatively with proper systemic antibiotic and frequent dressing, and muscle atrophy in 3 (2.5%) patients. The need for reoperation occurred only in 2 (4.17%) patients. There was a persistence of claudication in one patient. A revision procedure included medial facetectomy, pedicular fixation, and conventional laminectomy in this patient after 22 months of follow up. The other patient showed instability after 2 years of follow up and required fixation to stabilize. Operative and postoperative complications are illustrated in **(Table 4).**

Illustrated cases:

Case 1: A 54 years old male patient presented with progressive neurogenic claudication with maximum walking distance of 100 meters, associated with incapacitating low back pain and bilateral sciatica that failed to respond to conservative treatment after 6 weeks. MRI imaging illustrated focal lumbar canal stenosis at L4-L5 level. **(Fig. 2A)** is a T2 axial image demonstrating focal central and lateral recess stenosis. The patient underwent SP splitting microscopic central and lateral recess decompression. The patient started walking in the first day after operation and had improvement in his preoperative symptoms with a maximum walking distance of 500 meters. The patient showed significant improvement of his preoperative ODI and VAS for both leg pain and low back pain. Also, the A-P diameter of the spinal canal significantly improved as illustrated in postoperative axial T2 image in **(Fig. 2B).**

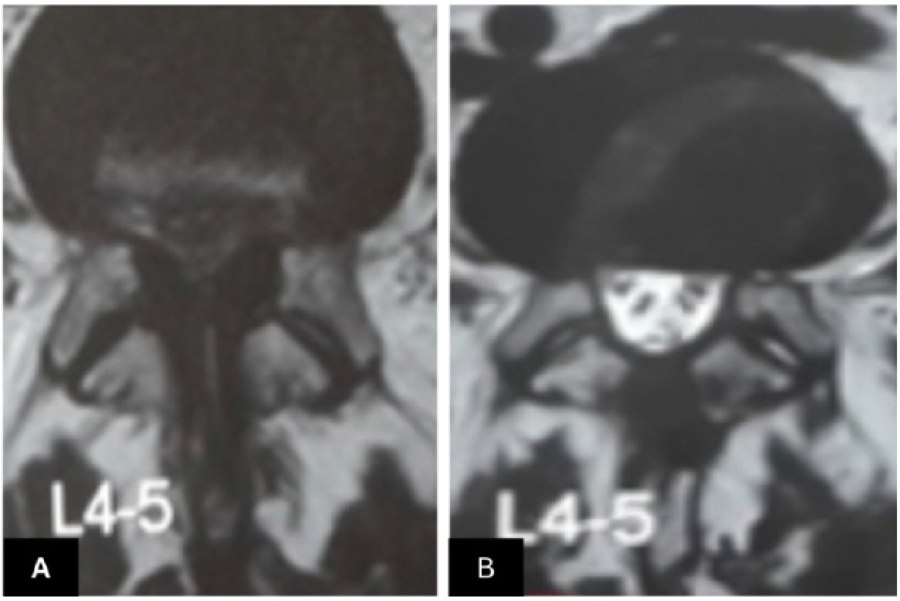

Fig 2: (A): Preoperative T2 axial MRI lumbosacral spine image of 54 years old male presenting with neurogenic claudication demon-strating focal central and lateral recess stenosis at L4-L5. (B): Postoperative T2 axial MRI lumbosacral spine image at level L4-L5 demonstrating that A-P diameter of spinal canal significantly improved after SP splitting decompression representing adequate central and lateral recess decompression. Patient showed significant clinical improvement.

Case 2: A 49 years old female patient had symptoms of severe low back pain and claudicating sciatica with a maximum walking distance of 120 meters. MRI T2 axial image showed focal canal stenosis in L5-S1 level as illustrated in **(Fig. 3A).** The patient underwent SP splitting microscopic discectomy of L5-S1 as illustrated in postoperative MRI T2 axial image in **(Fig. 3B).** The patient showed significant improvement of her preoperative symptoms and maximum walking distance increased to 600 meters coupled with significant improvement of her preoperative ODI and VAS and A-P diameter of the spinal canal.

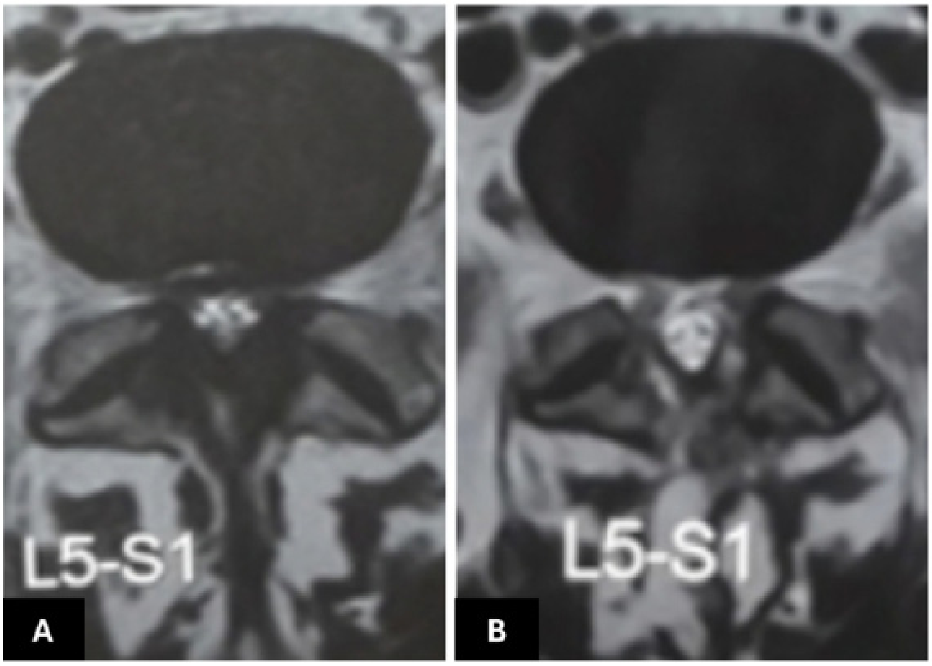

Fig 3: (A): Preoperative T2 axial MRI lumbosacral spine image illustrating focal stenosis at L5-S1 level in a 49 years old female patint presenting LBP and severe claudications. (B): Postoperative T2 axial MRI lumbosacral spine image demonstrating effective neural decompression after SP splitting microscopic decompression. Patient had improvement in maximum walking distance coupled with improvement in ODI and VAS.

Table 1: Basic demographic, clinical, and perioperative surgical data of the study participants

Variables		**(n=120)**
Age (Years)	Mean ± SD	56.2 ± 6.71
	Range	42-64
Gender, n, (%)	Male	83 (69.17%)
	Female	37 (30.83%)
Presentation, n, (%)	Back pain	84 (70%)
	Leg pain	110 (91.7%)
	Neurogenic claudication	118 (98.3%)
	Neurological deficit	0
Operative levels	L3/4	74 (61.67%)
	L4/5	33 (27.5%)
	L5/S1	13 (10.83%)
Operative time (min)		83.2 ± 17.37
Wound size (cm)		3.2 ± 0.98
Intraoperative blood loss (cc)		49.7 ± 6.45
Simultaneous microdiscectomy		77 (64.2%)
Postoperative blood loss (cc)		101.3 ± 13.23
Length of hospital stay (days)		1.66 (1-3)
Time to return to normal daily activities (days)		12.8 ± 1.99
Fusion rate, n (%)		98 (81.67%)

n; number, SD; standard deviation. Data are presented as mean ± SD or frequency (%).

Table 2: Comparison of preoperative and postoperative functional status of the studied group at 1 month and 1 year postoperatively

Variables	Preoperative	1 month postoperative	1 year postoperative
ODI	48.5 ± 9.47	10.5 ± 7.77	12.8 ± 7.89
	P	<0.001*	<0.001*
VAS-back pain	6.4 (5-7)	4.2 (3-5)	2.1 (1-3)
	P	<0.001*	<0.001*
VAS-leg pain	8.3 (6-9)	2.2(1-4)	1.2 (1-3)
	P	<0.001*	<0.001*

Abbreviations: ODI; Oswestry disability index, VAS; Visual analogue scale. P value was significant at P <0.05.

Table 3: Comparison of preoperative and postoperative biochemical markers of paraspinal muscles damage of the studied group preoperatively and at 2 weeks postoperatively

Markers	Preoperative	2 weeks postoperative	P value
CRP (mg/dl)	0.91 ± 0.47	0.92 ± 0.47	0.058
CPK (U/L)	90.69 ± 31.69	90.74 ± 31.71	0.057

CRP; C-reactive protein, CPK; Creatinine phosphokinase. P value was significant at P <0.05.

Table 4: Intraoperative and postoperative complications of treated patients

Complications		Value
Intraoperative, n, (%)	Accidental durotomy	1 (0.83%)
Postoperative, n, (%)	Superficial infection	1 (0.83%)
	Muscle atrophy	3 (2.5%)
	Re-Surgery	2 (1.7%)

Abbreviations: n; number.

DISCUSSION

Narrowing of the lumbar spinal canal is a prevalent diagnosis among older adults, with an increasing trend in surgical interventions worldwide.[12] In the initial stages of treatment of LCS, non-invasive approaches such as physical therapy, spinal injections, and lifestyle modifications are typically employed to alleviate symptoms.[13] However, surgical intervention is often considered valuable if these conservative measures fail to provide adequate relief.[14]

The decompressive approach is an effective treatment for alleviating symptoms of LCS.[15] In long-term outcomes, patients who underwent surgery exhibited more significant improvements in back pain and lower limb symptoms than those who did not.[16]

In the current study, the functional outcomes, as measured by the ODI and VAS scores, showed significant improvements at the 1 month and 1 year postoperatively compared to the preoperative status. Clinically, the improvement in mean maximum walking distance comparing preoperative and postoperative values was statistically significant after trans-spinous decompression. Also, radiologically, there was statistically significant improvement in mean A-P diameter of spinal canal compared to preoperative values. Comparing preoperative and 2-weeks postoperative values of biochemical markers of paraspinal muscles damage, CRP and CPK did not differ significantly. The complication rates were low, with a durotomy rate of 0.83% and a superficial infection rate of 0.83%. The incidence of muscle atrophy was low (2.5%) and only 2 (1.7%) cases needed reoperation.

Considering functional outcomes, Awaya et al. concluded that VAS significantly improved after SP splitting laminotomy.[17] Voglis et al. also reported that 93% of the population experienced improved functional outcomes following the SP splitting approach.[10] Cheon et al. also reported that VAS and ODI in the postoperative period significantly improved after SP splitting laminectomy.[18] Several authors documented similar results like Al

AlGioushy et al. and Watanabe et al., who concluded that SP splitting approach for microscopic decompression of lumbar canal stenosis is an effective approach achieving a significant functional outcome.[19,20] These conclusions matched the results of the current study.

Radiologically, SP splitting laminectomy achieved effective neural decompression as there was a statistically significant change in the mean A-P diameter of the spinal canal after surgery. Lee and Srikantha in their study revising radiological outcome after SP splitting laminectomy concluded that this technique afforded effective central and lateral recess decompression yet achieving several advantages over the conventional laminectomy technique.[9]

Also, in the current study, the mean maximum walking distance significantly improved after SP splitting laminectomy. Voglis et al. had results matching with current study results.[10] Ovaliogu et al. also stated that there was improvement in walking distance after SP splitting laminectomy.[7]

As regards operative findings, the current study included cases with single level LCS only. Watanabe et al. similarly, demonstrated that SP splitting laminotomy was performed in 69±29 minutes, and total blood loss was 44±75 ml.[20] AlGioushy et al. had a mean operative time of 108.3±13.4 minutes, and the mean blood loss was 168.3±45.3 cc.[19] Awaya et al. had similar results with an operative time of 124.3±48.1 minutes, and total blood loss was 107.0±129.7 ml.[17] These values are higher than those of the current study. Considering treating a single level of canal stenosis in the current study while treating multiple levels in other studies can justify the non significant variation in operative time and blood loss.

The relatively low inflammatory response and muscle damage associated with this surgical technique may be attributed to the less muscle dissection and disruption of soft tissues compared to other approaches, which can reduce inflammation and muscle damage.[19,21] This approach reduces the risk of postoperative muscle atrophy and weakness by preserving the para-spinal muscles and their attachments. The use of specialized retractors and a surgical microscope further enhances the precision of the procedure, minimizing muscle and bone damage and leading to better outcomes for the patient.[22]

The current study showed that the complication rate was low. Awaya et al. showed similar results demonstrating a low complication rate including incidental durotomy and superficial infection.[17] Only 2 cases needed reoperation, one case had persistence of significant claudication due to inadequate lateral recess decompression and was revised with conventional laminectomy and aggressive medial facetectomy and pedicular fixation. The other case had instability after 2 years follow up and needed stabilization by fixation.

Kitis et al. study findings indicated that SP splitting laminectomy offered a viable alternative to traditional laminectomy, with the added benefit of minimizing postoperative complications.[23]

Limitations

The limitations of this study include the lack of a control group and the retrospective nature of the study. Future studies with long follow-up periods and comparative analysis with other surgical techniques would strengthen the evidence supporting the SP splitting approach.

CONCLUSION

The SP splitting approach is a safe and effective minimally invasive technique for LCS surgical management that preserves the SP with favorable clinical outcomes, minimal surgical morbidity, and a relatively low complication rate. It is associated with significant improvement in ODI and VAS. Also, it affords significant favorable outcomes as regards the improvement in diameter of the spinal canal and neural decompression and in improving the maximum walking distance.

List of abbreviations

A-P: Antero-posterior.
CL: Conventional laminectomy.
CT: Computerized tomography.
CPK: Creatinine phosphokinase.
CRP: C-reactive protein.
IRB: Institutional review board.
LCS: Lumbar canal stenosis.
MISS: Minimally invasive spine surgery.
MRI: Magnetic resonance imaging.
n: Number.
ODI: Oswestry disability index.
SP: Spinous process.
SPSS: Statistical package for social sciences.
SD: Standard deviation.
VAS: Visual analogue scale.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this paper.

Funding

The authors received no financial support for the research, authorship, and/or publication of this paper.

REFERENCES

1. Lee BH, Moon SH, Suk KS, Kim HS, Yang JH, Lee HM. Lumbar spinal stenosis: Pathophysiology and treatment principle: A narrative review. *Asian Spine J.* 2020;14(5):682-693.

2. Deer T, Sayed D, Michels J, Josephson Y, Li S, Calodney AK. A review of lumbar spinal stenosis with intermittent neurogenic claudication: Disease

and diagnosis. *Pain Med.* 2019;20(Suppl 2):S32-S44.

3. Lee SY, Kim TH, Oh JK, Lee SJ, Park MS. Lumbar stenosis: A recent update by review of literature. *Asian Spine J.* 2015;9(5):818-828.

4. Guha D, Heary RF, Shamji MF. Iatrogenic spondylolisthesis following laminectomy for degenerative lumbar stenosis: Systematic review and current concepts. *Neurosurg Focus.* 2015;39(4):E9.

5. Zhang J, Liu TF, Shan H, et al. Decompression using minimally invasive surgery for lumbar spinal stenosis associated with degenerative spondylolisthesis: A review. *Pain Ther.* 2021;10(2):941-959.

6. Hanafy AM, El Gammal AS, Negm HM, Aborahma HY, Eissa MK. Different surgical modalities in the management of lumbar canal stenosis. *Menoufia Med J.* 2019;32(2):566-573.

7. Ovalioglu TC, Ozdemir Ovalioglu A, Canaz G, Gunes M, Babur M, Emel E. Efficacy of spinous process splitting decompression compared with conventional laminectomy for degenerative lumbar stenosis. *World Neurosurg.* 2022;164:e1233-e1242.

8. Rajasekaran S, Thomas A, Kanna RM, Prasad Shetty A. Lumbar spinous process splitting decompression provides equivalent outcomes to conventional midline decompression in degenerative lumbar canal stenosis: A prospective, randomized controlled study of 51 patients. *Spine (Phila Pa 1976).* 2013;38(20):1737-1743.

9. Lee S, Srikantha U. Spinous process splitting laminectomy: Clinical outcome and radiological analysis of extent of decompression. *Int J Spine Surg.* 2015;9:20.

10. Voglis S, Tosic L, Höbner LM, et al. Spinous-process-splitting versus conventional decompression for lumbar spinal stenosis: Comparative study with respect to short-term postoperative pain and analgesics use. *World Neurosurg.* 2022;160:e80-e87.

11. Baghdadi YM, Moussallem CD, Shuaib MA, Clarke MJ, Dekutoski MB, Nassr AN. Lumbar spinous process-splitting laminoplasty: A novel technique for minimally invasive lumbar decompression. *Orthopedics.* 2016;39(5):e950-e956.

12. Zhang F, Ye D, Zhang W, Sun Y, Guo L, Li J. Efficacy of lumbar decompression under large-channel spinal endoscope in elderly patients with segmental lumbar spinal stenosis. *J Orthop Surg Res.* 2024;19(1):16.

13. Gagliardi M, Guiroy A, Sícoli A, Masanés NG, Ciancio AM, Asghar J. Spinous process splitting laminectomy for lumbar spinal stenosis: 2D operative video. *World Neurosurg.* 2022;159:107.

14. Overdevest GM, Jacobs W, Vleggeert-Lankamp C, Thomé C, Gunzburg R, Peul W. Effectiveness of posterior decompression techniques compared with conventional laminectomy for lumbar stenosis. *Cochrane Database Syst Rev.* 2015;2015(3):CD010036.

15. Yuan H, Yi X. Lumbar spinal stenosis and minimally invasive lumbar decompression: A narrative review. *J Pain Res.* 2023;16:3707-3724.

16. Anjarwalla NK, Brown LC, McGregor AH. The outcome of spinal decompression surgery 5 years on. *Eur Spine J.* 2007;16(11):1842-1847.

17. Awaya T, Nishimura Y, Eguchi K, et al. Radiological analysis of minimally invasive microscopic laminectomy for lumbar canal stenosis with a focus on multilevel stenosis and spondylolisthesis. *World Neurosurg.* 2022;164:e224-e234.

18. Cheon S, Shin YS, Lee S-H, Kim E-S, Lee S. Clinical and radiological outcomes of spinous process-splitting laminectomy for lumbar spinal stenosis at 1 year: A preliminary report of a single-institution experience. *J Minim Invasive Spine Surg Tech.* 2023;8(2):205-213.

19. AlGioushy AM, Negm MAA, Abd ElHakim MAE. Minimally invasive spinous process splitting approach for management of lumbar canal stenosis. *Egypt J Hosp Med.* 2018;73(8):7394-7399.

20. Watanabe K, Matsumoto M, Ikegami T, et al. Reduced postoperative wound pain after lumbar spinous process-splitting laminectomy for lumbar canal stenosis: A randomized controlled study. *J Neurosurg Spine.* 2011;14(1):51-58.

21. Tomasi SO, Umana GE, Scalia G, et al. Lumbar spinous process–splitting technique for ligamentum flavum cyst removal. *J Neurol Surg A Cent Eur Neurosurg.* 2024;85(2):195-201.

22. Maruo K, Tachibana T, Inoue S, Arizumi F, Yoshiya S. Prognostic factors of surgical outcome after spinous process-splitting laminectomy for lumbar spinal stenosis. *Asian Spine J.* 2015;9(5):705-712.

23. Kitis S, Seyıthanoglu MH, Papaker MG, Cevık S, Emel E. Comparison of classical laminectomy and transspinous-split laminectomy techniques. *J Spine Neurosurg.* 2016;5:6.