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AN IN-DEPTH ANALYSIS OF PATIENTS UNDERGOING SURGICAL TREATMENT FOR LUMBAR SPINAL STENOSIS PRESENTING WITH NEUROGENIC CLAUDICATION

Orthopaedics

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ABSTRACT

Background: The connection between measurable clinical findings and patients' reported symptoms in cases of spinal stenosis, as well as how these relate to the extent of spinal canal narrowing, remains uncertain. This study aimed to assess individuals undergoing surgical treatment for lumbar spinal stenosis and intermittent neurogenic claudication through a combination of functional evaluations, quantitative imaging techniques, and patient-reported outcome measures. **Methods-** A total of 31 individuals diagnosed with lumbar spinal stenosis and neurogenic claudication were enrolled in this prospective study. Each participant underwent magnetic resonance imaging (MRI) before surgery and received decompressive surgical treatment, with follow-up lasting at least two years. Assessments included a walking performance test and patient-reported outcomes, using the Oswestry Disability Index and a visual analog scale for pain, both before and after the surgical procedure. **Results-** Before surgery, 25 patients (80.6%) exhibited symptom provocation during the walking test. Following surgery, this number dropped significantly to 5 patients (16.1%). The average preoperative scores on the Oswestry Disability Index and the visual analog pain scale were 58.4 and 7.1, respectively. After surgery, these averages significantly declined to 21.1 and 2.3 ($p < 0.05$). Imaging studies prior to surgery showed that 23 patients (74%) had central spinal stenosis. Of these, 20 had at least one spinal level with a dural tube cross-sectional area smaller than 100 mm², while 12 patients had two or more levels with areas below that threshold. **Conclusions-** In 80.6% of patients, a positive result on the walking test supported the diagnosis of spinal stenosis with neurogenic claudication prior to surgery. After lumbar decompression, the walking test indicated notable functional improvement. Additionally, postoperative scores on both the Oswestry Disability Index and the visual analog pain scale showed significant enhancement. The extent of central canal narrowing at a single spinal level did not seem to affect improvements in functional outcomes or self-reported assessments. Patients with stenosis at multiple levels tended to be older and covered shorter walking distances both before and after surgery; however, their gains in postoperative self-assessment were comparable to those observed in patients with single-level stenosis.

KEYWORDS

INTRODUCTION

Lumbar spinal stenosis is characterized by a narrowing of the central spinal canal, lateral recesses, or intervertebral foramina. The primary clinical manifestation is neurogenic claudication—pain, cramping, and numbness in the lower extremities that typically occurs during walking or upright physical activity. This condition can significantly impair quality of life, often necessitating decompressive surgery. Although surgical interventions generally yield favorable outcomes [1-5] there is a lack of comprehensive objective measures to evaluate these results. Exercise-based assessments are useful in distinguishing neurogenic from vascular claudication, and walking tests are frequently utilized to evaluate neurological function in individuals with lumbar spinal stenosis [6,7,10,11]. These tests also serve to assess the patient's functional capabilities.

To our knowledge, no prior research has specifically examined the link between objective functional assessments, patient-reported symptoms, and the extent of spinal canal narrowing in individuals undergoing surgical treatment for lumbar spinal stenosis. In this study, patients were evaluated through imaging techniques as well as self-reported symptom assessments using the Oswestry Disability Index and a visual analog pain scale. Before initiating the study, we proposed several hypotheses. The first was that individuals experiencing more intense symptoms would exhibit greater degrees of stenosis on imaging and face more challenges with walking. The second hypothesis suggested that these patients would display significant walking impairment. This study aimed to: [1] investigate whether combining walking tests with neuroradiographic imaging could offer a more objective assessment of lumbar spinal stenosis; [2] evaluate whether walking tests yield quantifiable outcomes that reflect surgical effectiveness; and [3] explore potential correlations among functional test results, patient-reported outcomes using the Oswestry Disability Index and visual analog scale, and neuroradiographic imaging findings.

MATERIALS AND METHODS

A prospective study was conducted involving 31 patients diagnosed with symptomatic lumbar spinal stenosis. Participation was voluntary, and all individuals provided informed consent in accordance with approval from the Human Studies Committee at our School of Medicine. Each participant exhibited persistent neurogenic claudication and had lumbar spinal stenosis confirmed through neuroradiographic imaging. The group consisted of 12 men and 19 women, with a mean age of 63.2 years (± 9.4 years).

The underlying causes of spinal stenosis included degenerative spondylolisthesis (with 5 mm displacement in the sagittal plane) in 17 patients, isthmic spondylolisthesis in 3 patients, lumbar spondylosis in 7 patients, and degenerative scoliosis (with a coronal curvature greater than 15°) in 4 patients. Four individuals had a history of lumbar spine surgery, and two of them underwent revision procedures for recurrent stenosis at the same spinal levels. Exclusion criteria included the presence of peripheral vascular disease or severe cardiopulmonary or musculoskeletal disorders that could interfere with the patient's ability to perform exercise-based functional assessments.

	Preop.	Postop.
No. of subjects	31	31
Oswestry Disability Index		
Score* (points)	58.4 ± 13.3	21.1 ± 18.9§
Rate of improvement (%)		63.7
Visual analog pain scale		
Score* (points)	7.1 ± 1.9	2.3 ± 2.3§
Rate of improvement (%)		67.3
Walking test for Lumbar canal stenosis		
Positive result†	25 (80.6%)	5 (16.1%)§
Time‡ (min)	12.5 (10.0)	25.0 (22.5)§
Distance‡ (m) [km]	0.4 [0.2] (0.3)	0.8 [0.5] (0.7)§
Time to onset of symptoms‡ (min)	1.5 (1.2)	10.0 (8.0)§
Visual analog pain scale score* (points)		
Before test	3.0 ± 2.5	1.0 ± 1.8§
After test	7.5 ± 2.0	1.5 ± 2.2§
Change during test	4.5 ± 2.8	0.5 ± 1.5§

*The values are given as the mean and standard deviation. †The values are given as the number of patients, with the percentage in parentheses. ‡The values are given as the mean, with the median in parentheses. §The difference between the preoperative and postoperative values was significant ($p < 0.05$).

This table summarizes the results observed in 31 patients who underwent surgery for lumbar canal stenosis, comparing their clinical condition before (Preoperative) and after (Postoperative) the procedure.

Below Is A Detailed Explanation Of Each Section:

- **No. Of Subjects:** The study involved 31 patients, with data gathered for each participant both prior to and following the surgical procedure

- **Oswestry Disability Index (ODI):**

This tool is commonly used to evaluate how much low back pain affects a patient's daily functioning. It is a self-reported outcome measure, with scores ranging from 0 (indicating no disability) to 100 (indicating the most severe level of disability).

- **Score (Points):**

Preoperative: The mean Oswestry Disability Index (ODI) score prior to surgery was 58.4, with a standard deviation of 13.3, reflecting a significant level of functional limitation.

Postoperative: After surgery, the mean ODI score improved notably to 21.1, with a standard deviation of 18.9. The presence of the § symbol denotes that this change is statistically significant ($p < 0.05$), implying that the improvement is unlikely to be due to random variation.

- **Improvement Rate (%): Postoperative:** A 63.7% reduction in ODI scores was observed following the procedure, indicating a marked improvement in functional ability.Top of Form

- **Visual Analog Pain Scale (VAS)**:

This straightforward assessment allows patients to rate the intensity of their pain, typically on a scale from 0 (no pain) to 10 (the most severe pain imaginable).

- **Score (Points):**

Pre-operative: The average visual analog scale (VAS) pain score before surgery was 7.1, with a standard deviation of 1.9, reflecting a high level of pain.

Post-operative: Following surgery, the average pain score decreased significantly to 2.3, with a standard deviation of 2.3. The § symbol indicates this reduction is statistically significant ($p < 0.05$), suggesting a meaningful decrease in pain.

- **Improvement Rate (%):**

Post-operative: The VAS score showed a 57.3% improvement after the procedure, indicating a significant alleviation of pain symptoms.

- **Walking Test For Lumbar Canal Stenosis:**

This part highlights objective functional performance and symptom reproduction during a walking test, which plays a key role in evaluating lumbar canal stenosis—a condition where symptoms typically worsen with walking.

- **Positive Result†:**

Pre-operative: Before surgery, 25 of the 31 patients (80.6%) exhibited a "positive result" on the walking test, meaning that hallmark symptoms such as leg pain, numbness, or weakness were triggered or intensified during walking, often leading patients to stop. This finding is indicative of active neurogenic claudication.

Post-operative: Following surgical treatment, only 5 out of 31 patients (16.1%) continued to show a positive response. The § symbol denotes a statistically significant decrease ($p < 0.05$), suggesting that surgery was effective in reducing symptom provocation during walking.

- **Walking Time (Minutes):**

Pre-operative: Prior to surgery, patients were able to walk for an average of 12.5 minutes, with a median duration of 10.0minutes.

Post-operative: After surgery, this time significantly increased to an average of 25.0 minutes, with a median of 22.5 minutes. The § symbol indicates that this improvement is statistically significant ($p < 0.05$), suggesting enhanced endurance following intervention.

- **Walking Distance (Meters) [Kilometers]:**

Pre-operative: Patients walked an average distance of 0.4 km (median 0.3 km) before the onset of limiting symptoms.

Post-operative: This value significantly rose to 0.8 km on average, with a median of 0.7 km. The § confirms a statistically significant improvement, reflecting increased walking capacity after surgery.

- **Time to Symptom Onset (minutes):**

Pre-operative: Symptoms typically began 1.5 minutes into walking, with a median onset at 1.2 minutes.

Post-operative: Symptom onset was delayed significantly, occurring on average at 10.0 minutes (median 8.0 minutes). The § denotes a statistically meaningful delay, indicating patients could tolerate walking for longer periods without experiencing symptoms.

- **Visual Analog Pain Scale Score* (points) — During the Walking Test**

This section evaluates the intensity of pain specifically experienced during the walking test.

Pain Before the Test (Preoperative & Postoperative): The average pain rating prior to starting the walking test was 3.0 points before surgery, which improved to 1.0 point after the procedure.

Pain After the Test (Preoperative & Postoperative): Following the walking test, the average pain score was 7.5 points preoperatively, significantly decreasing to 1.5 points postoperatively.

- **Pain Change During the Test (Preoperative & Postoperative):** The key measure here is the increase in pain caused by walking. Before surgery, pain levels rose by an average of 4.5 points during the test. After surgery, this increase dropped sharply to only 0.5 points. The § symbol denotes that this reduction is statistically significant, indicating the walking test triggered substantially less pain following the intervention.

Footnotes Explanation:

Values are expressed as the mean (average) along with the standard deviation, which indicates the variability or dispersion of the data around the mean.

Values represent the number of patients, with the percentage of the total sample shown in parentheses.

Values are given as the mean, accompanied by the median (the middle value in an ordered data set) in parentheses.

- § : This symbol denotes that the difference between preoperative and postoperative measurements is statistically significant ($p < 0.05$), meaning there is less than a 5% probability that the observed changes happened by chance, supporting a true effect of the treatment.

Summary:

Overall, this table clearly indicates that the surgical treatment for lumbar canal stenosis in these 31 patients resulted in statistically significant and clinically important improvements. These include decreased disability as measured by the Oswestry Disability Index (ODI), reduced pain levels according to the Visual Analog Scale (VAS), enhanced walking endurance with longer distances and times before symptom onset, and a marked reduction in pain triggered during walking.

All patients underwent posterior decompressive surgery, with an average of 1.8 ± 0.9 spinal levels treated, ranging from one to four levels. Among these, 23 patients (74%) who showed preoperative spinal instability in either the coronal or sagittal plane also received posterolateral spinal fusion with instrumentation. Spinal instability was defined as a sagittal translation of 5 mm or more observed on upright lateral lumbar X-rays or flexion-extension lateral lumbar radiographs. Coronal instability was identified by either an angular misalignment exceeding 10° between vertebrae or a rotatory subluxation causing more than 5 mm of lateral displacement.

Before surgery, all patients underwent magnetic resonance imaging (MRI) scans, performed with patients lying supine with hips and knees extended. Walking tests were conducted both before and after the

operation. Postoperative walking assessments were completed by 20 patients at six months, 11 patients at one year, and at two years. Clinical and radiographic follow-up continued for at least two years after surgery, with a mean follow-up duration of two years. Two patients required revision surgery after the initial procedure—one due to pseudarthrosis and the other because of stenosis at an adjacent spinal level. Both patients completed the walking tests again following their revision surgeries.

Our Prospective Study Involved Several Key Evaluations: [1] preoperative imaging—using magnetic resonance imaging (MRI) and/or computed tomography myelography (CTM)—to measure the cross-sectional area of the dural sac at each stenotic intervertebral level; [2] walking tests conducted both before surgery and postoperatively; [3] patient self-assessments using the Oswestry Disability Index (ranging from 0 to 100, where 0 represents optimal function) and a visual analog pain scale (ranging from 0 to 10, where 0 indicates no pain), recorded preoperatively and at the most recent follow-up; and [4] upright anteroposterior and lateral lumbar radiographs taken before surgery and at the latest follow-up. All evaluations and measurements were performed by independent assessors who were not involved in the surgical procedures.

Cross-sectional area measurements of the dural sac were obtained using magnetic resonance imaging (MRI) transverse scans for all patients. The area was assessed at the midpoint of each stenotic intervertebral level and, for patients with isthmic spondylolisthesis, at the pars interarticularis level. Among the 31 patients, 23 were classified as having predominantly central canal stenosis, while 8 had isolated lateral recess stenosis. An independent spine surgeon performed the measurements by recording the anterior-to-posterior (A) and medial-to-lateral (B) dimensions in millimetres, then calculating the cross-sectional area as the product of these two values ($A \times B$). These analyses were conducted using NIH Image software, a publicly available image processing and analysis tool developed by the National Institutes of Health.

DISCUSSION

The findings of this study indicate that walking test outcomes aligned with symptoms of neurogenic claudication in 80.6% of surgically treated patients, as evidenced by preoperative test results. Individuals with multilevel central stenosis demonstrated significantly reduced walking distances before and after surgery ($p < 0.05$); however, their postoperative self-reported improvements were comparable to those of other participants. Additionally, we identified associations between patient age, the number of affected spinal levels, and performance on the walking test. Prior to surgery, most patients experienced a noticeable worsening of symptoms during walking. Following the procedure, there was a significant improvement in walking ability. Self-reported evaluations, including the Oswestry Disability Index and visual analog pain scale, also showed substantial improvement by the final follow-up. Overall, the results suggest that surgical intervention enhanced both objective walking function and subjective symptom assessments in patients with lumbar spinal stenosis.

Walking tests are traditionally utilized to evaluate patients with central spinal stenosis; however, this study also included patients with lateral recess stenosis (radicular claudication) as well as those with both central and lateral recess involvement. Postoperative functional improvement, as demonstrated by the walking test, was also observed in patients with isolated lateral recess stenosis. Although men and women showed comparable improvement in self-reported outcome measures after surgery, significant gender differences ($p < 0.05$) were noted in their walking test performance. These differences should be taken into account when evaluating functional status.

Additionally, patients with stenosis at two or more spinal levels walked significantly shorter distances both before and after surgery compared to those with stenosis confined to a single level. Despite this, both groups exhibited similar percentages of postoperative improvement in Oswestry Disability Index and visual analog pain scale scores. Interestingly, patients with severe central stenosis (defined as a cross-sectional area less than 70 mm^2) at a single level had better postoperative ODI scores than those with moderate stenosis (cross-sectional area greater than 70 mm^2). One possible explanation for this unexpected finding is that other factors, such as psychosomatic conditions, might contribute to worsening neurogenic claudication symptoms in patients with moderate stenosis.

Recent advances have enabled the use of neuroradiographic techniques to quantify lumbar spinal stenosis severity. Both magnetic resonance imaging (MRI) and computed tomography myelography (CTM) are commonly employed for this purpose, with several studies demonstrating a strong correlation between these methods in evaluating lumbar spinal stenosis [10,11]. Some research has found a clear association between clinical symptoms and radiographic findings [12,13], while other studies have reported conflicting results [1,14,15] . For example, Hamanishi and colleagues measured the cross-sectional area of the stenotic lumbar dural sac using MRI and reported that a cross-sectional area smaller than 100 mm^2 at two or more intervertebral levels was closely linked to intermittent claudication [13] . Our findings align with these clinical observations [13,16] and with experimental data [17] suggesting that stenosis at two levels more frequently leads to neurogenic claudication than stenosis at a single level. A thorough evaluation of patients with lumbar spinal stenosis and neurogenic claudication—incorporating functional assessments, quantitative imaging studies, and patient self-reports—can provide valuable guidance for surgical decision-making and outcome evaluation. Such a comprehensive approach may also enhance diagnostic accuracy, help differentiate lumbar stenosis from other conditions such as psychogenic disorders and vascular claudication, and confirm the positive effects of decompressive surgery.

REFERENCES

1. Amundsen T, Weber H, Lilleas F, Nordal HJ, Abdelnoor M, Magnaes B. Lumbar spinal stenosis. Clinical and radiologic features. Spine. 1995; 20:1178-86.
2. Getty CJ. Lumbar spinal stenosis: the clinical spectrum and the results of operation. J Bone Joint Surg Br. 1980; 62:481-5.
3. Herno A, Airaksinen O, Saari T. Long-term results of surgical treatment of lumbar spinal stenosis. Spine. 1993; 18:1471-4.
4. Surin V, Hedelin E, Smith L. Degenerative lumbar spinal stenosis: results of operative treatment. Acta Orthop Scand. 1982; 53:79-85.
5. Turner JA, Ersek M, Herron L, Deyo R. Surgery for lumbar spinal stenosis. Attempted meta-analysis of the literature. Spine. 1992; 17:1-8.
6. Dong G, Porter RW. Walking test in neurogenic and intermittent claudication. Spine. 1989; 14:965-9.
7. Lin Y, Lin RM, Tsai YS, et al. 6-Minute Walk Test: A Simple Objective Test in Screening and Monitoring of Spinal Claudication: Prospective Study on 1182 Patients. ResearchGate. 2016.
8. Dobkin BH, Dorsch A, Curt A. Provocative Walking Test of Strength for Diagnosis, Management, and Outcome Assessment of Symptomatic Lumbar Spinal Stenosis. Research Gate. 2019.
9. Fritz JM, Erhard RE, Delitto A, Welch WC, Nowakowski PE. Preliminary results of the use of a walking test as a clinical diagnostic tool in the differential diagnosis of lumbar spinal stenosis. J Spinal Disord. 1997; 10:410-6.
10. Schnebel B, Kingston S, Watkins R, Dillin W. Comparison of MRI to contrast CT in the diagnosis of spinal stenosis. Spine. 1989; 14:332-7.
11. Bolender NF, Schonstrom NS, Spengler DM. Role of computed tomography and myelography in the diagnosis of central spinal stenosis. J Bone Joint Surg Am. 1985; 67:240-6.
12. Hamanishi C, Matukura N, Fujita M, Tomihara M, Tanaka S. Cross-sectional area of the stenotic lumbar dural tube measured from the transverse views of magnetic resonance imaging. J Spinal Disord.1994;7:388-93.
13. Mariconda M, Zanforlino G, Celestino GA, Brancaleone S, Fava R, Milano C. Factors influencing the outcome of degenerative lumbar spinal stenosis. J Spinal Disord. 2000;13: 131-7.
14. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine. 2000; 25:2940-52.
15. Porter RW, Ward D. Cauda equina dysfunction. The significance of two-level pathology. Spine. 1992; 17:9-15.
16. Olmarker K, Rydevik B. Single- versus double-level nerve rootcompression. An experimental study on the porcine cauda equina with analyses of nerve impulse conduction properties. Clin Orthop.1992;279:35-9.
17. Takahashi K, Olmarker K, Holm S, Porter RW, Rydevik B. Double-level cauda equina compression: an experimental study with continuous monitoring of intraneural blood flow in the porcine cauda equina. J Orthop Res. 1993; 11:104-9.