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A comparative study of bilateral laminotomy and laminectomy with fusion for lumbar stenosis

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Abstract

Laminectomy with fusion and bilateral laminotomy as a fenestration method have been used to improve pain, neurogenic claudication and neurological impairment in lumbar stenosis. To date it is not known whether the two surgical procedures have the same effectiveness in this degenerative disease. This is a retrospective review of 105 consecutive patients with lumbar stenosis who underwent surgery at the Sanglah General Hospital, Bali between 2005 and 2008. The aim of this study was to compare the results of bilateral laminotomy and laminectomy with fusion for canal decompression in lumbar stenosis. The study consisted of 46 patients who underwent bilateral laminotomy and 59 patients treated by laminectomy with fusion. The follow up ranged from 3-36 months. The outcome was evaluated by the *Visual Analog Scale* (VAS), *Neurogenic Claudication Outcome Score* (NCOS), and the *Oswestry Disability Index* (ODI) scores. The means of postoperative VAS for both groups were 2.6 $\pm$ 0.9, postoperative NCOS for both groups were 64.0 $\pm$ 13.9 and postoperative ODI for both groups were 24.4 $\pm$ 7.9. There was no clinical deterioration and side effect from the operative procedure. Our results show that bilateral laminotomy and laminectomy with fusion are equally effective over a short follow up. However, bilateral laminotomy is a less invasive procedure.

INTRODUCTION

Canal compression due to degenerative process at the lumbar nerve roots can cause low back pain, neurogenic claudication, significant neurological impairment and disabilities. Laminectomy has been established as an efficacious surgical management for patients with neurogenic claudication and radiographically confirmed lumbar stenosis. Lumbar stenosis is the result of degeneration of lumbar spine; degeneration and loss of disc elasticity as well as disc herniation, facet hypertrophy, spur formation, spondylosis, thickening of yellow ligament and spondylolisthesis, all impinging on the spinal canal and intervertebral foramen. The symptoms include back pain, aching and cramping of the leg, neurogenic claudication, muscle spasm, neurological deficits including numbness and paraesthesia, reflex loss, motor weakness, muscle atrophy and sphincter disturbance.[1,2]

Since Mixter and Barr developed laminectomy in 1934, the procedure has been widely used in the treatment of lumbar stenosis. Laminectomy decompression is effective although associated with significant blood loss, postoperative wound pain, prolonged hospital stay and impaired lumbar stability requiring fusion or stabilization. Modification to the original technique to reduce the morbidity without affecting its effectiveness include less invasive surgery such as partial laminectomy or bilateral laminotomy decompression, foraminotomy with medial facetectomy as well as microdiscectomy.[3-8]

To-date, outcome evaluations of bilateral laminotomy as compared to laminectomy with fusion as treatment for lumbar stenosis have not been reported. This is a retrospective comparative study of the two procedures based on patients admitted to the Sanglah General Hospital, Bali, Indonesia.

METHODS

The patients and selection

The study subjects were the 105 patients with lumbar stenosis admitted to the Sanglah General Hospital, Bali, between June 2005 and June 2008. In all patients, the lumbar canal stenosis

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Figure 1: Preoperative sagital T2-weighted MR image, demonstrating significant canal stenosis due to thickening of the yellow ligament and bulging disc on L4-5.

was confirmed by MR imaging demonstrating canal compression due to hypertrophic yellow (flavum) ligament, hypertrophic facet joints, posterior spur formation and disc bulging. (Figure 1) Conservative medical treatment, including bed rest, anti-inflammatory medication, physiotherapy, and external bracing, had failed to resolve symptoms. The patients underwent one of two types of canal decompression surgeries, i.e: bilateral laminotomy and laminectomy with

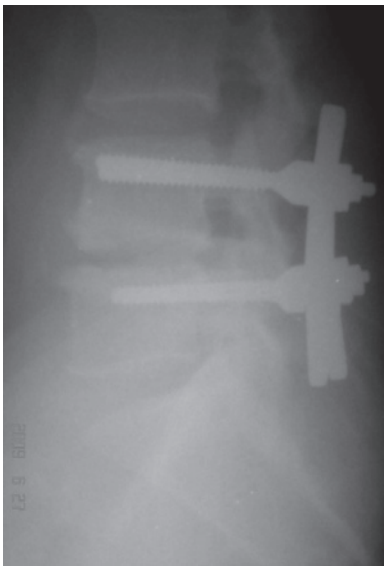

Figure 2: Postoperative lateral lumbosacral x-ray, showing pedicle screws and plate system inserted on L4-5 level

fusion. Patients who had mainly radiculopathy symptoms rather than low-back pain were candidates for bilateral laminotomy procedure. Those with spondylolysis, previous surgery, instability including slippage, local kyphosis underwent laminectomy with fusion procedure. All surgeries were performed by the first author (TGBM). All patients received a standard inhalational anesthetic with supplemental oxygen and nitrous oxide, from the anesthesiologists in the Hospital.

Bilateral laminotomy

Under general anesthesia, linear midline posterior skin incision was used, the muscle was split at the midline and continued by subperiosteal dissection downward until the lamina and facets of the stenotic level were exposed, then the spine retractor was placed. The spinous processes were removed at their insertion into the posterior arch by using a bone rongeur (Aesculap®), flavectomy was done leaving a narrow channel exposing the spinal canal. The Kerrison rongeur was used to undercut partial of the lamina at the stenotic levels then angled laterally to undercut the medial facets on each side, to visualize the edge of the dura, and to decompress the nerve roots while leaving most of the facets intact. The decompression was advanced to the lateral recesses and foraminal areas until all hypertrophic flavum ligament and hypertrophic facet joints, which encroached on the roots, had been completely removed. It involved a wider decompression of the spinal canal while maintaining most of the lamina and bone structures and included confirmation of dural pulsation. The disc spaces were carefully assessed for herniated disc material or prominent bulges, and when necessary, the discs were removed. Homeostasis was confirmed by bone wax (B-Braun®) and cauterization, vacuum drain was placed then the fascia and skin were closed in layers. This approach was termed as bilateral laminotomy decompression.[6,7,9-11]

Laminectomy with fusion

The decompressive procedure consisted of removal of the spinous process, bilateral laminectomy, partial bilateral facetectomy, and foraminotomy. Followed by spinal fusion using Luque or Hartshill rectangle (Gesco®) wiring techniques (in the beginning) or pedicle screw and rod systems (recently). Pedicle screws (GSS®-TSRH system) diameter were used in 4,5 to 5.5 mm, which were inserted and advanced

under fluoroscopic guidance in rostro-caudal orientation to the anterior cortex of the vertebral body, maintaining a trajectory that is parallel to the end plate. To determine both the required length of the rod or plate and its contour, should it need to be bent, a malleable tube was used as a template for the rod. The rods were bent to match the template and attached to the pedicle screws with the use of one-locking clamps.[11-14]

Post operative course and follow up evaluation

After the decompressive procedure, all patients were managed in regular ward. Their vital signs were checked every 2 hours on the first day and every 6 hours throughout the hospital stay. All patients were mobilized within 3 days postoperatively. Rehabilitation was initiated within the 1st week after surgery. The side effects that were looked for included neurological deterioration, cerebrospinal fluid (CSF) leakage, and wound infection. The patients were discharged when they could ambulate and had adequate pain control. The Visual Analog Scale (VAS) was used for pain evaluation preoperatively and at the discharged day, Neurogenic Claudication Outcome Score (NCOS), and the Oswestry Disability Index (ODI) were used for evaluation of the neurological outcome preoperatively and on follow up at least 3 months later. All patients underwent serial clinical follow-up evaluations for periods ranging from 3 to 36 months. Radiographs were obtained postoperatively and at regular follow-up intervals to evaluate the correct placement and stability of the implant system. The measurement of VAS, NCOS, and ODI scores were done by the first author (TGBM) and neurosurgery residence in single institution, pre and postoperatively. Long-term outcomes will be reported separately.

Statistical analysis

Statistical analysis were examined using Kolmogorov Smirnov test for Normality , for equality of variances using Levene's test, Mann-Whitney U test was applied to overcome the differences between VAS, NCOS, ODI, scores pre and postoperatively. Probability values of <0.05 were considered statistically significant. Numerical values were expressed as means $\pm$ standard deviations (range). Related factors for "not improved" (results) were analyzed using logistic-regression analysis. Univariate and multivariate logistic-regression models were used to estimate ORs and the associated 95% confidence intervals (CIs). For "not improved", the following variables were examined: sex (male/female), age ($<5^{th}$ decade / $\geq 5^{th}$ decade), Frankel (Scale E / < Scale E), spondylosis/hernia nucleus pulposus, preoperative VAS (<8 / ≥ 8), preoperative NCOS (<8 / ≥ 8), preoperative ODI (<80 / ≥ 80) and technique (bilateral laminotomy/ laminectomy-fusion).

RESULTS

The study population consisted of 87 men and 18 women, and the mean decade of age was the 5^{th} decade (range 3^{rd} –7^{th} decade). In 46 cases, bilateral laminotomy were performed, consisted of 38 male and 8 female. In 59 patients, laminectomy with fusion was performed, consisted of 49 male and 10 female. The demographics of the study patients are listed in Table 1. Lumbar stenosis was concomitant with disc herniation in 61, spondylolisthesis in 7 and spondylosis in 37 patients. Preoperatively no patient had spinal injury following accidents, and no cases of spondylolisthesis were related to previous lumbar surgery. Symptoms consisted of back, buttock, and posterior thigh claudication pain or lumbosacral radiculopathy in all patients. Neurological deficits as measured by the Frankel scales were defined before surgery which were then correlated with radiographically demonstrated pathological processes in all patients. Frankel scale is the most widely used system for evaluation of functional recovery in spinal lesion, which consists of five grades (A-E), based on motor and sensory deficits; A. Complete paralysis; B. Sensory function only below the injury level; C. Incomplete motor function below injury level; D. Fair to good motor function below injury level; E. Normal function. Neurological function were determined as Frankel E in 57, Frankel D in 36, Frankel C in 7 and Frankel B in 5 patients. For the fusion procedure, Luque (in 7 patients) and Hartshill wiring techniques (in 35 patients) were used in the earlier cases, pedicle screws and rod (TSRH system) were used (in 17 patients) in the more recent cases.

Table 1 lists the preoperative VAS score, NCOS score and ODI score of both groups of patients. As shown, there were no significant differences between the two groups in all the three measurements before operation.

In both groups (Table 2), the postoperative VAS score mean was 2.6 ± 0.99 (1-4), postoperative NCOS score mean was 64.0 ± 13.97 (26-78), and postoperative ODI score was 24.4 ± 7.92 (12-36). There were no postoperative complications

Table 1: The demographics data of the study patients

Characteristic	Bilateral laminotomy Group (46 patients)	Laminectomy with fusion Group (59 patients)	P value
Sex (Male: Female ratio)	38 : 8	49 : 10	1.00 †
Age (Decade of life)	5 (4-7)	5 (3-7)	0.083 †
Preop VAS	8.3 (6-10)	8.5 (5-10)	0.219‡
Preop NCOS	8.8 (0-22)	86 (52-100)	0.219‡
Preop ODI	82.8 (60-100)	86 (52-100)	0.219‡
Outcome (Improved: Not improved)	44 : 2	54 : 5	0.463‡

Preop VAS: Preoperative Visual Analogue Scale; Preop NCOS: Preoperative Neurogenic Cladification Outcome Score; Preop ODI: Preoperative Oswestry Disability Score
Values expressed as means (range) unless otherwise indicated
† Determined by means of X^2 test
‡ Determined by means of Mann-Whitney u test

among the 105 patients. No patient had additional surgery in the lumbar spine, during the follow-up period.

Related factor for the surgery result of "not improved" were analyzed using logistic-regression analysis. Among the independent variables with p values < 0.25 were: spondylosis without hernia nucleus pulposus (p=0.02), preoperative VAS (p=0.21), preoperative NCOS (p=0.20) and preoperative ODI (p=0.21); these variables were included in the subsequent multivariate analysis. The results of logistic-regression models are shown in Table 3. Spondylosis without hernia nucleus pulposus was the only significant factor in the multivariate models.

DISCUSSION

Lumbar decompression is a common procedure for spinal disorders including lumbar stenosis and spondylolisthesis. Conventional laminectomy remains the gold standard of therapy. Problems

Table 2: The outcome of the study patients

	Group	N	Mean	SD	Mean Rank	P value†
Postop VAS	Bilateral Laminotomy	46	2.8 (1-4)		59.15	0.055
	Laminectomy+Fusion	59	2.4(1-4)		48.20	
	Total	105	2.6 (1-4)	0.9		
Postop NCOS	Bilateral Laminotomy	46	59.2 (26-78)		46.78	0.052
	Laminectomy+Fusion	59	67.7 (40-78)		57.85	
	Total	105	64.0 (26-78)	13.9		
Postop ODI	Bilateral Laminotomy	46	26.3 (12-36)		59.15	0.055
	Laminectomy+Fusion	59	23.0 (12-36)		48.20	
	Total	105	24.4 (12-36)	7.9		

Postop VAS: Postoperative Visual Analogue Scale; Postop NCOS: Postoperative Neurogenic Cladification Outcome Score; Postop ODI: Postoperative Oswestry Disability Score

† Determined by means of Mann-Whitney u test.

Table 3: Analysis of factors for postoperative outcome "not improved" in the study patients

Variable	Univariate		Multivariate	
	OR	95%CI	OR	95%CI
Sex (female)	0.79	0.09-7.03	1.79	0.15-22.19
Age (>5th decade)	2.30	0.44-12.06	0.85	0.13-5.56
Frankel (<E)	1.74	0.30-9.90	3.39	0.42-27.46
Spondylosis without hernia nucleus pulposus	9.47	1.10-81.80	0.09	0.01-0.79
Preop VAS (>8)	0.20	0.02-1.81	2.28	0.35-15.11
Preop NCOS (>8)	3.31	0.55-19.91	0.41	0.07-2.90
Preop ODI(>80)	1.20	0.02-1.81	0.44	0.05-3.16
Groups (Laminectomy+fusion)	2.04	0.38-11.01	0.51	0.07-3.64

Data were calculated by logistic regression analysis on 105 patients.
VAS= Visual Analog Scale; NCOS= Neurogenic Claudication Outcome Score; ODI= Oswestry Disability Index.

with procedure occur due to the extensive soft tissue dissection, paraspinal muscles devascularization and the risk of spinal instability, thus the need of spinal fusion or stabilization. The current surgical treatment is not entirely satisfactory.[4,11-13]

The optimal treatment is therefore still under considerable debate. Feffer *et al* in 1985 compared two groups of patients with lumbar stenosis secondary to degenerative spondylolisthesis and reported that patients undergoing laminectomy decompression and fusion had more favorable outcomes than those treated with laminectomy decompression alone. Several factors appear to predispose patients with lumbar stenosis to poor outcomes.[2,14-16]

Meanwhile, Nancy in 1997 reported that lumbar stenosis with or without other disease may be managed solely by laminectomy without fusion in 90 to 95% of the time. The younger patients in whom radiographic and clinical instability are demonstrated should undergo primary fusion, whereas the majority of patient should be treated by laminectomy alone. Moreover, mild to moderate single level degenerative spondylolisthesis can be treated by bilateral laminotomy technique.[17]

In this study, a less invasive technique, fenestration approach of bilateral laminotomy decompression, and standard treatment as laminectomy with fusion were used to treat lumbar stenosis. The surgical outcome was analyzed descriptively and analytically. In both groups, low-back pain seem to improve after surgery; moreover, in our study, the surgical outcome, including results of the postoperative VAS, NCOS, and ODI scores, did not differ between the 2 groups. Bilateral laminotomy thus has an advantage as a less invasive method. No patient experienced worsening of low-back pain or neurological function. Based on the pre- and postoperative VAS, NCOS, ODI and scores results, good surgical outcome could be reached in both groups of patients; the option of less invasive surgery should thus be considered.

In this study, we showed that lumbar stenosis treated with both types of surgery had good clinical outcome. However, 7 patients (6.7%) did "not improved" with their treatment, and the only factor found to have a statistically significant association was spondylosis without hernia nucleus pulposus. It is generally believed that degenerative lumbar/spondylosis has a major contribution to chronic pain, anatomical distortion and irreversible neurological impairment.

The limitations of this study were: firstly, it is a retrospective study using medical records, with no randomization or blinding process. Secondly, the small numbers of subjects in each group and thirdly, the measurement of the NCOS, ODI and VAS scores were done by the first author and

the neurosurgical residents, with the potential of inter-observer bias.

In conclusion, the use of bilateral laminotomy in lumbar stenosis can provide good surgical outcome comparable to that in laminectomy with fusion technique in short term follow up. Despite all the limitations of this study, the authors conclude that the bilateral laminotomy strategy is effective, less invasive and may provide an option of surgical management in lumbar stenosis patients.

REFERENCES

1. Arnoldi CC, Brodsky Ae, Cauchoix J, *et al*. Lumbar spinal stenosis and nerve root entrapment syndromes. Definition and classification. *Clin Orthop* 1976; 115:4-5.
2. Domagoj C, Charles LB. Posterior lumbar interbody fusion in the treatment of symptomatic spinal stenosis. *Neurosurg Focus* 1997; 3(2): article 5.
3. Kunihiko S, Masayuki U, Tohkun M, Ei W, Hirokazu I. Microsurgical bilateral decompression via a unilateral approach for lumbar spinal canal stenosis including degenerative spondylolisthesis. *J Neurosurg Spine* 2008; 9:554-9.
4. Lin SM, Tseng SH, Yang JC, Tu CC. Chimney sublaminar decompression for degenerative lumbar spinal stenosis. *J Neurosurg Spine* 2006; 4:359-64.
5. Katz JN, Stucki G, Lipson SJ, Fossel AH, Grobler LJ, Weinstein JN. Predictors of surgical outcome in degenerative lumbar spinal stenosis. *Spine* 1999; 24:2229–2233.
6. Herno A, Airaksinen O, Saari T, Miettinen H. The predictive value of preoperative myelography in lumbar spinal stenosis. *Spine* 1994; 19:1335-8.
7. Airaksinen O, Herno A, Turn V, Saari T, Suomlainen O. Surgical outcome of 438 patients treated surgically for lumbar spinal stenosis. *Spine* 1997; 22:2278-82.
8. Johnson K-E, Willner S, Petterson H. Analysis of operated cases with lumbar spinal stenosis. *Acta Orthop Scand* 1981; 52:427-33.
9. Johnson B, Annertz M, Sjoberg C, Stromqvist B. A prospective and consecutive study of surgically treated lumbar spinal stenosis: Part II. Five-year follow-up by independent observer. Spine 1997; 22:2938-44.
10. Surin V, Hedelin E, Smith L. Degenerative lumbar spinal stenosis. *Acta Orthop Scand* 1982; 53:79-85.
11. Paine KWE. Results of decompression for lumbar spinal stenosis. *Clin Orthop* 1976; 115:96-100.
12. Amundsen T, Weber H, Nordal HJ, Magnaes B, Abdelnoor M, Lilleas F. Lumbar spinal stenosis: conservative or surgical management?: A prospective 10-year study. *Spine* 25:1424–35. doi: 10.1097/00007632-200006010-00016. 2000 Jun 1; discussion 1435–6. [PubMed]
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. Weiner BK, Fraser RD, Peterson M. Lumbar decompressive surgery. *Spine* 1999; 24:62-6.
15. Weiner BK, McCulloch JA. Microdecompression for lumbar spinal canal stenosis. *Spine* 1999; 24:2268-72.
16. Jhonsson B. Patient related factors predicting the outcomes of lumbar decompressive surgery. *Acta Orthop Scand* 1993; 251:69-70.
17. Nancy E.E. Surgical management of lumbar stenosis: decompression and indications for fusion. *Neurosurgical Focus* 1997; 3(2):Article 1.