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Original Article

A Prospective Study on the Outcome of Degenerative Lumbar Spinal Stenosis Treated With Open Laminotomy
椎板切開術對治療退化性腰椎管狹窄症成果的一個前瞻性研究

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ABSTRACT

Background: Laminotomy is one of the surgical treatments for spinal stenosis.
Method: We conducted a prospective study including 58 patients with mean follow-up of 37.5 months, successful rate was 72%.
Result: There were significant improvement of mean Japanese Orthopaedic Association lumbar score, Oswestry Disability Index(ODI), and visual analogue scale (VAS). Male had significantly better result in ODI and VAS. There was no significant difference regarding to older age (>65) or the presence of pre-existing degenerative spondylolisthesis. One patient was found to have increased lumbar instability after operation. The overall reoperation rate was 6.9%.

中文摘要

椎板切開術是治療退化性腰椎管狹窄症的其中一種方法。 我們進行了一個前瞻性的研究，當中有58位病人，平均覆診時期為37.5個月， 手術成功率為72%。 術後的日本骨科協會腰椎評分(JOA lumbar score)，歐式下背痛失能量表（ODI）和疼痛量表（VAS)的平均值有明顯的改善。 男性在ODI和VAS上有較好的術後結果。年長的(65歲以上） 或術前以知有退化性脊椎滑脫症的卻沒有明顯分別。 其中一位病人術後被發現腰椎不穩症惡化。整體上，再手術的比率為6.9%。

Introduction

Degenerative lumbar spinal stenosis is a common indication for spine surgery especially in the elderly. The stenosis is mainly caused by the osteoarthritic facet joints, hypertrophy of the ligamentum flavum, and bulging intervertebral disc. For the natural history of spinal stenosis, most patients do not improve with conservative treatment alone.[1,2] Historically, spinal stenosis was treated with extensive decompression with laminectomy and fusion. In recent decades, laminotomy has been advocated as an alternative for treating degenerative lumbar spinal stenosis with comparable results with the stability of the lumbar spine still be preserved. We conducted a prospective study to evaluate the clinical outcome of open laminotomy. We aimed to find out any variables that may affect the surgical result. The effect on spinal stability was also studied.

Methods

A total of 70 patients were recruited in this prospective study from September 2004 to April 2008. The selection criteria were as follows: (1) neurogenic claudication; (2) central spinal canal or lateral recess stenosis confirmed by magnetic resonance imaging (MRI); and (3) failed conservative management for at least 6 months.

Patients were excluded if they have any of the followings: (1) concomitant mechanical back pain and radiologic instability (grade II or above spondylolisthesis); (2) lytic spondylolisthesis; (3) previous operation at same site; or (4) achondroplasia/acromegaly.

Laminotomy was done for all patients by the same surgical team. Postoperatively, the patients were followed up in our outpatient clinic at fixed intervals. The following preoperative and postoperative clinical outcomes were recorded to monitor the progress, including Japanese Orthopaedic Association (JOA) lumbar score, Oswestry Disability Index (ODI), and visual analogue scale (VAS). The improvement rate (Hirabayashi method)[3] based on JOA lumbar

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score was calculated [(postoperative score − preoperative score)/(29 − preoperative score) × 100%]. The results of improvement rate were classified into four groups as excellent (≥75%), good (50%–74%), fair (25%–49%), and poor (≤24%).[3] Surgery was considered successful if the improvement rate was more than 25%.[3,4]

Statistical analysis was done by using the SPSS (Statistical Package for the Social Sciences by IBM Corporation) Statistics version 17.0. A paired *t*-test was used for the comparison of the means of preoperative and postoperative scores. Mann–Whitney test was used to compare the difference of clinical outcome between different age, gender and presence of degenerative spondylolisthesis. Values of *p* less than 0.05 were considered significant.

Operative technique

All operations were performed by the same surgical team. The patient was lying prone on a Jackson frame. The level of laminotomy was identified with the help of intraoperative fluoroscopy. A posterior midline longitudinal skin incision was made over the corresponding level. Lamina was exposed after subperiosteal dissection of the paraspinal muscles. The laminotomy was made with the lamina removed carefully with a high-speed diamond-head pneumatic burr, leaving a margin of at least 7 mm from superior border and 5 mm from lateral border of the lamina (Figure 1). The ligamentum flavum was then removed with Kerrison rongeurs; the hypertrophied ligamentum flavum and facet joint capsule narrowing the nerve root exit zone were also removed. Any osteophytes encroaching the spinal canal and lateral recess were excised. The adequacy of decompression was determined by inspection of the thecal sac and nerve roots as well as probing the lateral recess and the nerve root exit zone.

Results

A total of 70 patients had undergone bilateral laminotomies from September 2004 to April 2008. A total of 58 (82.9%) patients had follow-up of at least 1 year. There were 28 males and 30 females. The average age was 60 years of age (range, 38–81). The average duration of follow-up was 37.5 months. A total of 13 (22%) patients had preexisting degenerative spondylolisthesis without mechanical back pain, which signifies preoperative lumbar instability. A total of 24 patients had laminotomies at ine level done; 24 patients at two levels; six patients at three levels; three patients at four levels; and four patients at five levels. (Table 1) The average operating time was 148 minutes.

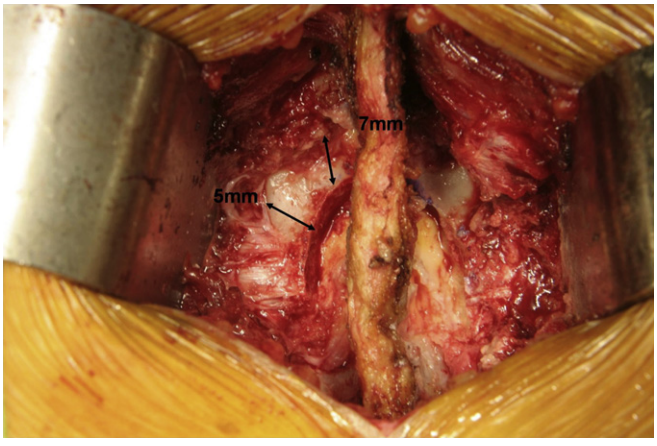

Figure 1. Intraoperative photograph. Laminotomy made with leaving a margin of at least 7 mm from superior border and 5 mm from lateral border.

Table 1
Demographic data and clinical variables

Demographic data	
Patients included	58
Mean age (yrs)	60.2 (38–81)
Follow-up (mos)	37.5 (12–74)
Clinical variables	Patients (*n*)
Sex	
Male	28
Female	30
Age (yr)	
≤65	38
>65	20
Degenerative spondylolisthesis	13
No spondylolisthesis	45
Levels of laminotomy (*n*)	
1	24
2	24
3	6
4	3
5	4

The overall clinical results were shown in Table 2. There was significant improvement of mean JOA lumbar score, ODI, and VAS after the operation. The mean JOA lumbar score improved from 19.8 to 24.1($p = 0.007$). The mean ODI improved from 43.1% to 21.5% ($p = 0.012$). The mean VAS improved from 7.9 to 2.7 ($p = 0.043$).

The mean improvement rate of JOA lumbar score was 43.8%. A total of 31 patients (54%) had good or excellent results. Surgery was considered successful in 40 patients (72%) as their improvement rate higher than 25%.

Table 3 showed the clinical outcomes in terms of age, sex, and presence of degenerative spondylolisthesis. There was significant difference of the postoperative result between males and females; males had significantly better results in ODI ($p = 0.006$) and VAS ($p = 0.001$), but not the JOA lumbar score ($p = 0.077$). There was no significant difference in the postoperative results regarding to older age (>65) or the presence of preexisting degenerative spondylolisthesis.

There was no wound related complications in all patients. We encountered dural tear in three patients (5%) and all were repaired through the laminotomy or converted hemilaminectomy. There was no subsequent fluid collection, wound infection, or pseudomeningocele afterward. All patients showed improvement in symptoms and functional scores.

One patient was found to have increased instability after the operation. The patient had increased low back pain and recurrence of spinal claudication symptoms 2 years after the operation. MRI and computed tomography scan confirmed inferior articular

Table 2
Overall results of clinical outcomes

	Preoperative	Last FU
JOA lumbar score	19.8*	24.1*
ODI	43.1*	21.5*
VAS	7.9*	2.7*
Improvement rate of JOA score	Patients, *n* (%)	
Excellent, ≥75%	16 (28)	
Good, 50%–74%	15 (26)	
Fair, 25%–49%	11 (19)	
Poor, ≤24%	16 (28)	

Values are reported as means.
*$p < 0.05$; *p* values using paired *t*-test.
FU = follow-up; JOA = Japanese Orthopaedic Association; ODS = Oswestry Disability Index; VAS = visual analogue scale.

Table 3
Clinical outcome of different variables

	JOA lumbar score		ODI		VAS	
	Preoperative	Last FU	Preoperative	Last FU	Preoperative	Last FU
Age ≤ 65 yr ($n = 38$)	20.3	24.2	41.9	20.9	8	2.9
Age > 65 yr ($n = 20$)	19.1	23.9	45.3	22.7	7.6	2.3
Male ($n = 28$)	20	24.8	41.2	15.8*	7.7	1.5*
Female ($n = 30$)	19.7	23.4	44.8	26.9*	8.1	3.8*
Degenerative spondylolisthesis ($n = 13$)	18.9	23.1	50.1	22.8	8.4	2.7
No spondylolisthesis ($n = 45$)	20.1	24.4	41.1	21.2	7.8	2.7

Values are reported as means.
*$p < 0.05$, p values compare age, sex, and presence of degenerative spondylolisthesis using the Mann–Whitney test.
FU = follow-up; JOA = Japanese Orthopaedic Association; ODS = Oswestry Disability Index; VAS = visual analogue scale.

process fracture. A reoperation of laminectomy with intervertebral fusion was performed. Another three patients also need reoperation because of recurrence of spinal claudication symptoms, and all of them had intervertebral disc protrusion causing spinal stenosis at the same level of previous laminotomy. However, there was no instability or progression of spondylolisthesis noted in their follow-up radiographs. All had laminectomy with either instrumented intervertebral fusion or posterolateral fusion done in the reoperations.

Discussion

Classically, lumbar spinal stenosis was treated with extensive removal of posterior elements, including the lamina, spinous process, interspinous ligaments, and facet joints.[1,5] However, this extensive procedure will destabilise the lumbar spine and may cause secondary spondylolisthesis[6,7]; hence, fusion with or without instrumentation was recommended in most cases. In view of this, several less invasive procedures, e.g., multiple laminotomies, unilateral laminotomy for bilateral decompression and, micro-endoscopic decompressive laminotomy, have been developed. The main challenge is to have adequate decompression while preserving the spinal stability. Knowing the common cause of lumbar spine stenosis, one can use less extensive lamina removal to provide adequate decompression for spinal stenosis. It has been well studied for the safety margin of laminotomy for these purposes.[6,8–10]

Laminotomy as a treatment for spinal stenosis in selected patients was very successful, and the improvements in JOA, ODI, and VAS were significant in our studies. In a historical meta-analysis done by Tuner,[1] the success rate of decompression for spinal stenosis was 64%. Several recent studies showed even better outcome with good or excellent results of 72 to 88%.[7,9,11–13]

The literature showed that the result of laminotomy is not inferior to laminectomy with or without fusion in terms of functional outcome and symptomatic relief as a treatment of spinal stenosis.[1,5,8,11] Different biomechanical and clinical studies also proved that spinal instability will not be affected by laminotomy or medial facectomy.[6,8,13] So, laminotomy alone has the advantage of preserving stability of lumbar spine while avoiding the associated complications of instrumentation or fusion, such as increased bleeding and operative time, failure of fusion causing pseudoarthrosis, implants failure, and skin impingement or irritation by implant hardware.[8]

We believe the presence of spondylolisthesis was not equal to spinal instability in all patients. If it is only a low-grade degenerative spondylolisthesis, dynamic radiographs show no increase in translation and the patient also does not complain of any mechanical back pain, we could perform laminotomy. We believe decompression with fusion is unnecessary in this group of patients. In our series, 13 of 58 patients had preexisting degenerative spondylolisthesis, only one of them was found to have increase in angular instability caused by the articular process fracture. Kleeman et al[4,9] noted that the clinical outcome was similar in those patients with or without preoperative degenerative spondylolisthesis; 87% of patients with degenerative spondylolisthesis showed no change in slip after laminotomy. Johnsson et al[14], Frazier et al[15], and Iguchi et al[4] showed there was enhanced risk of further slipping in degenerative spondylolisthesis after posterior decompression without fusion, but the increased slip did not affect the operative results.

Several authors also suggested that fusion is not necessary in the absence of instability.[1,5,7,8,11] Turner[1] found no difference of clinical outcome in the patients with or without fusion in their literature review. Grob et al[8] showed no significant difference between instrumented fusion and laminectomy without fusion in randomised controlled trial of 45 patients with degenerative spinal stenosis. Rompe et al[11] found the results were similar among three groups of patients with laminotomy, laminectomy alone, and laminectomy with fusion done 8 years after the operations.

Our studies showed male patients had significant better ODI and VAS score after surgery while there was no significant difference of surgical outcome regarding to age; however, several studies found conflicting results of the surgical outcome regarding to age and sex.[1,10,12] Yamashita et al[10] performed a prospective study with 5-year follow-up showing older age predicts a higher risk of late recurrence of symptoms, and women have higher VAS score after surgery.

Meta-analysis concluded that decompression alone has the fewest complications.[1,5] In our series, we encountered dural tear in three of 58 patients (5%). The incidence was comparable with other studies in the literature.[1,5,12,13]

Our reoperation rate was 6.9%, which is similar to the literature from 9% to 19%.[1,10–12]

There are some limitations of our study. Firstly, we do not have an independent observer for recording the postoperative results on follow-up. Secondly, the mean follow-up period of 37.5 months is considered a mid-term result, so longer follow-up is needed to conclude the long-term results and reoperation rate.

In conclusion, laminotomy is a good and feasible option of surgical intervention for degenerative lumbar spinal stenosis without spinal instability in our locality.

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