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Original Article

Comparative Study of Minimally Invasive Lumbar Decompression versus Decompressive Laminectomy with Posterolateral Transpedicular Fixation for the Treatment of Degenerative Lumbar Canal Stenosis

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Abstract

Background: The classic laminectomy for spinal decompression was the treatment of choice of the degenerative lumbar canal stenosis (LCS). Many surgeons prefer to add instrumented lumbar fusion to avoid future instability after the removal of posterior elements. Adding fusion is associated with more bleeding and longer periods of hospitalization. Minimally invasive lumbar decompression (MILD) has been advocated for successful decompression with less bleeding loss and shorter hospitalization. **Aim of the Work:** To evaluate and compare the clinical outcomes of two different treatment modalities for degenerative LCS: the classic laminectomy with posterolateral transpedicular screw fixation and the MILD. **Patients and Methods:** Fifty patients with degenerative LCS were randomized from two institutions: Ain Shams University Hospital and Arab Contractors Medical Center, who underwent surgeries for degenerative LCS between 2016 and 2018 with 1-year follow-up. The study compared two cohorts: Group A – 25 patients underwent classic lumbar laminectomy with posterolateral transpedicular fixation, and Group B – 25 patients underwent MILD. **Results:** There were no statistically significant differences between both treatment modalities in the VAS for leg pain and back pain, the patient satisfaction index, and the Oswestry disability index after 1 year. The fusion operations were associated with higher estimates of blood loss, longer hospital stay, and more financial costs. **Conclusion:** MILD has the same satisfactory results as classic laminectomy with posterolateral fixation for the treatment of degenerative LCS with less bleeding loss and shorter hospitalization. Since the results are comparable, MILD is suggested in low-income countries as Egypt for economic reasons.

Keywords: *Canal stenosis, classic laminectomy, degenerative lumbar, minimally invasive lumbar decompression, posterolateral transpedicular fixation*

Introduction

Degenerative lumbar canal stenosis (LCS) remains one of the most common indications for lumbar spine surgery in elderly patients.[1]

LCS is classified according to the etiology into degenerative and congenital types, as well as according to the site of compression into central, lateral recess, and foraminal stenosis.[2]

Symptoms vary depending on the type of LCS; in central LCS, patients experience neurogenic claudication; patients with lateral recess stenosis usually present with radicular symptoms.[3]

Radiographic evidence of narrowing of the spinal canal is sought. Magnetic resonance imaging (MRI) is the diagnostic imaging of choice with many proposed trials to classify the severity of LCS.[4]

The appropriate management of LCS was a subject of debate in many studies with different outcomes and recommendations, which made generating evidence-based guidelines difficult.[5]

Conservative management is usually tried including medications and physiotherapy.[6]

The classic surgical approach for lumbar stenosis was a wide bilateral decompressive laminectomy along with resection of the medial portion of the facet joints to decompress the affected neural elements.[7] Despite its efficacy to relieve stenosis and

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improve symptoms, many drawbacks were reported especially increasing the possibility of iatrogenic instability.[8]

Table 1: Patient satisfaction index used in this study[11]

Score	Patient responses
1	Surgery met my expectations
2	I did not improve as much as I had hoped, but I would undergo the same operation for the same results
3	Surgery helped, but I would not undergo the same operation for the same outcome
4	I am the same or worse as compared to before surgery

Adding instrumented lumbar fusion to the classic decompressive laminectomy improved the clinical outcomes, but it was associated with some complications including increased incidence of adjacent segment degeneration and hardware-related complications.[9]

To avoid these drawbacks, minimally invasive spine surgeries have been introduced, including bilateral laminotomy and unilateral laminotomy with bilateral decompression (ULBD). They are associated with minimal bleeding and less postoperative pain, which shorten the recovery period.[10]

Table 2: Demographic data of both groups

	Fusion group (*n*=25)	Mild group (*n*=25)	Test value	*P*	Significance
Age					
Mean±SD	54.36±8.00	54.28±8.06	0.035**	0.972	NS
Range	40-81	39-68			
Sex, *n* (%)					
Female	0 (0.0)	3 (12.0)	3.191*	0.074	NS
Male	25 (100.0)	22 (88.0)			

*Chi-square test; **Independent *t*-test. *P*>0.05 – NS; *P*<0.05 – S; *P*<0.01 – HS. NS – Nonsignificant; SD – Standard deviation; HS – Highly significant; S – Significant

Table 3: Preoperative clinical presentation of both groups

	Fusion group (*n*=25)	MILD group (*n*=25)	Test value**	*P*	Significance
VAS leg					
Mean±SD	7.20±1.00	7.40±1.12	−0.667	0.508	NS
Range	6-8	6-9			
VAS back					
Mean±SD	4.56±1.36	4.60±1.66	−0.093	0.926	NS
Range	2-6	2-7			
ODI					
Mean±SD	46.76±9.90	50.88±10.14	−1.453	0.153	NS
Range	32-68	26-62			

*Chi-square test; **Independent *t*-test. *P*>0.05 - NS; *P*<0.05 - Significant; *P*<0.01 - Highly significant. VAS – Visual analog score; ODI – Oswestry disability index; SD – Standard deviation; NS – Nonsignificant; HS – Highly significant; S – Significant

Table 4: Number of levels and their distribution

	Fusion group (%)	Mild group (%)	Test value**	*P*	Significance
Number of levels					
1	7 (28.0)	10 (40.0)	3.029*	0.387	NS
2	15 (60.0)	9 (36.0)			
3	2 (8.0)	4 (16.0)			
4	1 (4.0)	2 (8.0)			
Which level					
L1.2.3.4.5	0 (0.0)	2 (8.0)	8.446*	0.295	NS
L2.3.4.5	1 (4.0)	2 (8.0)			
L2.3.4.5.S1	1 (4.0)	0 (0.0)			
L3.4.5	13 (52.0)	6 (24.0)			
L3.4.5.S1	1 (4.0)	2 (8.0)			
L4.5	6 (24.0)	10 (40.0)			
L4.5.S1	2 (8.0)	3 (12.0)			
L5.S1	1 (4.0)	0 (0.0)			

*Chi-square test; **Independent *t*-test. *P*>0.05 - NS; *P*<0.05 - Significant; *P*<0.01 - Highly significant. NS – Nonsignificant; HS – Highly significant; S – Significant

Aim of the study

To evaluate and compare the clinical outcomes of two different treatment modalities for degenerative LCS: classic laminectomy with posterolateral transpedicular screw fixation and minimally invasive lumbar decompression (MILD) (bilateral laminotomy or ULBD).

Patients and Methods

This was a randomized study of 50 patients with degenerative LCS. The study compared two cohorts: Group A – 25 patients underwent classic lumbar laminectomy with posterolateral transpedicular fixation (even number cases), and Group B – 25 patients underwent MILD (odd number cases). Patients in this study were treated between November 2016 and December 2018 in the Arab Contractors Medical Center and Ain Shams University Hospitals, with a follow-up at least 1 year. We included patients presented with symptoms of neurogenic claudication referable to degenerative lumbar stenosis, not responding to conservative treatment for at least 6 months. Patients with radiologic features of instability, deformity, nondegenerative pathology (infection or neoplasm), previous surgery for the lumbosacral spine, discogenic canal stenosis (not associated with ligamentum flavum hypertrophy or facet joint hypertrophy), congenital bony canal stenosis, and mental or psychological illness were excluded from the study.

Preoperative evaluation

This evaluation includes detailed history of the symptoms using the grading system of the visual analogue scores (VAS) for back pain and leg pain, as well as the impact on the functional state of the patient in daily life using the Oswestry disability index (ODI). Examination of the motor power, eliciting stretch signs, and tests for sacroiliac and hip joints were routinely done. Written informed consent was obtained. MRI lumbosacral spine, plain X-rays with anteroposterior, lateral, flexion, extension, right oblique and left oblique views were done for all the patients. Computed tomography (CT) scans were not done routinely as all images were not older than 6 months.

Postoperative management

Hospital postoperative analgesia was in all cases the intravenous administration of paracetamol 1 g every 8 h (maximum dose 4 g in nonhepatic patients with minimum interval of 6 h). Two grams of cefazolin (first-generation cephalosporin) was administered intravenously 1 h before the operation and continued for 3 days postoperatively. Patients who underwent lumbar fixation were

Table 5: Difference between pre- and post-operative scores in the fusion group

	Fusion group (*n*=25)				Test value**	*P*	Significance
	Pre	Immediate	6 months	1 year			
VAS leg							
Mean±SD	7.20±1.00	2.44±0.87		2.60±0.91	21.294	0.000	HS
Range	6-8	1-4		2-4			
VAS back							
Mean±SD	4.56±1.36	4.30±1.27		3.08±1.58	25.427	0.000	HS
Range	2-6	3-6		1-6			
ODI							
Mean±SD	46.76±9.90		29.16±9.33	19.52±7.97	11.210	0.000	HS
Range	32-68		15-45	10-40			

**Paired *t*-test; ≠ - Wilcoxon test. *P*>0.05 - NS; *P*<0.05 - S; *P*<0.01 - HS. NS – Nonsignificant; HS – Highly significant; S – Significant; VAS – Visual analog score; SD – Standard deviation

Table 6: Difference between pre-and post-operative scores in the mild group

	Mild group (*n*=25)				Test value**	*P*	Significance
	Pre	Immediate	6 months	1 year			
VAS leg							
Mean±SD	7.40±1.12	2.60±0.91		2.44±0.87	16.695	0.000	HS
Range	6-9	2-4		1-4			
VAS back							
Mean±SD	4.60±1.66	3.59±1.10		3.56±1.56	5.024	0.031	S
Range	2-7	3-5		2-6			
ODI							
Mean±SD	50.88±10.14		25.08±8.42	25.12±9.23	13.814**	0.000	HS
Range	26-62		13-45	11-42			

**Paired *t*-test. *P*>0.05 - NS; *P*<0.05 - S; *P*<0.01 - HS. VAS – Visual analog score; ODI – Oswestry disability index; SD – Standard deviation; NS – Nonsignificant; HS – Highly significant; S – Significant

instructed to wear a lumbosacral corset for 3 months. Take-home medications usually were paracetamol tablets (1 g every 8 h for 10 days).

Clinical evaluation

The surgical outcomes assessed were the preoperative to postoperative changes in leg/back pain and disability/function and patient satisfaction with the procedure. Pain was measured according to the visual analog scale (VAS) for leg pain and back pain immediate and after 1 year. Functional scores were measured using the ODI at 6 months and after 1 year. Patient satisfaction with the procedure was measured using a patient satisfaction index (PSI) questionnaire (an early version of the North American Spine Society Outcome Questionnaire) during the final visit.[11] Possible scores of 1–4, i.e., scores of 1 and 2 were considered to indicate "satisfied/good" while scores of 3 or 4 were considered to indicate "dissatisfied/poor" as shown in Table 1.

Radiological evaluation

Postoperative plain X-rays for cases of lumbar fixation were obtained on the 2nd day postoperatively and then after 3 months and 6 months for the assessment of fusion. Postoperative CT was done in selected cases to assess the accuracy of the implanted screws when in doubt for the fixation group. MRI lumbosacral with contrast was done when the symptoms of recurrence or new pattern of pain developed.

Results

A total of 50 patients underwent decompression for the treatment of a single level or multiple levels of degenerative LCS.

Baseline demographic data

Group A – classic laminectomy and posterolateral fixation (fusion group) included 25 patients with a mean age of 54.36 (range 40–81) years. All patients were males. Group B – MILD group included 25 patients with a mean age 54.28 of (range 39–68) years. Twenty-two patients were male and three patients were female. There were no statistically significant differences between both groups in regard to age and sex distribution as shown in Table 2.

Baseline patients' clinical data

The mean preoperative VAS for low back pain was 4.56 ± 1.36 in the fusion group and was 4.6 ± 1.66 in the MILD group. The mean preoperative VAS for lower limb pain was 7.2 ± 1.00 in the fusion group and was 7.40 ± 1.12 in the MILD group. The mean preoperative ODI was 46.76 ± 9.90 in the fusion group and was 50.88 ± 10.14 in the MILD group. There were no significant differences in the clinical presentation between the fusion and the MILD groups, making our cohorts comparable as shown in Table 3.

Number of levels and their distribution in both groups

The most frequent level that needed decompression in both groups was L4–5 (98%) and then L3–4 (56%). Single-level canal stenosis was 17 cases in both groups; 7 cases in the fusion group and 10 cases in the MILD group. The difference was statistically insignificant. There was no statistically significant disturbance between the distributions of levels between groups as in Table 4.

Clinical outcomes

Fusion group

There is a highly statistically significant decrease in VAS back from preoperative mean of 4.56 to the immediate postoperative mean of 4.30 and the improvement continued at the 1-year mean of 3.08. There is also a highly statistically significant decrease in VAS leg from preoperative mean of 7.2 to the immediate postoperative mean of 2.44 and continued at the 1-year mean of 2.6. There is a highly statistically significant decrease in ODI from preoperative mean of 46.76 (range 32–68) to postoperative mean of ODI at 6 months 29.16 (range 15–45) and at 1 year 19.52 (range 10–40) as in Table 5.

Minimally invasive lumbar decompression group

There is a statistical significant decrease in VAS of back pain from preoperative mean of 4.6 to the immediate postoperative mean of 3.59 and continued to the 1-year mean of 3.56. There is also a highly statistically significant decrease in VAS of leg pain from preoperative mean of 7.4 to the immediate postoperative mean of 2.6 and 1-year postoperative mean of 2.44.

There is a highly statistically significant decrease in ODI from preoperative mean of 50.88 to the 6-month postoperative mean of ODI of 25.08 and continued to the 1-year mean ODI of 25.12 as in Table 6.

There is no statistically significant difference between the immediate postoperative VAS of leg pain. The immediate postoperative VAS of back pain is significantly higher in the fusion group.

However, after 1 year, there is no statistically significant difference between the fusion group and the MILD group in the VAS of back pain and VAS of leg pain as in Table 7.

After 6 months, there is no difference in the mean ODI values in both groups; however, after 1 year, it was significantly higher in the MILD group as shown in Table 8.

There is no statistically significant difference between mean ODI changes (preoperative and postoperative) between both groups at 6 months and 1 year as in Table 9.

The percentage of patients who are satisfied postoperatively after 1 year was 84% in the fusion group and 88% in the MILD group, but this difference was not statistically significant ($P = 0.683$) as in Table 10.

Table 7: Comparison between visual analogue score values of back pain and leg pain between both groups immediate postoperative and after 1 year

	Fusion group (*n*=25)	Mild group (*n*=25)	Test value**	*P*	Significance
Immediate					
VAS leg					
Mean±SD	2.44±0.87	2.60±0.91	0.634	0.529	NS
Range	1-4	2-4			
VAS back					
Mean±SD	4.30±1.27	3.59±1.10	2.127	0.039	S
Range	3-6	3-5			
1 year postoperative					
VAS leg					
Mean±SD	2.60±0.91	2.44±0.87	0.634	0.529	NS
Range	2-4	1-4			
VAS back					
Mean±SD	3.08±1.58	3.56±1.56	−1.082	0.284	NS
Range	1-6	2-6			

**Independent *t*-test. *P*>0.05 - NS; *P*<0.05 - S; *P*<0.01 - HS. NS – Nonsignificant; HS – Highly significant; S – Significant; VAS – Visual analogue score; SD – Standard deviation

Table 8: Comparison between both groups in the mean Oswestry disability index values after 6 months and after 1 year postoperatively

Difference	Fusion group (*n*=25)	Mild group (*n*=25)	Test value**	*P*	Significance
ODI after 6 months					
Mean±SD	29.16±9.33	25.08±8.42	1.623	0.111	NS
Range	15-45	13-45			
ODI after 1 year					
Mean±SD	19.52±7.97	25.12±9.23	−2.296	0.026	S
Range	10-40	11-42			

**Independent *t*-test. *P*>0.05 - NS; *P*<0.05: S; *P*<0.01 - HS. NS – Nonsignificant; HS – Highly significant; S – Significant; ODI – Oswestry disability index; SD – Standard deviation

Table 9: Mean Oswestry disability index change between preoperative and 6 months and 1 year, respectively

	Fusion group (*n*=25)	Mild group (*n*=25)	Test value**	*P*	Significance
Mean ODI change preoperatively and 6 months postoperativley					
Mean±SD	−17.60±14.91	−25.80±14.08	1.999	0.051	NS
Range	−45-3	−47-14			
Mean ODI change preoperatively and 1 year postoperative					
Mean±SD	−27.24±12.1	−25.76±9.32	0.980	0.332	NS
Range	−46-7	−42-8			

**Independent *t*-test. *P*>0.05 - NS; *P*<0.05 - S; *P*<0.01 - HS. NS – Nonsignificant; HS – Highly significant; S – Significant; ODI – Oswestry disability index; SD – Standard deviation

Blood loss

The estimated blood loss was higher in the fusion group with a mean of 422 ml (range 150–1000) than in the MILD group with a mean of 298 ml (range 180–600). There is a highly statistically significant difference between both groups.

Operative time

The operative time of the classic laminectomy with transpedicular fixation ranged from 2 to 6 h (mean 3.24). The operative time of MILD ranged from 2 to 6 h (mean 3.33). The difference is statistically insignificant.

Complications

Six patients in the study had complications; two cases in the fusion group and four in the MILD group (The difference is statistically insignificant). In the fusion group, one patient had an unintended dural tear which was successfully managed intraoperatively with the dural repair. Another one had a superficial surgical site infection (SSI) on the 3rd day postoperatively which required debridement without system removal. The patient stayed 16 days and then was discharged with secondary stitches. In the MILD group, four cases had accidental

dural tears, which were covered by muscle grafts and blood patches.

Hospital stay

The length of hospital stay was higher in the fusion group with a mean of 5.56 days (range 3–16) than in the MILD group with a mean of 3 days (range 2–7). The difference is statistically highly significant as shown in Table 11.

Cost

The classic laminectomy with posterolateral fixation demands higher costs than the MILD because of the used implants and the longer hospitalization as shown in Table 12.

Discussion

Degenerative LCS remains one of the most common indications for spine surgery in the elderly. The pathophysiology of stenosis is a cumulative process over the years, leading to thickening or buckling of ligamentum flavum, as well as facet joint hypertrophy. Associated aspects of degeneration affecting intervertebral discs and spondylolisthesis may be found.[2]

Surgical intervention is usually advised after the failure of conservative treatment, including nonsteroidal anti-inflammatory drugs, muscle relaxants, physical therapy, and less commonly used epidural steroid injections. There is no consensus regarding the exact period for conservative management. The main goal of surgical intervention is to decompress the neural elements.[12]

For the classic laminectomy, all posterior elements are removed, followed by complete laminectomy, medial facetectomy, and bilateral foraminotomy. The drawbacks of this technique were reported, including bleeding loss, increased hospital stay, and spine instability.[13] Even with the preservation of the facet joint, *in vitro* and clinical studies showed that removing the posterior elements is sufficient to destabilize this segment of the spine. These patients may require reoperation for fixation. A biomechanical study of removing the posterior elements was done by Bresnahan *et al.* using an *in vitro* model. They concluded that the removal of posterior elements at L3–L4 and L4–L5 results in increased flexion-extension and axial rotation at the surgical site. They suggested that minimally invasive approaches may avoid iatrogenic instability.[14]

MILD spares most of the posterior elements without risking the stability of the segment as proved before by

Table 10: Patient satisfaction index in both groups

PSI	Fusion group, *n* (%)	Mild group *n* (%)	Test value**	*P*	Significance
Grade I-II	21 (84)	22 (88)	0.166	0.683	NS
Grade III-IV	4 (16)	3 (12)			

**Independent *t*-test. *P*>0.05 - NS; *P*<0.05 - S; *P*<0.01 - HS. PSI – Patient satisfaction index; NS – Nonsignificant; HS – Highly significant; S – Significant

Table 11: Blood loss and hospital stay are higher in the fusion group

	Fusion group (*n*=25)	Mild group (*n*=25)	Test value**	*P*	Significance
Operative time (h)					
Mean±SD	3.24±1.16	3.33±1.30	−0.263**	0.794	NS
Range	2-6	2-6			
Blood loss (mL)					
Mean±SD	422.00±185.45	298.00±116.76	2.829**	0.007	HS
Range	150-1000	180-600			
Complications, *n* (%)					
No	23 (92.0)	21 (84.0)	0.758*	0.384	NS
Yes	2 (8.0)	4 (16.0)			
Hospital stay					
Mean±SD	5.56±2.42	3.00±1.19	4.752**	0.000	HS
Range	3-16	2-7			

Blood loss and hospital stay are higher in the fusion group. They are equal in mean operative time and complications. *Chi-square test; **Independent *t*-test. *P*>0.05 - NS; *P*<0.05 - S; *P*<0.01 - HS. NS – Nonsignificant; HS – Highly significant; S – Significant; SD – Standard deviation

Table 12: Cost per Egyptian pound of both treatment modalities

Cost × 1000 Egyptian pound	Fusion group (*n*=25)	Mild group (*n*=25)	Test value**	*P*	Significance
Mean±SD	47.3±5.0	27.5±2.5	17.710	<0.001	HS
Range	40-60	25-30			

**Independent *t*-test. *P*>0.05 - NS; *P*<0.05 - S; *P*<0.01 - HS. NS – Nonsignificant; HS – Highly significant; S – Significant; SD – Standard deviation

biomechanical studies.[8] Both bilateral laminectomies and ULBD are superior to the classic laminectomy in preserving spine stability.[15] They are associated with less bleeding amount and less decreased hospital stay.[16]

In our study, we compared two techniques of decompression; the classic laminectomy with posterolateral transpedicular fixation versus MILD techniques; either bilateral laminotomy or ULBD.

Patient population

The mean age in our study was 54 years, slightly younger than what was reported in the literature that the degenerative process of the lumbar spine starts during or after the seventh decade of life. This can be explained by the remarkable increase in the prevalence of obesity to be more than one-third of the whole population; being more than double among females (46%) as compared to males (22%).[17]

Only three women were included in our study as most of the patients in our study seeking for the treatment of LCS were manual workers. In the literature, there is no agreement about gender differences in the prevalence of symptomatic LCS. However, the prevalence in females was found to be higher after the age of 70 years according to some studies.[14]

The most common affected level was L4–5 followed by L3–4 as was reported in the literature.[18]

Clinical outcomes

There is no statistical difference between both groups in the mean ODI differences after 6 months and 1 year. However, if the ODI mean values are interpreted according to Fairbank and Pynsent's study,[19] patients in the fusion group after 1 year have a minimal disability and do most of the normal daily activities (mean ODI = 19.52). In most cases, no treatment was needed, but the patients should take care while liftingand sitting, keep fit, and control their body weight. Patients in the MILD group with moderate disability may have more pain with standing, sitting, and lifting with the low back complaint which can be treated conservatively (mean ODI = 25.12).

Immediate postoperative VAS for back pain was significantly higher in the fusion group than in the MILD group. This was due to the larger incisions. However, after 1 year, there was no statistically significant difference between both groups. Both groups show no differences in the PSI score.

Adding fusion to the decompression procedures is a subject of debate in cases without spinal instability. In the Swedish randomized clinical trial by Forsth *et al.*, 247 patients with degenerative LCS with or without spondylolisthesis were recruited with 5-year follow-up. There was no ODI difference between the groups who underwent decompression alone and who had added fusion after 2 and 5 years.[20]

Another study by Munting *et al.* compared laminectomy alone, laminectomy with fusion, and bilateral laminotomy and ULBD in 1176 cases with 1-year follow-up. Patients had better satisfactory results when adding fusion but with higher rates of complications.[21]

Intraoperative parameters

There was no significant difference between both treatment modalities in the surgery duration. The increased operation time in the MILD is due to the steep learning curve for manipulating instruments through a small space and for adequate decompression without complications. In our study, adding transpedicular fixation to the classic laminectomy and longer incisions may be the cause for extending the duration.

Adding fusion to decompression was associated with a longer duration in other studies.[20,22]

Procedural complications

The bleeding loss was significantly higher in the fusion group with a mean of 422 ml while in the MILD group was 298 ml. None of these patients required perioperative blood transfusion.

In our study, the accidental dural tears occurred in four patients in the MILD group (three cases in the ULBD and one case in the bilateral laminotomy) while occurred in one patient in the fusion group. In the literature, the durotomy rates for laminectomy have been shown to range from 5% to 15%. The bilateral laminotomy is complicated by the accidental dural tears in 2%–6% and the ULBD in 3.5%–12%.[23]

Primary repair was done successfully in the one case of the classic laminectomy, while it was difficult to be done in the four cases of the MILD group. It was not clinically feasible, especially in cases of ULBD when the dural defect in the contralateral side. In these cases, other methods described for repair of durotomies were used, including using muscle or fat graft and blood-soaked gelfoam. Watertight closure was done in these cases.

Accidental dural tear is one of the most common complications of spine surgery. Improper management of dural tears may lead to a persistent cerebrospinal fluid (CSF) leak and the formation of a pseudomeningocele or CSF fistula, with symptoms of postural headache, nausea, and back pain.[24] These sequelae may not be present in the minimally invasive surgeries as small incisions and limited muscle separation do not create potential spaces for CSF collection.[25]

Only one patient in the study had an SSI on the 3rd day postoperatively. Wound swabs for microbiologic culture were taken. He underwent wound debridement without

removing the screws. There were no signs of infection affecting the implants intraoperatively or by the imaging studies. Intravenous antibiotics were prescribed according to the culture results, and the patient was discharged after the decline of the inflammatory markers. The incidence of SSI after instrumented spinal surgery has been reported to range from 2.2% to 20%.[26]

Hospital stay and costs

The length of hospital stay was significantly higher in the fusion group, which is considered a burden for any healthcare system even in developed countries. The increased hospital stay may increase the risk of hospital-acquired infection.

Minimally invasive spine surgeries with small incisions and limited tissue destruction usually have short recovery time with less postoperative pain and early mobilization. These are great concerns in old age, obesity, and comorbidities, e.g., diabetes mellitus and cardiovascular diseases, which may affect wound healing and early mobilization.[10]

In our study, the costs of the fusion group were significantly higher. The reports of the costs in the literature are variable, as not all these reports calculate the initial procedure, hospital, outpatient, emergency department, and medication charges. A study of 12,657 patients concluded that at 5 years, the cost were similar for both who received decompression alone and who underwent decompression with fusion.[27] Different results by a systematic review for studies done in Italy and the United Kingdom showed less costs with minimally invasive spine surgeries.[28]

Reoperation

During the follow-up, one patient in the fusion group underwent debridement without screws removal. Otherwise, no patient in our study was operated for residual symptoms of lumbar stenosis or new symptoms. No postoperative slippage occurred in the MILD group requiring reoperation and fixation.

The causes of reoperation are multifactorial, ranging from the type of the procedure performed or associated comorbidities. The literature does not indicate the superiority of any particular procedure. The reported causes of reoperation were inadequate decompression, the postoperative instability, or the adjacent segment degeneration after fusion operations.[29]

There was no statistical difference in the Swedish randomized controlled trial between decompression alone and adding fusion.[20] Using a larger study group (11,027 patients), a Korean study concluded also that the reoperation rate was not different between decompression and fusion surgeries after 5-year follow-up.[30] Deyo *et al.* retrospectively inspected 31,543 cases who underwent decompression alone or added fusion. They stated that the lower rate of reoperation in their study after the 1st year may be due to delayed bone fusion in elderly patients needed to generate adjacent segment pathologies.[9]

Study limitations

Our study has limitations as 1-year follow-up is not sufficient to assess the reoperation rate in case of adding fusion.

Other limitations include small sample size and lack of information about the body mass index of each patient and the associated comorbidities.

Conclusion

MILD has the same satisfactory results as classic laminectomy with posterolateral fixation for the treatment of degenerative LCS with less bleeding loss and shorter hospitalization. Since the results are comparable, MILD is suggested in low-income countries as Egypt for economic reasons.

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Conflicts of interest

There are no conflicts of interest.

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