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Long-term Outcomes of Two Different Decompressive Techniques for Lumbar Spinal Stenosis

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Study Design. A prospective study to evaluate the outcomes of 2 different decompressive techniques for lumbar spinal stenosis.

Objective. To explore a more effective and less invasive decompression technique without instrument and fusion for lumbar spinal stenosis.

Summary of Background Data. The traditional surgical decompression of spinal stenosis involves laminectomy or unilateral laminotomy. Even in unilateral laminotomy cases, 85.3% had an excellent-to-fair operative result, and the incidence of complications was 9.8%. Although the addition of instrumentation does not increase the complication rate, but compared to the efficiency, the higher costs was controversial. Minimal invasion and destabilization are recommended.

Methods. This prospective study included 152 consecutive patients, sequentially divided into 2 groups, underwent Windows technique (group A) and decompressive laminectomy (group B) by 2 groups of surgeons.

Results. The evaluation of the back pain, leg pain, walking tolerance, and neurologic recovery were performed before surgery and after surgery. In group A, at the final evaluation, the overall results were good to excellent in 89% (68/76) of the patients, fair 11% (8/76), and poor 0%. In group B, at the final evaluation, the overall results were good to excellent in 63% (48/76) of the patients, fair 30% (23/76), and poor 7% (5/76).

Conclusion. Degenerative spinal stenosis can be decompressed adequately with preserving the posterior elements. The "Windows technique" laminoforaminotomy, which obtained satisfactory long-term outcomes with few complications and low cost, can be a standard procedure for the surgical treatment of the degenerative spinal stenosis even with slight congenital spinal stenosis.

Key words: lumbar spinal stenosis, decompression, laminectomy, laminoforaminotomy. **Spine 2008;33:514–518**

Acquired spinal stenosis is the most common condition leading to spine surgery in the geriatric population. Degenerative changes lead to central stenosis from ligamentum flavum hypertrophy, disc bulging, and osteophytes. Lateral recess or foraminal compression can result from facet hypertrophy and settling. Several studies on nonoperative treatment of patients with between 1 and 5 years of follow-up suggest that variably 15% to 43% of patients will have continued improvement after nonoperative treatment.[1] On the other side, for most patients, surgical procedures are preferred.

Traditionally, laminectomy is the most popular surgical decompression of spinal stenosis involved extensive removal of the posterior elements including the lamina, spinous processes, interspinous ligaments, and even facet joints. Although, the short-term outcome of the laminectomy is good enough but the long-term outcome is not so satisfactory. Seven to 10 years after decompressive surgery for spinal stenosis, 23% of patients had undergone reoperation and 33% of respondents had severe back pain.[2] Even in unilateral laminotomy cases, 85.3% had an excellent-to-fair operative result, and the incidence of complications was 9.8%.[3]

A minimal removal decompressive procedure was prospectively evaluated for the treatment of lumbar spinal stenosis compared to traditional laminectomy. From 2002 to 2004 in our hospital, a total of 152 consecutive patients were divided into 2 groups and operated by different spine surgeons. No instruments and fusions were performed. At an average follow-up assessment of 40 months, the outcomes in 2 groups were evaluated prospectively.

Materials and Methods

A total of 152 consecutive patients undergoing surgery between March 2002 and October 2004 were studied prospectively, including 113 degenerative spinal stenosis, 39 congenital combined with degenerative spinal stenosis, were sequentially divided into group A and B. The subjects were allocated so that the patient 1 got 1 type of surgery, and number 2 a second type *etc*. In group A, 37 men and 39 women ranged in age from 47 to 70 years (averaged 57 years), including 21 congenital combined with degenerative spinal stenosis underwent minimal removal decompressive procedure named "Windows technique" laminoforaminotomy. The number of decompressed segments was 1 level in 25 patients, 2 levels in 29 patients, 3 levels in 14 patients, and 4 levels in 8 patients. In group B, 33 men and 43 women ranged in age from 45 to 73 years (average, 57 years), including 18 congenital combined with degenerative spinal stenosis underwent traditional laminectomy procedure. The number of decompressed segments was 1 level in 28 patients, 2 levels in 29 patients, 3 levels in 15 patients, and 4 levels in 4 patients. The operations were done by 2 spine surgeon teams respectively. The patients were observed up every 3 months in the first year and every 6 months in the second year.

Inclusion criteria required that each patient have (1) neurogenic claudication as defined by leg pain limiting standing, ambulation, or both; (2) a history of exercise intolerance; (3) mag-

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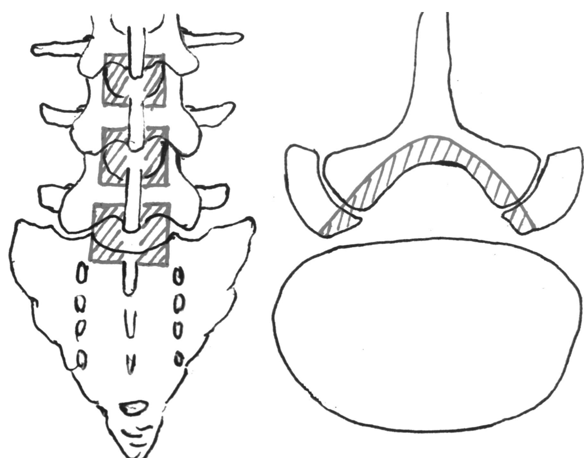

Figure 1. Decompression area including the complete excision of the ligamentum flavum, partial excision of the laminae, the base of the spinous process and the facet process bilaterally. The spinous processes, interspinous ligaments, facet capsules, and part of laminae were meticulously preserved.

netic resonance imaging (MRI), myelogram, or computed tomography (CT) confirmation of compressive central stenosis (central sagittal diameter less than 10 mm) with or without lateral recess stenosis (lateral recess diameter less than 3 mm); and (4) failure of conservative therapy after an adequate trial.

Patients were excluded from the study if they had (1) previous spinal surgery at the same level, (2) isthmic spondylolisthesis, (3) the bony midsagittal diameter of the congenital spinal stenosis less than 8 mm caused by short pedicles, (4) dynamic instability determined by the presence of sagittal vertebral translation greater than 3 mm and angulation more than 10° on a dynamic radiograph, (5) cauda equina syndrome (CES), (6) an active workers' compensation claim or other litigation, and (7) dieing of other disease or lost to follow-up.

Evaluation of the symptoms included visual analog scale (VAS) and Oswestry disability index (ODI) for the back and leg pain, walking tolerance (described in terms of distance and duration) were performed before and after surgery.

After surgery, the final interview took place in January of 2007. A good to excellent outcome was described as absent or occasional mild back and leg pain. Additionally, the patients were able to ambulate more than 1 mile or 20 minutes, and that they did not restrict themselves from their usual activities. A fair result implied persistent mild back or leg pain with occasional moderate pain, and less than 1 mile or 20 minutes of ambulation endurance. These patients also acknowledged some mild restrictions in their customary physical activity. A poor result implied little to no pain relief from surgery, major activity limitations, or both. A repeat operation for any reason was considered a poor result, regardless of the ultimate level of function.[4] Data were analyzed using the statistical data analysis program.

Operative Procedure

In group A, "Windows technique" laminoforaminotomy was introduced. The technique was slightly modified from traditional laminoforaminotomy, which was used for the treatment of the lumbar disc herniation for many years. The goal of the surgical technique was to decompress the spinal canal and nerve roots canal as completely as possible. The surgery removed the complete excision of the ligamentum flavum, partial excision of the laminae, the base of the spinous process, and the facet process bilaterally. The spinous processes, interspinous ligaments, facet capsules, and part of laminae were meticulously preserved (Figure 1).

With the patient placed in the prone position, a midline incision was made. The spine was exposed, with care taken to preserve the facet capsules. An angled lamino-rongeur with thinnest cutting edge was used to remove the inferior 1/3 laminae at the superior level of the decompression, then to remove the ligamentum flavum completely at the level of the decompression, and the superior 1/3 laminae at the inferior level of the decompression. Even for multilevels decompression, the mid-1/3 lamina was always preserved. After the dural sac was exposed, the partial facet process (never more than 1/2 of the facet process) was removed to enlarge lateral recess and foraminal with care taken to protect the nerve root. After that, the ventral cortex and cancellous of the vestigial laminae and the base of spinous process were removed to enlarge the central spinal canal. Sodium hyaluronate and gelfoam were placed in the outside dural sac space to try to avoid subsequent fibrosis and arachnoiditis. The wound was closed over a suction drain with suturing of the lumbodorsal fascia directly to the spinous processes using absorbable sutures. Ambulation with bracing was encouraged on the next day of surgery.

In group B, traditional laminectomy was performed. Of course, the facet capsules were preserved. Sodium hyaluronate and gelfoam were placed in the outside dural sac space to try to avoid subsequent fibrosis and arachnoiditis. Ambulation with bracing was encouraged on the next day of surgery.

Results

In group A, the mean length of follow-up time to the final evaluation was 40 months (range, 27–58 months). The evaluation of the back pain, leg pain, walking tolerance, and neurologic recovery were performed before surgery and after surgery, as described in Table 1. There were 3 intraoperative dural tears and 2 postoperative complications of urinary tract infection, and no repeat operation for recurrent stenosis and degenerative instability. None spinal instabilities were found. At an average 40.6

Table 1. Outcomes in Group A

Group A	VAS of Back Pain	VAS of Leg Pain	ODI	Walking Tolerance
Before surgery	1.14 ± 0.96	4.41 ± 1.12	39.26 ± 6.54	Averaged 12.59 (min)
At the final interview	0.05 ± 0.22	0.01 ± 0.11	0.37 ± 0.96	3% (2/76) > 1/2 h 8% (6/76 > 1 h 89% (68/76) nonlimitation
P	0.000 (assessed by paired *t* test)	0.000 (assessed by paired *t* test)	0.000 (assessed by paired *t* test)	

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Table 2. Outcomes in Group B

Group B	VAS of Back Pain	VAS of Leg Pain	ODI	Walking Tolerance
Before surgery	1.17 ± 0.91	4.53 ± 1.32	39.76 ± 6.94	Averaged 12.19 (min)
At the final interview	0.63 ± 1.07	0.36 ± 0.87	3.37 ± 8.55	15% (11/76) > 1/2 h 34% (26/76) > 1 h 51% (39/76) nonlimitation
P	0.000 (assessed by paired *t* test)	0.000 (assessed by paired *t* test)	0.000 (assessed by paired *t* test)	

months after surgery, 93% (51/55) of the patients with back pain before surgery stated that their pain was absent, 7% (4/55) believed that the pain was improved, and none rated the pain as worse. In 28% (21/76) of the patients, back pain was not a preoperative problem. Also, 99% (75/76) of the patients believed that their leg pain had resolved, 1% (1/76) judged the pain to be better, and none described any worsening of their leg pain. Of 64 patients with preoperative leg numbness, 94% (60/64) stated that the numbness was eliminated after surgery, 6% (4/64) that it had improved, and none was worse. Numbness was not described as a preoperative problem by 16% (12/76) of the patients. Preoperative leg weakness reported by 11 patients was resolved in 91% (10/11), improved in 9% (1/11), and made worse in none. In 86% (65/76) of the patients, no focal motor weakness before surgery was reported. No patient had full function before surgery. Ambulatory endurance before surgery averaged 12.6 minutes, with 2 patients able to ambulate longer than 15 minutes. No patient was able to walk more than half an hour. At the final evaluation, 100% could walk more than 30 minutes, 97% could walk more than 1 hour, and 89% had unlimited walking endurance. At the final evaluation, the overall results were good to excellent in 89% (68/76) of the patients, fair 11% (8/76), and poor 0% (Table 3).

In group B, the mean length of follow-up time to the final evaluation was 40 months (range, 27–58 months). The evaluation of the back pain, leg pain, walking tolerance, and neurologic recovery were performed before surgery and after surgery, as described in Table 2. There were 2 intraoperative dural tears and 2 postoperative complications of urinary tract infection, 6 postoperative degenerative spinal instabilities with associated worsening of their back pain symptoms, and 4 repeat instrumented fusion operations with instruments and fusions for recurrent stenosis and degenerative instability. At an average 40 months after surgery, 54% (31/57) of the patients with back pain before surgery stated that their pain was absent, 25% (14/57) believed that the pain was improved, 12% (7/57) reported no change in their level of pain, and 9% (5/57) rated the pain as worse. In 25% (19/76) of the patients, back pain was not a preoperative problem, but 26% (5/19) reported back pain after surgery. Also, 80% (61/76) of the patients believed that their leg pain had resolved, 18% (14/76) judged the pain to be better, 1% (1/76) rated the pain as the same, and none described any worsening of their leg pain. Of 64 patients with preoperative leg numbness, 88% (56/64) stated that the numbness was eliminated after surgery, 9% (6/64) that it had improved, 3% (2/64) that it was the same, and 0% that it was worse. Numbness was not described as a preoperative problem by 16% (12/76) of the patients. Preoperative leg weakness reported by 16 patients was resolved in 56% (9/16), improved in 38% (6/16), the same in 6% (1/16), and made worse in none. In 79% (60/76) of the patients, no focal motor weakness before surgery was reported. No patient had full function before surgery. Ambulatory endurance before surgery averaged 12.2 minutes, with 1 patient able to ambulate longer than 15 minutes. No patient was able to walk more than half an hour. At the final evaluation, 100% could walk more than 30 minutes, 86% could walk more than 1 hour, and 51% had unlimited walking endurance. At the final evaluation, the overall results were good to excellent in 63% (48/76) of the patients, fair 30% (23/76), and poor 7% (5/76) (Table 3).

Statistical analysis (by SPSS 10.0) was performed between group A and B (Table 3).

Table 3. Outcomes Comparison Between Group A and Group B

	Group A	Group B	*P*
Ages	57.78 ± 4.91	57.47 ± 5.07	0.709*
Decompression levels	2.07 ± 0.97	1.93 ± 0.88	0.384*
Follow-up duration	40.64 ± 8.15	40.55 ± 8.14	0.945*
VAS of back pain			
Before surgery	1.14 ± 0.96	1.17 ± 0.91	0.863*
At the final interview	0.05 ± 0.22	0.63 ± 1.07	0.000*
VAS of leg pain			
Before surgery	4.41 ± 1.12	4.53 ± 1.32	0.552*
At the final interview	0.01 ± 0.11	0.36 ± 0.87	0.001*
ODI			
Before surgery	39.26 ± 6.54	39.76 ± 6.94	0.648*
At the final interview	0.37 ± 0.96	3.37 ± 8.55	0.003*
Leg numbness eliminated and improved (at the final interview)	100% (64/64)	97% (62/64)	0.496†
Leg weakness resolved and improved (at the final interview)	100% (11/11)	94% (15/16)	1.000†
Good to excellent (at the final interview)	89%	63%	0.000†
Good to excellent and fair (at the final interview)	100%	93%	0.058†
Poor (at the final interview)	0%	7%	

*Assessed by independent-samples *t* test.
†Fisher exact test.

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Discussion

Lumbar spinal stenosis is the most common indication for spinal surgery in the geriatric population. Surgery procedures include decompression with or without restabilization of the spine. Biomechanical studies show the importance of the posterior column including the interspinous ligaments, the facet joints, and the capsules in maintaining spinal stability.[5,6] In 1986, Johnsson *et al*[7] reported results of decompressive lumbar laminectomy alone without fusion in 45 patients. Degenerative spondylolisthesis is found in 20 patients and acquired spinal stenosis in 25.

For the purpose of the treatment of the spinal stenosis, the improvement of the symptoms and the function were the most important, and the low relevance between the function improvement and the postoperative spinal canal size, so that we think the most effective evaluation of the treatment results of the spinal stenosis was the function improvement. Although the decompression was more complete after traditional laminectomy than that after "Windows technique" laminoforaminotomy, but the neurologic improvement was not better than that after "Windows technique" laminoforaminotomy. At the final interview, the leg pain, the leg numbness eliminated or improved, the leg weakness resolved or improved, and the neurogenic claudication improved ratios were even better after "Windows technique" laminoforaminotomy than those after traditional laminectomy.

In our studies, after traditional laminectomy with the facet joints and the capsules preserved, spinal instabilities were found in 8% (6/76) patients at the final interview, and the VAS of the back pain was greater than that before surgery. Although the symptoms of the neurogenic claudication, the leg pain, leg numbness, and leg weakness were eliminated or improved satisfactorily after surgery, it showed that the decompression was complete by the laminectomy, but for the overall results, the good to excellent ratio were not so high, and the reoperations for the recurrent stenosis and degenerative instability were significantly more than that none in group A. It also implied that the importance of the posterior column including the interspinous ligaments, the facet joints, and the capsules in maintaining spinal stability.

In 1992, Postacchini and Cinotti[8] described that fusion may prevent recurrent stenosis. Several studies recommended instrumentation to achieve a better fusion rate and long-term clinical outcome.[9] The addition of instrumentation does not increase the complication rate.[10] The controversy continues regarding efficacy of fusion in degenerative disease. Fischgrund *et al*[11] defended the instrumentated fusion. The arguments consisted of similar results with and without instrumentation, increased morbidity and complication, reoperation rate with instrumentation, poor cost-effectiveness with instrumentation, and risk of impingement of pedicle screws on the adjacent "nonfused" facet joints at the proximal end of fusion.[12–15] Furthermore, there is some evidence that fusion may increase the biomechanical stresses imposed on the adjacent segments leading to transitional disease,[16] which may occur at an earlier rate in instrumented fusion cases.[17] On the basis of the above experience, we introduced a modified laminoforaminotomy, named "Windows technique," to be a standard procedure for decompression of the degenerative lumbar spinal stenosis.

Traditionally, the laminoforaminotomy was used in posterior lumbar discectomy for lumbar disc herniation. The minimal destructive procedure preserves most posterior elements, and few instability was found after surgery. For the degenerative spinal stenosis, degenerative changes lead to central stenosis from ligamentum flavum hypertrophy, disc bulging, and osteophytes. Lateral recess or foraminal compression can result from facet hypertrophy and settling. Therefore, the spinal stenosis generally located at the disc levels, similar to the lumbar disc herniation, so the laminoforaminotomy was feasible for the degenerative spinal stenosis theoretically. Compared to the traditional laminoforaminotomy, we modified the procedure to remove the partial facet process (never more than 1/2 of the facet process) for enlarging lateral recess and foraminal, and to remove the ventral cortex and cancellous of the vestigial laminae and the base of spinous process for enlarging the central spinal canal using an angled lamino-rongeur with thinnest cutting edge, so that it also suits for the decompression of the congenital combined with degenerative spinal stenosis (the bony midsagittal diameter of the congenital spinal stenosis greater than 8 mm).

After "Windows technique" laminoforaminotomy, no spinal instabilities were found. The VAS of the back pain was satisfactorily improved after surgery. It implied the good stability maintaining and minimal invasion with the "Windows technique." The VAS of leg pain, the ODI, the leg numbness, and leg weakness also were improved satisfactorily after surgery. Improvement in walking tolerance was the most dramatic and significant benefit of the reported procedure. Ambulatory endurance before surgery averaged 12.7 minutes, with 3 patient able to ambulate longer than 15 minutes. No patient was able to walk more than half an hour. At an average 40.3 months follow-up evaluation, 100% could walk more than 30 minutes, 96% could walk more than 1 h, and 87% had unlimited walking endurance. It implied the enough decompression with the "Windows technique." The subjective function recovery and the overall results in group A were significantly better than that in group B, and it supported the advantages of the "Windows technique."

Conclusion

Degenerative spinal stenosis can be decompressed adequately with preserving the posterior elements. The "Windows technique" laminoforaminotomy, which obtained satisfactory long-term outcomes with few complications and low cost, can be a standard procedure for the

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surgical treatment of the degenerative spinal stenosis even with slight congenital spinal stenosis.

Key Points

- To introduce a modified laminoforaminotomy decompression technique, without instrument and fusion for lumbar spinal stenosis.
- A prospective study to evaluate the outcomes of 2 different decompressive techniques for lumbar spinal stenosis.
- The "Windows technique" laminoforaminotomy, instead of laminectomy, obtained satisfactory long-term outcomes with few complications and low cost, can be a standard procedure for the surgical treatment of the degenerative spinal stenosis.

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