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Bilateral Laminotomy for Lumbar Spinal Stenosis; A Minimum 5-year Follow-up Results

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Abstract

Aim: To evaluate minimum 5-year surgical outcomes of bilateral laminotomy for lumbar spinal stenosis.

Methods: Forty-four consecutive patients, in whom bilateral laminotomy for lumbar spinal stenosis were performed were included. Clinical outcome was measured using Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), and subjective satisfaction rate. Radiological follow-up included dynamic x-ray films.

Results: There were 25 men and 19 women, whose mean age was 62.3 years (range 43-78 years). The mean follow-up period was 70.5 months (range 67-73 months). The mean VAS score for back pain and leg pain decreased, from 5.8 to 3.6 and 7.1 to 3.1, respectively (both $p<0.001$). The mean ODI score improved from 51.2 to 22.4% ($p<0.001$). The mean subjective satisfaction rate was 68.8%. In one patient (2.3%), segmental instability developed at a treated level, which was treated conservatively. Improvement of functional status was significantly related with incidence of postoperative complication and patient's age ($p=0.009$ and $p=0.045$, respectively). Patient satisfaction with surgery was significantly related with age ($p=0.035$).

Conclusion: Bilateral laminotomy for lumbar spinal stenosis produces favorable outcome 5 years after surgery.

Keywords: Spinal stenosis; Laminotomy; Lumbar; Spine

Introduction

Lumbar spinal stenosis is a narrowing of the spinal canal, nerve root canal, or intervertebral foramina with encroachment on the neural structures by surrounding bone and soft tissue. Patients with lumbar spinal stenosis complain of low back and leg pain with intermittent neurogenic claudication. Decompressive surgery yields better outcomes than conservative treatment for patients with severe stenosis symptoms [1-3]. Total laminectomy has been a popular surgical option for lumbar spinal stenosis. However, limitations of the procedure are a high complication rate and poor long-term clinical outcomes [4-7].

In this regard, several minimally invasive or less invasive surgical techniques have been developed for lumbar spinal stenosis, as an alternative for total laminectomy [8-13].

Bilateral laminotomy is one of the less invasive surgical techniques for lumbar spinal stenosis. The approach preserves posterior midline structures. Favorable short-term results of bilateral laminotomy for lumbar spinal stenosis have been reported [8,11,14,15]. Nonetheless, the possibility of delayed back pain and/or instability has been suggested due to inevitable damage of facet joints during the procedure.

The purpose of the present study is to analyze minimum 5-year surgical outcomes of bilateral laminotomy for lumbar spinal stenosis.

Methods

Of consecutive 51 patients who underwent bilateral laminotomy for lumbar spinal stenosis between December 2003 and June 2004, 44 patients (86.2%) who were followed-up for more than 5 years were retrospectively enrolled. The inclusion criteria of this study were lumbar spinal stenosis grade 2 or 3 demonstrated on Magnetic Resonance Imaging (MRI) [16]; radicular symptoms, claudication, and/or back pain consistent with the radiologic findings; and unsuccessful conservative therapy had been administered for at least 6 weeks. Exclusion criteria were spondylolisthesis, segmental instability, and history of spinal surgery.

Before and after surgery, pain was measured by the 10-point Visual Analogue Scale (VAS) scoring (0-10), function was assessed by the Oswestry Disability Index (ODI) scoring (0-100) [17], and postoperative satisfaction was evaluated using a patient's subjective satisfaction rate (0-100%) [18]. Good outcome of pain, functional status, and patient's satisfaction was defined as the VAS score reduced more than 50% compared with the preoperative values, ODI reduced more than 50% compared with the preoperative values, and patient's subjective satisfaction rate increased more than 50%, respectively. All other patients were classified as having poor outcome. Plain radiographs of standing lateral and flexion-extension lateral view were performed before and after surgery to assess spinal stability. All patients visited the outpatient department in January 2010 and a trained nurse collected follow-up clinical and radiological data. All patients enrolled in the present study gave written consent for their information to be used for research.

All statistical analyses were performed using R for Windows (version 3.2.5). The Wilcoxon singed rank test was used to compare the differences between pre- and postoperative parameters of clinical outcomes. Clinical and radiological factors affecting good clinical outcome were assessed by means of chi-square test, and Mann-Whitney U test. A p value less than 0.05 was considered significant.

Surgical Technique

With the patient placed in the prone position, a midline incision was made. The spine was exposed bilaterally, with care taken to preserve the facet capsules. Bilateral partial laminectomy was performed on the area of the ligamentum flavum insertion using a high-speed diamond drill. Partial medial facetectomy was also performed using a drill in an oblique shape laterally. The remaining cortical bone was resected using Kerrison rongeur. The ligamentum flavum was removed en bloc, if possible. While a microscope was directed laterally, the ligamentum flavum remaining in the lateral side of the spinal canal was resected. And then, the thecal sac and the nerve root in the both sides were confirmed to be decompressed. If necessary, foraminotomy was performed to decompress the nerve root. In addition, if the disc herniation and compression of the nerve root was clearly identified, discectomy was performed (Figure 1). All the patients were recommended to walk 4 hours after surgery. Postoperative follow-up MRI was performed within 24 hours after surgery. Patients were discharged usually at the second or third postoperative day.

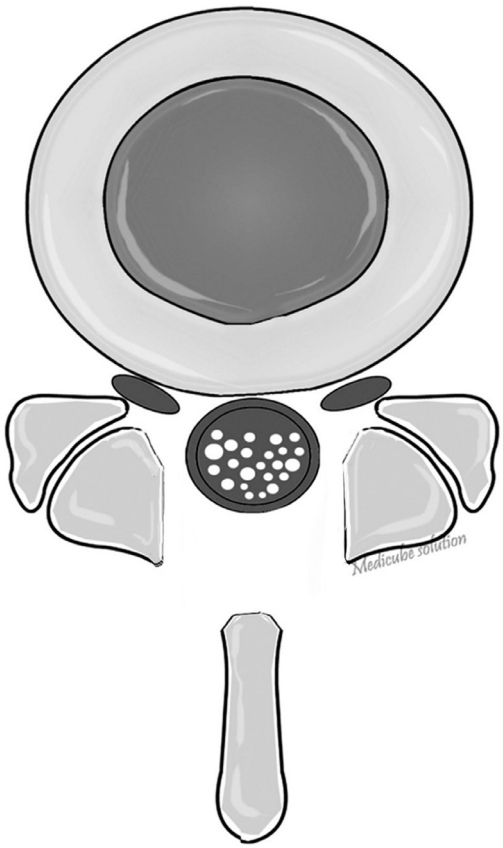

Figure 1: Illustrations showing bilateral laminotomy for lumbar spinal stenosis

Results

The mean age of the patient population was 62.3 years (range, 43-78 years). Of a total of 44 patients, 25 (56.8%) were men and 19 were women. Two patients (4.5%) had diabetes mellitus and 16 patients (36.4%) had hypertension. Thirteen patients (29.5%) were smokers. The mean body mass index was 23.9 kg/m2 (range, 17.2-30.4 kg/m2). Leg pain was the predominant preoperative symptom in 26 patients (59.1%). The mean preoperative symptom duration was 28.5 months (range, 1.5-120 months). The American Society of Anesthesiologists (ASA) classification was class I in 22 patients (50%), class II in 18 patients (40.9%), and class III in 4 patients (9.1%). Modic change was seen in 6 patients (13.6%). Half of 44 patients had grade 3 degree of disc degeneration. Root redundancy was evident in 11 patients (25.0%). Demographic details are summarized in Table 1. A total of 58 laminectomies were performed. Thirty two patients (72.7%) were decompressed at one level, 10 patients (22.7%) at two levels, and 2 patients (4.5%) at three levels. The most affected level was L4-5 (69.0%), followed by L3-4 (25.9%), L5-S1 (3.4%), and L2-3 (1.7%). Discectomy was performed in 24 patients (54.5%).

Variables	Values
Mean age	62.3 years (range, 43-78)
Gender	Men : women = 25 : 19
Mean follow-up period	70.5 months (range, 67-73)
Symptom	
Leg pain	26 (59.1%)
Claudication	5 (11.4%)
Leg pain/claudication	13 (29.5%)
ASA classification	
1	22 (50%)
2	18 (40.9%)
3	4 (9.1%)
Disc degeneration at the operated level	
Grade 2	7 (15.9%)
Grade 3	22 (50.0%)
Grade 4	13 (29.5%)
Grade 5	2 (4.5%)

Table 1: Demographic characteristics of 44 patients with lumbar spinal stenosis

Perioperative complications occurred in 5 patients (11.4%). Incidental durotomy occurred in 2 patients, postoperative epidural hematoma in 1 patient, wound infection in 1 patient, and wound dehiscence in 1 patient. All were treated surgically. Delayed complications occurred in 2 patients (4.5%). One patient complained of recurred leg pain at 11 months postoperatively. Re-herniated disc was noticed on radiographic study and removed via endoscopic surgery. The other patient complained of intermittent back pain 69 months after index surgery. Spondylolisthesis was noticed at the laminectomy level. However, the patient tolerated the back pain when medicated and another surgery was not performed.

During the mean follow-up period of 70.5 months (range, 67-73 months), surgical decompression resulted in a reduction of overall pain and functional status. The preoperative mean VAS score was 5.8 for back pain and 7.1 for leg pain. At the latest follow-up, the mean VAS score was 3.6 for back pain and 3.1 for leg pain, which changes were statistically significant (both $p < 0.001$). Mean ODI score was also reduced significantly from 51.2 preoperatively to 22.4 at the latest follow-up ($p < 0.001$). The mean subjective satisfaction rate was 68.8%. Good outcome was reported in 25 patients (56.8%) for back pain, 29 (65.9%) for leg pain, 30 (68.2%) for functional status, and 37 (84%) for satisfaction rate.

No significant associations were found between improvement of back pain or leg pain and the preoperative characteristics of patients, including age, sex, symptom duration, hypertension, diabetes mellitus, ASA grade, smoking, Modic change, disc degeneration grade, root redundancy, level of operation, concomitant discectomy, and complication. Improvement of functional status was significantly correlated with incidence of complication ($p = 0.009$; chi-square test) and patient's age (mean 60.20 years and 66.71 years for good and bad outcome groups, respectively, $p = 0.045$; chi-square test). Patient's satisfaction to surgery was significantly associated with patient's age (mean 60.86 years and 69.71 years for good and bad outcome groups, respectively $p = 0.035$; chi-square test).

Discussion

Bilateral laminotomy provides more limited decompression specifically directed to stenosis pathology itself, while preserving posterior midline structures [8]. Aryanpur et al. achieved excellent outcome in 90% of lumbar spinal stenosis patients who were treated by decomprssive laminotomy [8]. When compared with total laminectomy, bilateral laminotomy showed similar or superior clinical outcomes [19-21]. Postacchini et al. compared surgical outcomes of bilateral laminotomy with total laminectomy, and reported satisfactory results in 81% of patients after bilateral laminotomy and 78% of the patients after total laminectomy at a mean follow-up duration of 3.7 years [19]. Thomas et al. also compared surgical outcomes of bilateral laminotomy with total laminectomy and reported good outcome in 58 % of patients after total laminectomy and in 50% of patients after bilateral laminotomy at a mean follow-up duration of 36.7 months [20]. Clinical outcomes of bilateral laminotomy are comparable or superior to those of unilateral lamintomy. Thomé et al. performed a randomized comparison of unilateral laminotomy, bilateral laminotomy, and laminectomy for lumbar spinal stenosis [21]. The study revealed that in most outcome parameters, bilateral laminotomy was associated with a significant benefit and thus constitutes a promising treatment alternative; improvement of SF-36 scores and patient satisfaction was most pronounced and significantly superior in the bilateral laminotomy group [21]. Hong et al. compared bilateral and unilateral laminotomy and concluded that at a mean follow-up duration of 49.3 months, clinical outcomes were similar in both groups [22]. In the present study, improvements of back pain, leg pain, and functional status were significant and still maintained 5 years after bilateral laminotomy. Good clinical results of back pain, leg pain, functional status, and patient's satisfaction were achieved in 56.8%, 65.9%, 68.2% and 84% of the patients, respectively, which corresponded well with the results of previous studies.

In a randomized comparison study of unilateral laminotomy, bilateral laminotomy, and laminectomy for lumbar spinal stenosis, the overall complication rate was lowest in patients who had undergone bilateral laminotomy [21]. In a retrospective comparison study, bilateral laminotomy showed similar complication rate when compared with unilateral laminotomy [22]. In the present study 11.4% of all patients experienced perioperative complications. Two patients underwent another operation due to incidental durotomy. In one study, cerebrospinal fluid fistulas occur in 4.6% of patients after the first operation for spinal stenosis and 9.8% of patients after the second operation for spinal stenosis [23]. Patients with incidental durotomy have been shown to have a poorer outcome after surgery [24]. Patients with incidental durotomy have a tendency to require more reoperations, a longer duration of inability to work, more back pain, and functional limitations related to back pain [24]. Since patients with lumbar spinal stenosis generally present with severe stenosis with long symptom duration, the spinal dura tends to be thin and redundant. Therefore, care should be taken to prevent incidental durotomy during decompressive laminotomy. Lumbar decompression procedures with unilateral or bilateral laminotomy have a 14.6 percent overall incidence of postoperative spinal epidural hematoma [25]. An age of 50 years or more is strongly associated with the development of postoperative spinal epidural hematoma [25]. In the present study, postoperative spinal epidural hematoma developed in one female patient aged 54 years. She underwent second operation for hematoma removal.

Delayed segmental instability is one of the major concerns for decompressive spinal surgery. Iguchi et al. investigated 37 patients who underwent decompressive laminectomy and were followed longer than 10 years [26]. Newly developed spondylolisthesis occurred in 6 patients (16.2%), which did not need surgical correction [26]. When compared with unilateral laminotomy, however, bilateral laminotomy induces more translational motion increase postoperatively [22]. Radiographically, the amount of increased translational motion was significantly increased after bilateral laminotomy, but the amount of increased angular motion was not significantly different between unilateral and bilateral laminotomy [22]. Inevitable violation of medial portion of bilateral facet joints during bilateral laminotomy seems to be the cause of these radiological differences. In the present study newly developed spondylolisthesis was noticed at the laminectomy level in just one patient (2.3%), who was treated conservatively. A tailored decompression combined with the preservation of posterior midline structures may explain the low incidence of delayed segmental instability in this study. Further long-term follow-up studies concerning postoperative segmental instability after bilateral laminotomy are necessary.

Several factors have been reported to affect long-term clinical outcomes after decompressive laminectomy [20,26-28]. Katz et al. demonstrated that preoperative comorbidity was significantly associated with poor outcome [28]. In a study by Thomas et al., SF-36 measurements of poor functioning because of health factors and bodily pain correlated somewhat with poor outcomes in the patients who had undergone laminectomies [20]. Iguchi et al. reported that the number of resected segments (multiple laminectomy) and increased sagittal rotation at the disc in laminectomied vertebra were preoperative factors predisposing the poor results, both of which were thought to be correlated with postoperative spinal instability [26]. In addition, disc herniation in and adjacent to the laminectomy segments, regrowth of vertebral arch, duration of symptoms existing before surgery, and increased comorbidities including cardiopulmonary disease, osteoarthritis of the leg, and diabetes mellitus can influence inferior outcomes in long-term follow-up. Few studies have focused on factors affecting clinical outcomes after bilateral laminotomy for lumbar spinal stenosis. Patients with poor outcome can have worse comorbid medical conditions than patients with good outcome [20]. In patients who had undergone laminotomies, the only statistically significant finding among the outcome groups is the effect of poor emotional health on activity for the patients with poor outcomes [20]. In the present study, analyzed prognostic factors for each clinical parameters were back pain, leg pain, functional status, and patient satisfaction. The incidence of postoperative complication significantly affected patient's functional status at the latest follow-up. Six of the 7 patients with postoperative complications had to undergo reoperation, which seemed to exert a strong negative influence on the improvement of functional status. Of the 7 patients with postoperative complications, 5 were classified as perioperative complication. Care should be taken to prevent postoperative complications, especially in the perioperative period. Age was another factor affecting the improvement of functional status. Patients in good functional status was significantly younger than patients in poor functional status. Age also significantly affected patient satisfaction rate, with younger patients being more likely to profess satisfaction.

Limitations include the retrospective study design, lack of control group, and the small number of patients. These limitations should be considered when interpreting the results.

Conclusion

In conclusion, bilateral laminotomy for lumbar spinal stenosis produces favorable clinical and radiological outcomes 5 years after surgery. The incidence of postoperative complication and patient's age are significantly related with patient's clinical outcomes.

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