ORIGINAL ARTICLE

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Transverse decompression technique in the surgical treatment of degenerative lumbar canal stenosis

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Objective: The aim of this study was to assess the outcomes of fusion technique via posterior instrumentation in combination with transverse decompression in the surgical treatment of degenerative lumbar canal stenosis.

Methods: Forty-five patients–39 women (86.7%) and 6 men (13.3%)–were included. Mean age was 58.68±8.63 years with mean follow-up of 51.71±20.96 months. Preoperative and postoperative clinical evaluation was performed using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for overall pain. Preoperative and postoperative imaging studies were used to measure the degree of spondylolisthesis and the angle of scoliosis and lumbar lordosis. The presence of preoperative facet joint arthrosis and changes in the diameter of anterior, posterior, and transverse spinal canal were assessed by computed tomography (CT). Preoperative disc degeneration, disk herniation, and spondylolisthesis were examined by magnetic resonance imaging (MRI).

Results: Mean preoperative ODI and VAS scores were 59.2% and 7.06, respectively, while postoperative ODI and VAS scores were 14.4% and 1.7%, respectively (p=0.001). Anteroposterior diameter of the central canal increased from 10.43±2.18 mm preoperatively to 19.63±2.01 mm postoperatively (p=0.0001). Mean preoperative and postoperative spondylolisthesis were 5.81±4.88 mm and 3.87±4.53 mm, respectively (p=0.0001). Mean preoperative and postoperative scoliosis angles were 5.84°±10.14° and 2.04°±5.08°, respectively (p=0.0002). Mean preoperative and postoperative lordosis angles were 22.47°±13.98° and 33.73°±10.89°, respectively (p=0.0001). Complications included pulmonary embolism in 1 patient (2.2%), superficial injury site infection in 1 patient (2.2%), and deep surgical site infection in 1 patient (2.2%). Two patients (4.4%) experienced dural tears. One patient (2.2%) had intraoperative radix damage.

Conclusion: The results of the present study suggest that the fusion technique via posterior instrumentation, in combination with transverse decompression, offers a clinical improvement in patients with lumbar canal stenosis.

Keywords: Canal stenosis; complication; decompression; instrumental fusion; laminectomy; surgical treatment.

Level of Evidence: Level IV Therapeutic Study

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Spinal stenosis is characterized by a narrowing of the spinal canal in the lateral recess or neural foramen by the bones or soft tissues.[1] It is often caused by osteophytes due to degenerative facet and intervertebral joints, thickened ligamentous structures, or protrusion of the intervertebral disc.[2–5] Spinal stenosis was first described anatomically and clinically by Verbiest in 1949.[6]

Degenerative lumbar canal stenosis presents with various signs and symptoms, including lower back pain, diffuse pain in the lower limbs, and decreased walking ability.[3,7] It is the most common cause of pain and dysfunction in the elderly, in particular, and reason for spinal surgery.[2,3,8] It is more frequent in women than men and mostly develops in the seventh decade of life.[4]

Patients with lumbar canal stenosis without severe complaints can be treated conservatively in the early stage of the disease. Those with severe lumbar canal stenosis with progressive neurological involvement and pain which severely restricts activities of daily living (ADL) who are unresponsive to conservative treatment are candidates for surgical intervention.[2,4,9] Although several surgical treatment modalities have been defined, wide decompression and fusion in combination with laminectomy has been widely adopted.[8,10,11] The most common surgical-related complications are instability and chronic pain.[2,8,9,11]

In this study, for the surgical treatment of lumbar canal stenosis, we present a successful spinal decompression technique preserving intact laminas with an adequate number of bones. We aimed to assess the outcomes of fusion technique via posterior instrumentation in combination with transverse decompression in the surgical treatment of degenerative lumbar canal stenosis.

Patients and methods

Forty-five patients–39 women (86.7%) and 6 men (13.3%)–were included. Mean age was 58.68±8.63 years (range: 42–78 years) with mean follow-up of 51.71±20.96 months (range: 9–82 months). Inclusion criteria was as follows: unresponsiveness to conservative treatment for a minimum of 6 months, severe lower back and limb pain which significantly restricted ADL, presence of severe neurogenic claudication, neurological deficit, absence of severe comorbidities, and confirmed differential diagnosis of vascular claudication.

Forty patients (88.8%) presented with lower back and limb pain, 28 (62.2%) with neurogenic claudication, 18 (40%) with lethargy, 18 (40%) with weakness, and 4 (8.8%) with urinary incontinence. Preoperative neurological examination revealed motor impairment in 17 (37.7%) patients, sensory impairment in 21 (46.6%), loss of deep tendon reflex in 28 (62.2%), positive straight leg raising test result in 12 (26.6%), radix compression positivity in 25 (55.5%), and tenderness on Valleix point in 29 (64.4%).

Preoperative and postoperative clinical evaluation was performed using the Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for overall pain. Preoperative and postoperative imaging studies were used to measure the degree of spondylolisthesis and the angle of scoliosis and lumbar lordosis. The presence of preoperative facet joint arthrosis and changes in the diameter of anterior, posterior, and transverse spinal canal were assessed by computed tomography (CT). Preoperative disc degeneration, disk herniation, and spondylolisthesis were examined by magnetic resonance imaging (MRI).

Surgery was performed under general anesthesia. All patients were in the prone position. Posterior midline incision was performed on vertebrae to be decompressed. Once vertebral level was achieved, spinous processes were excised for fusion. All bone tissues were visible, and transverse decompression was performed. The inferior facet joint and one-third of the cranial part of the superior facet at the stenosis level, as well as the medial part of the superior facet, ligamentum flavum, and one-third of the cranial margins of the lower lamina were excised. A transverse rectangular window was formed at the level of facet joints (Figure 1). All intact laminas which had no impact on stenosis were preserved. Discectomy was

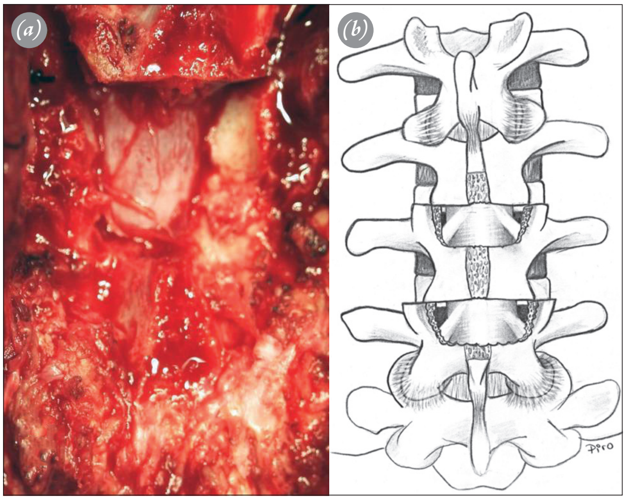

Fig. 1. **(a, b)** Inferior facet joint and one-third of the cranial part of the superior facet at the stenosis level as well as medial part of the superior facet, ligamentum flavum, and one-third of the cranial margins of the lower lamina were excised. A transverse rectangular window was formed at the level of the facet joints. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

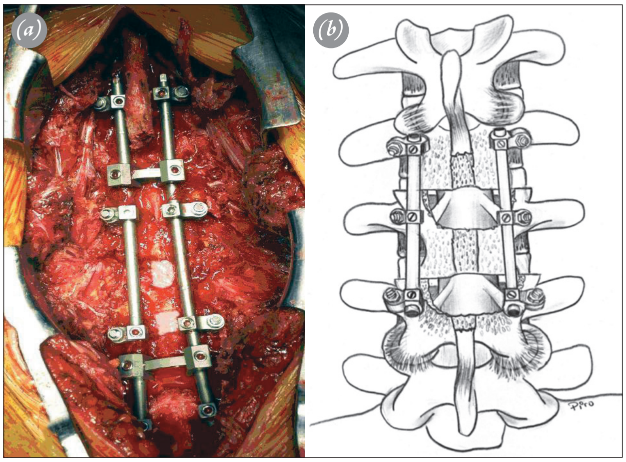

Fig. 2. **(a, b)** Placement of transpedicular screws and rods and appearance of the dura. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

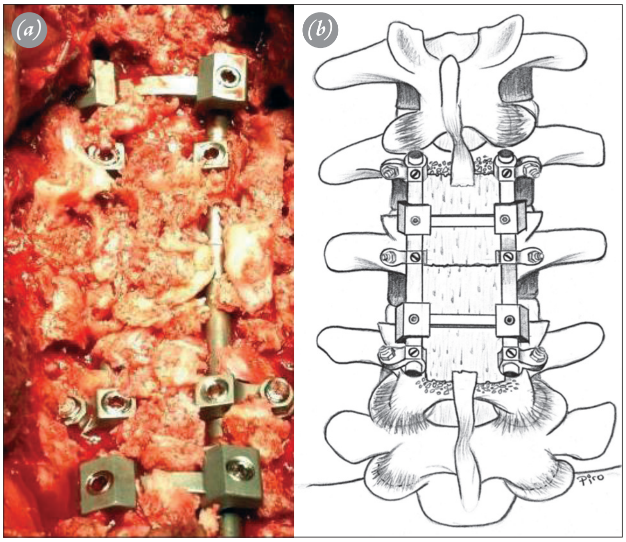

Fig. 3. **(a, b)** Postoperative images of the dura covered by free adipose tissue and placement of the graft. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

performed where applicable. Enlarged central and lateral canals were evaluated. The dura was covered with free adipose tissue or lumbosacral fascia tissue. Transpedicular screws and rods which were bent according to the physiological lordosis were attached to the vertebrae to produce fusion. Scoliosis and lordosis were corrected through derotation maneuver. One or 2 transverse connectors were used based on the level of fusion (Figure 2). Laminas were decorticated. Grafts derived from the spinous processes, facet joints, and laminas were used to create posterior fusion, while autografts or spongious block allografts of the posterior iliac wing were used at the fusion level (Figure 3). Drains were inserted, and layers were covered.

Statistical analysis was performed using SPSS v11.0 software (SPSS Inc., Chicago, IL, USA). Paired t-test was used to analyze the data. A p value of <0.05 was considered statistically significant.

Results

Medical history revealed previous surgery for disc hernia in 2 patients, lumbar canal stenosis in 1 patient, and degenerative scoliosis in 1 patient. Patients who underwent surgery due to disc hernia or lumbar canal stenosis experienced intraoperative instability. Fusion technique failed in the patient with degenerative scoliosis. According to the Meyerding classification system, 19 patients (42.2%) had grade 1 spondylolisthesis, and 13 patients (28.9%) had grade 2 spondylolisthesis. Of these patients, 27 had anterior spondylolisthesis, and 5 had retrolisthesis. Nine patients (20%) had a $<10°$ scoliosis curve, whereas 9 patients (20%) had a $>10°$ scoliosis curve.

During surgery, single-level decompression was applied in 17 patients (37.7%), two-level decompression in 15 patients (33.3%), three-level decompression in 8 patients (17.7%), four-level decompression in 3 patients (6.6%), and five-level decompression in 2 patients (4.4%). The total number of vertebral spaces decompressed was 93 in 45 operated cases, with L4–L5 being the most frequently used vertebral space (n=39, 41.9%). Twenty-three (24.7%) L3–L4 vertebral spaces were decompressed. Twelve (12.9%) L5–S1 vertebral spaces were decompressed, while 4 (4.3%) L1–L2 vertebral spaces were decompressed. Twelve patients (26.6%) underwent 2 vertebral instrumentations, 14 (31.1%) underwent 3 vertebral instrumentations, 8 (17.7%) underwent 4 vertebral instrumentations, 11 (24.4%) underwent 5 or more vertebral instrumentations.

Mean duration of surgery was 4.29 ± 1.05 hours (range: 2–6 hours), while postoperative length of hospitalization stay was 9.09 ± 4.13 days (range: 3–20 days). Mean preoperative ODI and VAS scores were 59.2% and 7.06, respectively, while postoperative ODI and VAS scores were 14.4% ($p=0.001$) and 1.7%, respectively ($p=0.001$).

Preoperative anteroposterior diameter of the central canal increased from 10.43 ± 2.18 mm (range: 8–13 mm) to 19.63 ± 2.01 mm (range: 15–22 mm) postoperatively ($p=0.001$). Mean preoperative transverse diameter increased from 13.46 ± 2.18 mm (range: 11–18 mm) to 24.53 ± 2.37 mm (range: 21–30 mm) postoperatively ($p=0.0001$).

Mean preoperative and postoperative spondylolisthesis were 5.81 ± 4.88 mm (range: 0–18 mm)

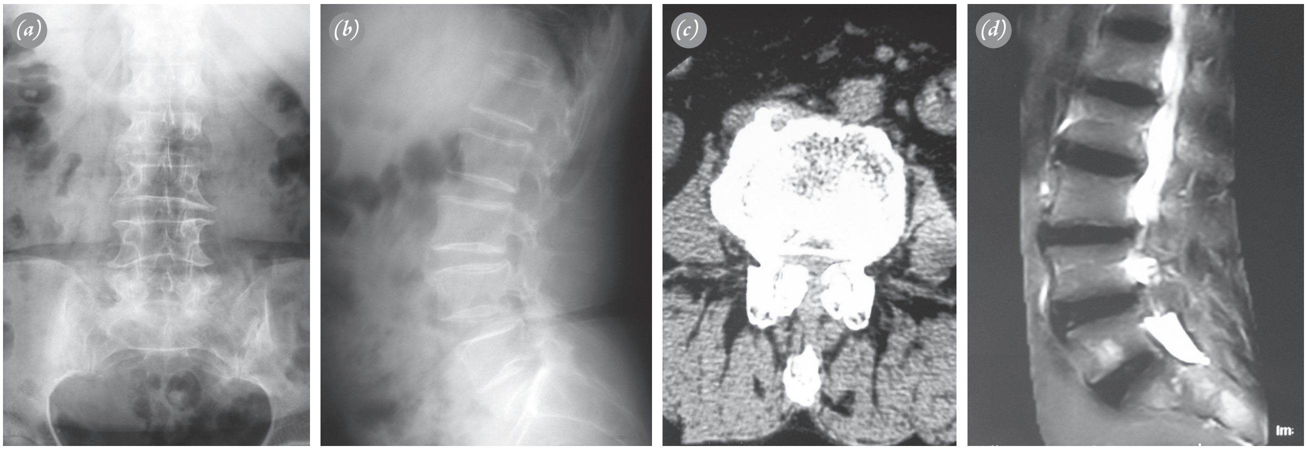

Fig. 4. **(a)** Preoperative anteroposterior and **(b)** lateral radiographies of lumbar degenerative alterations at the level of L3–L5 in a 68-year-old woman. **(c)** Spinal canal stenosis as shown by axial CT slices at the level of L3–L4. **(d)** T2-weighted sagittal MRI image showing spinal canal stenosis at the level of L3–L4 and L4–L5.

and 3.87±4.53 mm (range 0–16 mm), respectively (p=0.0001). Mean preoperative and postoperative scoliosis angles were 5.84±10.14 (range: 0–46 mm) and 2.04±5.08 (range: 0–21°), respectively (p=0.0002). Mean preoperative and postoperative lordosis were 22.47±13.98 (range: 50–60°) and 33.73±10.89 (range: 10–60°), respectively (p=0.0001) (Figures 4, 5).

Complications included pulmonary embolism in 1 patient (2.2%), superficial injury site infection in 1 patient (2.2%), and deep surgical site infection in 1 patient (2.2%). Two patients (4.4%) underwent revision surgery due to technical failure in the previous surgery. Two patients (4.4%) experienced dural tear. One patient (2.2%) experienced intraoperative radix damage.

Discussion

Lumbar canal stenosis can be treated via several surgical techniques.[2] There are reports in the literature describing limited or wide decompression, fusion, and instrumentation techniques, though the clinical results are inconsistent, and thus no consensus has been reached regarding the best surgical technique in the treatment of lumbar canal stenosis has.[4] The primary goal of surgical treatment is to provide sufficient decompression, while preserving lumbar spine stability. This outcome can usually be achieved by wide laminectomy and facetectomy; however, these techniques may disrupt the mechanical integrity of the lumbar spine.[9] As a result, instrumentation is usually applied to maintain postoperative stability and sagittal balance of the lumbar spine. Though several techniques–including less invasive, multiple laminotomy, unilateral laminotomy for bilateral decompression, microendoscopic decompression, and sublaminar decompression–have been developed,[12–15] long-term safety and efficacy results suggest that decompressive laminectomy is more effective than the other aforementioned techniques.[2,9] Of note, the major cause of surgical failure in the treatment of spinal canal stenosis is insufficient decompression.[1] In the present study, we applied sufficient decompression, preserving intact laminas and appropriate graft beds for posterior fusion.

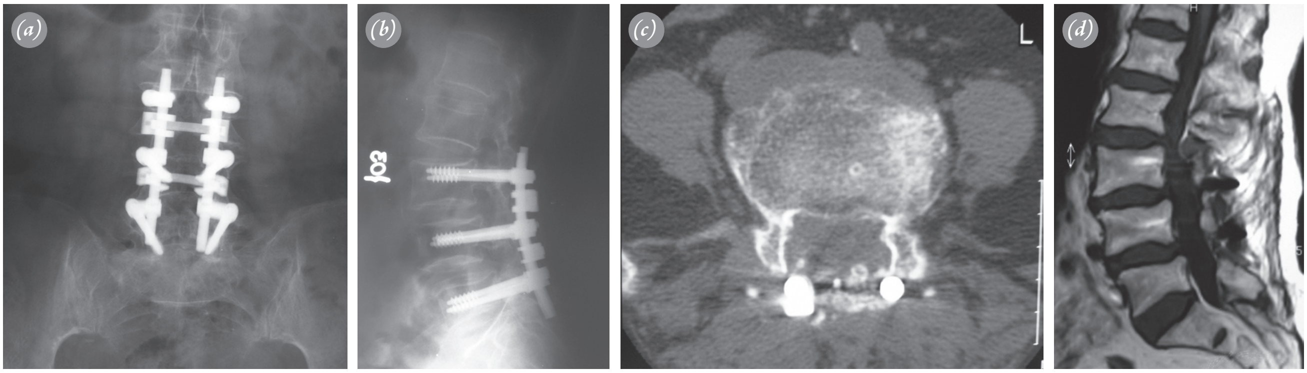

Fig. 5. Postoperative **(a)** anteroposterior and **(b)** lateral radiographies of the same patient. **(c)** Increased diameter of spinal canal as shown by axial CT slices at the level of L3–L4 following surgery. **(d)** T1-weighted sagittal MRI image showing enlarged spinal canal.

Laminectomy has long been utilized as the basic surgical treatment of lumbar canal stenosis. It yields a 72–88% surgical success rate,[8] while that of decompressive laminectomy is 45–86%, depending on working capacity, neurological symptoms, and lower back and limb pain.[16–19] However, some reports in the literature describe the surgical failure of decompressive laminectomy.[20] In the case of failure due to instability and deformity, decompression should be performed in combination with instrumental or non-instrumental fusion.[21–23]

The surgical success rate of spinal fusion increases in patients with instability and deformity.[4] The success rate of decompression in combination with fusion has been reported to increase in patients with degenerative spondylolisthesis compared to decompression alone.[24,25] Nonetheless, some authors suggest that fusion is not essential in the absence of instability. In a randomized controlled study including 45 patients, Grob et al.[24] demonstrated no significant difference in laminectomy with and without instrumental fusion. In a three-arm study, Rompe et al.[5] reported similar results among the patients undergoing laminotomy, laminectomy plus fusion, and laminectomy alone. Fischgrund et al.[26] showed higher success rates of instrumental fusion in the treatment of degenerative spondylolisthesis. Mardjetko et al.[27] similarly demonstrated that instrumental fusion increased the success rate in such cases. Overall, instrumental fusion has been recommended to achieve successful long-term results.[17,18] Decompression in combination with instrumental fusion is primarily indicated in the treatment of lumbar canal stenosis due to the necessity of decompressive laminectomy in 2 or more segments, as well as arthrodesis, iatrogenic instability, pseudoarthrosis revision, degenerative spondylolisthesis, and degenerative scoliosis.[4,7] In the current study, transverse decompression in combination with instrumental fusion was performed. Nineteen patients (42.2%) had grade 1 spondylolisthesis, and 13 patients (28.9%) had grade 2 spondylolisthesis. Nine patients (20%) had scoliosis and spondylolisthesis.

Review of the literature reveals that the major complication rates for spinal fusion range between 6% and 14.4%.[28] The incidence of complications is as follows: 0.05–0.2% for pulmonary thromboembolism, 1–14% for iatrogenic dural tear, 0.5–2.1% for postoperative deep infection, 0.6% for neurological deficit, and 0.15% for death.[1,28] In the present study, 1 patient (2.2%) developed pulmonary thromboembolism and was treated during in-hospital stay. Two patients (4.4%) had dural tear, which was repaired. One patient (2.2%) had superficial injury site infection and was treated with debridement at 2 weeks postoperatively, as well as antibiotherapy. One patient (2.2%) had deep surgical site infection, and implants were removed. Another patient (2.2%) had intraoperative radix damage. Hypoesthesia developed postoperatively in this patient. Two patients (4.4%) required revision surgery within 24 hours due to technical failure. Complication-related redo surgery rate has been reported as 9–19% in the literature.[8]

Imaging studies indicate that the major causes of lumbar canal stenosis include ligamentum flavum hypertrophy, facet hypertrophy, facet joint degeneration and instability, disc degeneration, and protrusion.[1–5] In this study, 88.9% of patients had facet joint degeneration, 73.3% had spondylolisthesis, 28.9% had disc hernia, and 20% had scoliosis.

The major cause of surgical failure is insufficient decompression, although symptoms can reappear in patients with sufficient decompression.[1,4] In our study, only 3 patients (6.6%) who suffered from preoperative and postoperative pain were symptomatic. Spinal canal diameter increased significantly postoperatively with increased walking capacity.

The main advantage of decompressive techniques, which lead to fewer traumas and provide increased lumbar spine stability, is the absence of required additional surgical fixation. In the present study, we chose to perform posterior stabilization over less invasive procedures. We performed transverse decompression to eliminate transversal structures predisposing to spinal stenosis and to preserve intact laminas. Decompressive techniques are able to apply wide fusion in a limited decompressive area with preserved intact laminas.

In conclusion, the results of this study suggest that a fusion technique via posterior instrumentation, in combination with transverse decompression, offers clinical improvement in the surgical treatment of lumbar canal stenosis.

Conflics of Interest: No conflicts declared.

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