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ORIGINAL ARTICLE

# Minimal clinically important difference (MCID)-based analysis of single- versus two-level laminectomy for lumbar spinal stenosis: a prospective study

Emir Begagić[1*], Hakija Bečulić[1,2], Fahrudin Alić[1], Anes Mašović[1], Goran Lakičević[3,4], Lemana Buljubašić[5], Muhamed Haračić[6]

[1]Department of Neurosurgery, Cantonal Hospital Zenica, [2]Department of Anatomy, School of Medicine, University of Zenica, [3]Department of Neurosurgery, University Hospital Mostar, [4]Department of Surgery, University of Mostar, [5]Department of Physical Medicine and Rehabilitation, University Clinical Centre Tuzla, [6]Department of Plastic and Reconstructive Surgery, Cantonal Hospital Zenica; Bosnia and Herzegovina

## ABSTRACT

**Aim** To compare outcomes and minimal clinically important differences (MCID) between single-level laminectomy (SLL) and two-level laminectomy (TLL) for lumbar spinal stenosis (LSS).
**Methods** This prospective study included 119 patients with confirmed LSS who underwent SLL or TLL at Cantonal Hospital Zenica from January 2018 to January 2025. Assessments were performed preoperatively and at 1 and 6 months postoperatively using the Oswestry Disability Index (ODI), Swiss Spinal Stenosis Questionnaire (SSSQ), and Visual Analogue Scale (VAS) for back and leg pain, along with evaluation of motor, sensory, and urinary function. MCID values were used to assess meaningful improvement.
**Results** At six months, SLL patients had lower ODI (15.0 vs. 18.0; $p = 0.006$), VAS-LB (3.0 vs. 5.0; $p < 0.001$), and SSSQ score (17.2 vs. 21.6; $p < 0.001$) comparing to TLL patients. Motor deficits (14.8% vs. 35.5%; $p = 0.019$) and urinary dysfunction at 1 month (5.7% vs. 22.6%; $p = 0.013$) were less frequent in SLL. More SLL patients achieved MCID for ODI (80.7% vs. 58.1%; $p = 0.024$) and SSSQ (73.9% vs. 48.4%; $p = 0.017$) at 6 months, with TLL patients 28% and 34% less likely to reach MCID for ODI and SSSQ, respectively. No significant differences were found preoperatively or at 1 month.
**Conclusion** The study suggests that SLL and TLL have comparable outcome, with a slight tendency toward better functional improvement and fewer deficits after SLL.
**Keywords:** degenerative spinal stenosis, disability evaluation, nerve root compression, outcome assessment

## INTRODUCTION

Lumbar spinal stenosis (LSS) is the narrowing of the lumbar spinal canal, lateral recess, or neural foramina, either congenitally or due to degenerative spondylosis (1). Aging, chronic wear, and trauma contribute to intervertebral disc degeneration, leading to posterior protrusion, osteophyte formation, facet hypertrophy, synovial cysts, and *ligamentum flavum* thickening (2). According to Framingham study 19.4% of individuals aged 60–69 had a spinal canal diameter <10 mm (3). This condition significantly impacts patients' quality of life by often restricting mobility and everyday activities (4). The LSS most commonly presents with neurogenic claudication, typically involving a single spinal level. Multi-level involvement is considerably rare, resulting in a limited number of studies specifically addressing multi-level LSS (5).

The assessment of LSS relies on clinical, radiological, and self-reported evaluations, providing a foundation for long-term patient monitoring (1). To standardize the quantification of clinical status, Jaeschke originally defined the minimal clinically important difference (MCID) as the smallest score change perceived as beneficial by patients, warranting therapeutic modification in the absence of significant adverse effects or excessive costs (6). Over time, this concept has been refined to encompass the minimal clinically meaningful score change, the threshold risk reduction necessary to justify treatment, or the mean score difference between cohorts with optimal and suboptimal outcomes (7). Despite the established role of MCID in evaluating treatment efficacy, research comparing the outcome of single-level laminectomy (SLL) versus two-level laminectomy (TLL) for LSS remains limited. While MCID-based assessments have been conducted in LSS populations, no prior studies have specifically examined MCID-based outcomes in the context of SLL versus TLL.

***Corresponding author:** Emir Begagić
Department of Neurosurgery, Cantonal Hospital Zenica
Crkvice 67, 72000 Zenica, Bosnia and Herzegovina
E-mail: begagicem@gmail.com
Phone: +387 32 447 461;
ORCID ID: https://orcid.org/0000-0002-3988-8911

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The aim of this study was to evaluate and compare clinical outcome following single-level laminectomy (SLL) versus two-level laminectomy (TLL) in patients with lumbar spinal stenosis (LSS). Additionally, the study seeks to conduct a minimal clinically important difference (MCID)-based analysis to determine whether the perceived benefits of surgical intervention differ between cases involving compression of a single nerve root versus compression of two nerve roots.

## PATIENTS AND METHODS

### Patients and study design

This prospective study was conducted at the Neurosurgery Department of Cantonal Hospital Zenica from January 2018 to January 2025. A total of 119 consecutive patients meeting the inclusion criteria were enrolled, all with radiologically and clinically confirmed degenerative LSS, treated surgically with SLL or TLL. Exclusion criteria encompassed congenital LSS, involvement of more than two levels, coexisting disc herniation, spondylolisthesis (spinal segmental instability), spinal trauma, spinal tumours, and a history of lumbar spine surgery. Patients were divided into two groups: those who underwent SLL and those who underwent TLL.

All included patients provided signed informed consent.

Ethical approval was obtained from the Ethics Committee of Cantonal Hospital Zenica, Bosnia and Herzegovina.

### Methods

Demographic data on age and sex were extracted from medical records. All patients underwent lumbar spine MRI (1.5 T Magnetom Avanto, Siemens, Germany) to determine the affected vertebral level and grade LSS using the Schizas classification (8): A - no or minor stenosis with visible cerebrospinal fluid (CSF), B - moderate stenosis with identifiable rootlets filling the dural sac, C - severe stenosis without visible rootlets and a homogeneous gray dural sac signal, while posterior epidural fat remains present, D - complete absence of identifiable rootlets and posterior epidural fat. The MRI was used to verify the type of spinal stenosis, distinguishing central canal stenosis, lateral recess stenosis, and foraminal stenosis.

Preoperatively, the patients completed the Oswestry Disability Index (ODI), Swiss Spinal Stenosis Questionnaire (SSSQ), and Visual Analogue Scale (VAS) to assess functional impairment and pain severity. The ODI, consisting of ten sections, evaluated disability related to lower back pain, with scores ranging from 0 (no disability) to 100 (maximum disability) (9). The SSSQ included 12 items, with symptom severity and physical function subscales, yielding a total score between 12 and 55, where higher values indicate more severe symptoms (10). Pain intensity in the lower back (VAS-LB) and lower extremities (VAS-LE) was measured using the VAS, scored from 0 (no pain) to 10 (worst pain) (11).

Neurological assessment included an evaluation of motor deficit using the Medical Research Council (MRC) muscle power scale (12): 0 – no visible contraction, 1 – minimal visible contraction, 2 – movement without overcoming gravity, 3 – active movement overcoming gravity, 4 – movement against some resistance, and 5 – normal strength. Patients with an MRC score <5 were classified as having a motor deficit. Sensory function was assessed using the Sensory Assessment Scale (SAS) for L1-S3 dermatomes, scored as 0 – absent, 1 – reduced, and 2 – normal (12, 13). A SAS score <2 indicated sensory impairment. Urinary function was evaluated on a scale of 0 – complete dysfunction, 1 – partial dysfunction, and 2 – normal function (12), with score <2 indicating urinary dysfunction.

The indication for surgical intervention was the presence of neurogenic claudication accompanied by MRI-confirmed lumbar spinal stenosis classified as Schizas grade D (Figure 1A and 1B) or grade C (Figure 1D and 1E). The surgical procedure consisted of laminectomy with removal of the spinous process and flavectomy, aiming to achieve adequate decompression of the central dural sac.

Postoperative follow-up was conducted at one (±5 days) and six (±15 days) months, assessing ODI, SSSQ, VAS-LB, VAS-

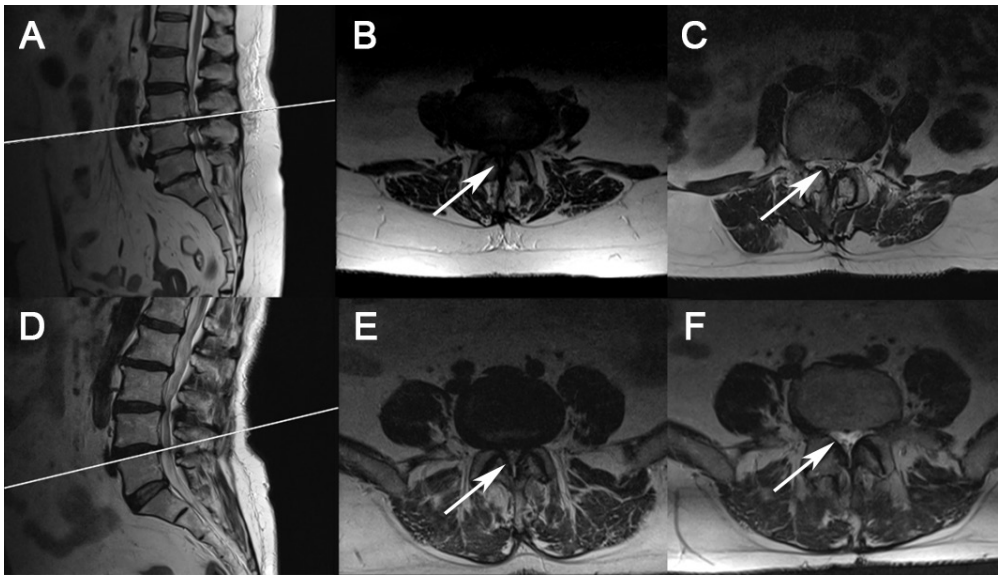


**Figure 1. Preoperative and postoperative MRI of the lumbar spine. Patient 1. A) Sagittal T2-weighted MRI showing lumbar spinal stenosis (LSS) at L3/L4 and L4/L5, treated with two-level laminectomy; B) preoperative axial MRI demonstrating Schizas grade D stenosis (arrow); C) postoperative axial MRI at 6 months showing restored rootlets and cerebrospinal fluid space (arrow). Patient 2. D) sagittal MRI of a patient with LSS at L4/L5; E) axial MRI demonstrating Schizas grade C stenosis (arrow); F) postoperative axial MRI at 6 months showing successful decompression with visible rootlets and cerebrospinal fluid space (arrow).**

LE, as well as motor, sensory, and urinary function. The average hospitalization duration was three days, during which wound status and signs of infection were monitored. Wound re-evaluation was performed on the 10th postoperative day. The MCID was defined as a change of -10.8 for ODI (14), -5.8 for SSSQ (14), and -3.0 for both VAS-LB and VAS-LE (15), calculated for the intervals from preoperative assessment to 1-month postoperative and preoperative to six-month postoperative. Postoperative evaluation included follow-up MRI of the lumbosacral spine at six months to assess the extent and adequacy of decompression (Figure 1C, F).

### Statistical analysis

Continuous variables were presented as median with interquartile range (IQR), based on distribution normality assessed using the Kolmogorov-Smirnov test, while categorical variables were expressed as frequency (N) and percentage (%). Group differences were analysed using the Mann-Whitney U test for continuous variables and Pearson's $\chi^2$ test for categorical variables. For the MCID-based analysis, relative risk (RR) with corresponding 95% confidence intervals (CI) was calculated in the context of TLL versus SLL. Statistical significance was set at $p<0.05$.

## RESULTS

The median age was 54 years (IQR: 42.5–61.0) in the SLL group and 56 years (IQR: 44.0–62.0) in the TLL group (p=0.524). The SLL group included 39 males (44.3%) and 49 females (55.7%), while the TLL group had 15 males (48.4%) and 16 females (51.6%) (p=0.445). Central canal stenosis was present in 54 (61.4%) SLL and 18 (58.1%) TLL patients (p=0.741), lateral recess stenosis in 76 (86.4%) and 27 (87.1%) (p=0.913, and foraminal stenosis in 56 (63.6%) and 20 (64.5%) patients, respectively (p=0.921). Schizas grade C occurred in 54 (61.4%) SLL and 15 (48.4%) TLL patients, and grade D in 34 (38.6%) and 16 (51.6%) patients, respectively (p=0.307) (Table 1). Among 103 SLL patients (Figure 2A), the most commonly treated levels were L3 (N=31; 30.1%) and L4 (N=30; 29.1%). In 33 TLL patients (Figure 2B), the most frequently decompressed levels were L3–L4 (N=13; 41.9%) and L4–L5 (N=9; 29.0%).

The ODI scores were lower in the SLL comparing to TLL group at one month, 34.0 vs. 39.0 (p=0.010), and at six months, 15.0 vs. 18.0 (p=0.006). The VAS-LB was lower at six months in SLL patients, 3.0 vs. 5.0 (p<0.001). The SSSQ scores were lower in the SLL comparing to TLL group preoperatively, 37 vs. 44 (p=0.005), at one month, 24.5 vs 30.8 (p<0.001), and at six months, 17.2 vs. 21.6 (p<0.001). Motor deficits were more frequent in TLL comparing to SLL patients at six months, 35.5% vs. 14.8% (p=0.019), and urinary dysfunction was higher at one month, 22.6% vs. 5.7% (p=0.013) (Table 2).

A higher number of patients who underwent SLL achieved MCID for ODI at six months, 71 (80.7%), compared to those with TLL, 18 (58.1%) (p = 0.024). Similarly, MCID for SSSQ at six months was more frequently reached in the SLL group, 65 (73.9%), than in the TLL group, 15 (48.4%) (p=0.017). Patients who underwent TLL were 28% less likely to achieve MCID for ODI at six months (RR=0.72; 95% CI: 0.52–0.99) and 34% less likely to achieve MCID for SSSQ at six months (RR=0.66; 95% CI: 0.45–0.96) compared to those who underwent SLL (Table 3).

**Table 1. Characteristics of the patients with single-level laminectomy (SLL) and two-level laminectomy (TLL)**

| Variable | SLL (N=88) | TLL (N=31) | p |
|---|---|---|---|
| **Median age (IQR)** (years) | 54 (42.5-61.0) | 56 (44.0-62.0) | 0.524 |
| | **No (%) of patients** | | |
| **Sex** | | | 0.445 |
| Male | 39 (44.3) | 15 (48.4) | |
| Female | 49 (55.7) | 16 (51.6) | |
| **Type of stenosis** | | | |
| Central canal | 54 (61.4) | 18 (58.1) | 0.741 |
| Lateral recess | 76 (86.4) | 27 (87.1) | 0.913 |
| Foraminal | 56 (63.6) | 20 (64.5) | 0.921 |
| **Schizas grade** | | | 0.307 |
| C | 54 (61.4) | 15 (48.4) | |
| D | 34 (38.6) | 16 (51.6) | |

IQR, interquartile range;

## DISCUSSION

To our knowledge, this is the first study comparing MCID achievement between SLL and TLL, indicating better functional improvement and symptom relief in patients with single level LSS.

A significant finding indicating better six-month outcomes is that 80.7% of patients in the SLL group achieved ODI-based MCID, compared to 58.1% in the TLL group. These results

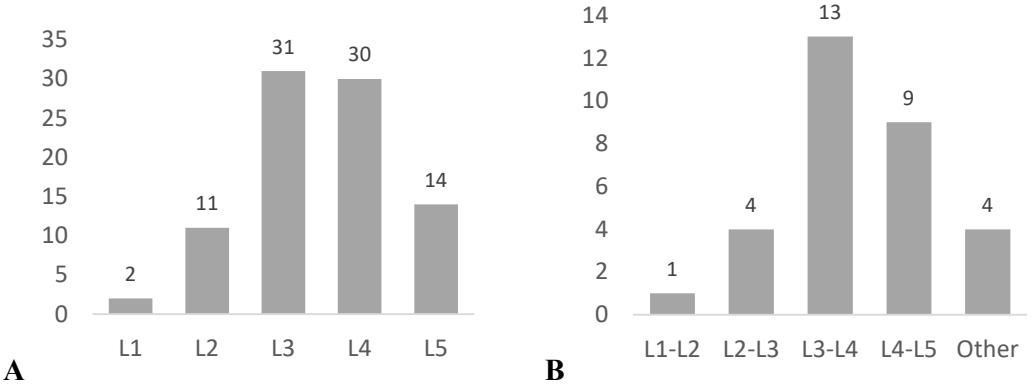


**Figure 2. Distribution of A) single-level (SLL) and B) two-level laminectomies (TLL) by vertebral region**

**Table 2. Results of observed variables preoperatively, at 1-month and 6-month follow-up**

| Variable | Follow-up period | SLL (N=88) | TLL (N=31) | p |
|---|---|---|---|---|
| | | Median (IQR) | | |
| ODI | Preoperative | 52.0 (41.0-62.0) | 52.0 (41.0-65.0) | 0.824 |
| | 1 month | 34.0 (28.0-41.0) | 39.0 (30.0-45.5) | 0.010 |
| | 6 months | 15.0 (11.0-17.0) | 18.0 (12.0-22.0) | 0.006 |
| VAS-LB | Preoperative | 7.0 (5.0-7.0) | 8.0 (5.0-10.0) | 0.039 |
| | 1 month | 5.0 (3.0-7.0) | 6.0 (4.0-8.0) | 0.058 |
| | 6 months | 3.0 (2.0-6.0) | 5.0 (3.0-8.0) | <0.001 |
| VAS-LE | Preoperative | 8.0 (6.0-8.0) | 8.0 (6.0-10.0) | 0.481 |
| | 1 month | 5.0 (3.5-8.0) | 6.0 (4.0-9.0) | 0.107 |
| | 6 months | 3.0 (2.0-6.0) | 4.0 (3.0-7.0) | 0.058 |
| SSSQ | Preoperative | 37 (25-48) | 44 (34-48) | 0.005 |
| | 1 month | 24.5 (17.5-31.2) | 30.8 (23.8-33.6) | <0.001 |
| | 6 months | 17.2 (12.3-21.8) | 21.6 (16.7-23.5) | <0.001 |
| | | No (%) of patients | | |
| Motor deficit | Preoperative | 36 (40.9) | 15 (48.4) | 0.529 |
| | 1 month | 21 (23.9) | 13 (41.1) | 0.067 |
| | 6 months | 13 (14.8) | 11 (35.5) | 0.019 |
| Sensitive deficit | Preoperative | 74 (84.1) | 25 (80.6) | 0.780 |
| | 1 month | 51 (59.0) | 22 (70.1) | 0.286 |
| | 6 months | 28 (31.8) | 11 (35.5) | 0.826 |
| Urinary dysfunction | Preoperative | 9 (10.2) | 8 (25.8) | 0.069 |
| | 1 month | 5 (5.7) | 7 (22.6) | 0.013 |
| | 6 months | 4 (4.6) | 4 (12.9) | 0.203 |
| Surgical wound infection | 6 months | 3 (3.4) | 1 (3.2) | 0.981 |
| Revision | 6 months | 4 (4.5) | 5 (16.1) | 0.051 |

SLL, single-level laminectomy; TLL, two-level laminectomy; IQR, interquartile range; ODI, Oswestry disability index; VAS-LB, visual analogue scale for lower back; VAS-LE, visual analogue scale for lower extremities; SSSQ, Swiss spinal stenosis questionnaire

**Table 3. Minimal clinically important difference (MCID) of perceived benefits of surgical intervention between patients with single-level laminectomy (SLL) versus two-level laminectomy (TLL)**

| Variable | Preoperative follow-up period | No (%) of patients MCID | | p | Risk ratio (95% CI) |
|---|---|---|---|---|---|
| | | SLL (N=88) | TLL (N=31) | | |
| ODI | 1 month | 39 (44.3) | 13 (41.9) | 0.984 | 0.95 (0.59-1.52) |
| | 6 months | 71 (80.7) | 18 (58.1) | 0.024 | 0.72 (0.52-0.99) |
| VAS-LB | 1 month | 58 (65.9) | 17 (54.8) | 0.378 | 0.83 (0.58-1.18) |
| | 6 months | 74 (84.1) | 26 (83.9) | 0.999 | 1.00 (0.83-1.19) |
| VAS-LE | 1 month | 58 (65.9) | 14 (45.2) | 0.069 | 0.69 (0.45-1.04) |
| | 6 months | 69 (78.4) | 27 (87.1) | 0.430 | 1.11 (0.93-1.32) |
| SSSQ | 1 month | 43 (48.9) | 11 (35.5) | 0.281 | 0.73 (0.43-1.22) |
| | 6 months | 65 (73.9) | 15 (48.4) | 0.017 | 0.66 (0.45-0.96) |

CI, confidence interval; ODI, Oswestry disability index; VAS-LB, visual analogue scale for lower back; VAS-LE, visual analogue scale for lower extremities; SSSQ, Swiss spinal stenosis questionnaire

are consistent with a previous study (16), which demonstrated superior recovery in terms of ODI and VAS scores, as well as walking distance, among LSS patients treated with SLL versus TLL. It was confirmed that single-level treatment of LSS compared to multilevel treatment yields significantly better favourable outcome for patients (17). It is crucial to differentiate between studies where treatment was performed at a different level once "moderate" stenosis is confirmed. The better outcome in our study likely stem from the indication for surgery being MRI-verified Schizas C or D grade with corresponding imaging, limiting comparability. This is supported by the fact that patients' clinical presentation preoperatively was significantly more severe, as indicated by VAS-LB and SSSQ score. Similarly, it was reported that patients undergoing TLL had significantly more severe symptoms before surgery (18).

Findings from previous studies remain inconsistent. Some reports suggest that the number of operated levels does not significantly influence surgical outcome (19), while others indicate that multilevel surgery in LSS patients results in similarly favourable outcome and complication rate as single-level procedures (20). A recent meta-analysis showed that decompression involving two or more levels produced postoperative results comparable to single-level decompression, suggesting it may be a non-inferior approach (21). In the present study, MCID analysis showed a trend toward more favourable postoperative outcome in patients who underwent single-level lumbar decompression, which may be related to compression involving only a single nerve root and a less severe clinical presentation. Previous research suggests that patients with a longer duration of LSS-related pain may experience poorer outcome, and that demographic, health, and clinical factors are more predictive of clinical results than surgery-related factors (22). In some cases, decompression at two levels has been associated with greater clinical improvement at six months, with significant benefit achieved in around 60% of cases and MCID reached in 77.6% of patients (23). However, excessive surgical intervention, particularly beyond two levels, may compromise spinal stability and negatively affect long-term recovery (24). Patient selection should therefore consider both the severity of stenosis and the risk of postoperative complications (23).

Future research should standardize MCID assessment in LSS, as variations in definition and reporting limit comparability. Differences may arise from baseline severity, patient expectations, and methodological inconsistencies (25,26). Establishing uniform criteria could improve outcome evaluation and surgical decision-making, especially when comparing single- and multilevel decompression (27).

This study has several limitations. The short follow-up period may not adequately assess long-term functional outcomes, the potential for symptom recurrence, or the need for reoperation. Additionally, the absence of standardized MCID thresholds for LSS complicates cross-study comparisons and may impact the interpretation of clinical improvement.

In conclusion, this study suggests that SLL may be associated with higher MCID achievement rates compared to TLL, potentially reflecting better functional improvement and symptom relief. These findings raise the possibility that two-level compression could influence surgical outcome, perhaps contributing to a more complex disease course and less favourable postoperative recovery. However, due to variability in MCID thresholds and the relatively short fol-

low-up period, further studies using standardized outcome measures and longer-term data are needed to better understand these associations and assess the durability of surgical benefits.

## AUTHOR CONTRIBUTIONS

Conceptualization, E.B and H.B.; methodology, E.B., H.B. and G.L.; software, E.B.; validation, F.A. and A.M.; formal analysis, E.B.; investigation, E.B., H.B., F.A., A.M.; resources, E.B.; data curation, E.B.; writing—original draft preparation, E.B., F.A., A.M. and M.H.; writing—review and editing, H.B. and G.L.; visualization, E.B.; supervision, H.B., F.A. and G.L.; project administration, E.B.; All authors have read and agreed to the published version of the manuscript.

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## TRANSPARENCY DECLARATION

Conflict of interests: None to declare.

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