Chimney sublaminar decompression for degenerative lumbar spinal stenosis

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Object. The authors evaluated the efficacy and safety of so-called chimney sublaminar decompression, a new technique to decompress the degenerative stenotic lumbar spinal canal without stripping of the paravertebral muscles.

Methods. Eighteen patients (nine men and nine women whose mean age was 67 years) with symptoms of claudication were selected to undergo chimney sublaminar decompression. The duration of symptoms was greater than 6 months in 17 patients. Two lumbar segments were involved in seven patients, three in eight, and four in the remaining three patients. Central canal stenosis was present in 13 patients, and lateral recess stenosis in five patients. Mild spondylolisthesis was noted in seven patients. All the patients underwent chimney sublaminar decompression.

After surgery, mild wound pain developed in 14 patients, moderate wound pain in two, and severe wound pain in two. The postoperative hospital stay was 4 days or fewer in 14 patients. At follow-up examination, excellent, good, and fair outcomes were achieved in 11, five, and two patients, respectively. No patient required a body brace, and no worsening of preexisting spondylolisthesis was detected. The spinal canal was increased to two- to 6.8-fold (mean 4.2-fold) the preoperative size.

Conclusions. Compared with laminectomy or endoscopic surgery, the aforementioned chimney sublaminar decompression technique was an equally effective and less invasive technique in the treatment of degenerative lumbar canal stenosis.

KEY WORDS • spondylosis • spinal stenosis • lumbar spine • minimally invasive surgery • sublaminar decompression

Although 70 years have elapsed since Mixter and Barr developed the laminectomy technique, this procedure continues to be widely used in the treatment of lumbar spine lesions. Although laminectomy is clearly effective in nerve root decompression, it is associated with many drawbacks including significant blood loss, postoperative wound pain, prolonged recovery time, and impaired spinal function. In response to these problems, modifications have been developed to decrease the procedure’s invasiveness without compromising its effectiveness. These modifications have become important in the treatment of various spinal pathological conditions. Minimally invasive surgery, however, is usually applicable to limited spinal levels because multilevel lumbar surgery is technically difficult. Furthermore, minimally invasive techniques are often associated with muscle splitting and laminar loss.

In this report we describe a new minimally invasive surgical technique, the so-called chimney sublaminar decompression, used in patients with nerve root compression due to degenerative lumbar canal stenosis. This procedure does not require manipulation of paraspinal muscles and is applicable to multiple spinal levels.

Clinical Material and Methods

Clinical Features

Eighteen patients with symptomatic degenerative lumbar canal stenosis were enrolled in this study. The patient population included an equal number of male and female patients. Their mean age was 67 years (range 48–83 years). All patients presented with back pain. Fifteen patients suffered bilateral leg pain, and three suffered unilat-
eral leg pain; symptom duration was 5 months in one patient, 6 to 12 months in seven, and more than 1 year in 10. In 17 patients, the leg pain was so severe that they could not walk for more than 10 minutes; in the remaining patient, leg pain developed after a 30-minute walk. The presence of spinal stenosis was confirmed in all patients by using plain radiography, CT, and magnetic resonance imaging. A summary of the stenotic feature is presented in Table 1. The number of involved lumbar segments was two in seven patients, three in eight, and four in three. In five patients stenosis was limited to the lateral recess. Central canal stenosis was present in 13 patients; eight of these patients presented with severe stenosis (canal size < 50% of the nonstenotic segments) and five with moderate stenosis (canal size 50–75% of the nonstenotic segments). In seven patients, a mild degree (Grade I) of spondylolisthesis was observed in the absence of dynamic spinal instability, whereas no spondylolisthesis was present in 11 patients.

**Chimney Sublaminar Decompression**

All patients underwent chimney sublaminar decompression (Fig. 1). After induction of general anesthesia, the patient was placed prone on bolsters, and the skin over the targeted spinal levels was incised to expose the tip of the spinous processes. The stenotic spinal segments were decompressed individually. First, the spinous process was bisected with a high-speed air drill under headlight illumination until the deep cortex at the laminal–spinous process junction was exposed. The deepest cortex of the spinous process was removed piecemeal with Kerrison rongeur to complete the bisection. Sublaminar decompression was conducted first using a straight osteotome and then a curved one via the gap of the bisected spinous processes to split the outer one-third thickness of the lamina. The layers were bent laterally with the osteotome to expose the inner two-third thickness of the lamina and hypertrophic ligamenta flava, which were then cleaned with Kerrison rongeur. The decompression was advanced to the lateral recesses and foraminal areas in the same manner until all hypertrophic ligamenta flava and inner part of facet joints, which encroached on the roots, had been cleanly removed. During the procedure, the interspinous ligaments were split longitudinally to facilitate the exposure of the sublaminar space. After decompression, the ligaments were stitched together at approximately the same sites. The fascia and skin were closed in layers, without drainage. Because the shape of the axial section of the surgically treated spine has the look of a chimney (the spinous process on the roof), we coined the phrase chimney sublaminar decompression.

**Outcome Evaluation**

Postoperatively, the type of analgesic agent required, the frequency of analgesic agent use, and the time to ambulation were recorded to classify the degree of wound pain. Patients who needed only oral NSAIDs for pain relief and who were ambulatory on the day of surgery or the 1st postoperative day were classified as having mild wound pain; those requiring an NSAID and four or fewer narcotic injections for pain relief and who were ambulatory on the 2nd postoperative day were classified as having

| TABLE 1  |
|------------------------|-----------------|
| Characteristics of the stenotic spines in 18 patients |
| Characteristics | No. of Cases |
| involved vertebrae | |
| 2 vertebrae | 7 |
| L4–5 | 6 |
| L5–S1 | 1 |
| 3 vertebrae | 8 |
| L3–5 | 5 |
| L4–S1 | 3 |
| 4 vertebrae | 3 |
| L3–S1 | 2 |
| L2–5 | 1 |
| types of stenosis | |
| central | 13 |
| severe* | 8 |
| moderate† | 5 |
| lat recess | 5 |
| Grade I spondylolisthesis | |
| present | 7 |
| absent | 11 |

* Canal size less than 50% the size of nonstenotic segments.
† Canal size 50 to 75% the size of nonstenotic segments.
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moderate wound pain; and those needing an NSAID and five or more narcotic injections and who were ambulatory on or after the 3rd postoperative day were classified as having severe wound pain. The postoperative hospital stay and the degree of symptomatic improvement were also closely monitored. Clinical outcome was measured using the modified Macnab criteria. In patients with no pain, no restriction of mobility, and who had returned to normal work and level of activity, outcome was classified as excellent; in those with occasional nonradicular pain, relief of presenting symptoms, and who returned to a modified level of work, outcome was classified as good; in those with some improved functional capacity, some form of handicap, and who were unemployed, outcome was classified as fair; and finally, in those with continued objective symptoms of nerve root involvement, and who required additional operative intervention at the index level irrespective of postoperative follow-up duration, outcome was classified as poor. Dynamic radiography of the spine was performed to measure lumbar stability and the extent to which preexisting spondylolisthesis worsened after the operation. Each patient also underwent CT scanning postoperatively. The pre- and postoperative cross-sectional area of each segment of the spinal canal was measured, and the mean increase in the cross-sectional area of all spinal segments subjected to the surgery was calculated.

Results

All patients responded well to the surgery and none required an intraoperative blood transfusion. Neither wound drainage nor a body brace was required postoperatively. No significant complications occurred except for a dural tear and subcutaneous cerebrospinal fluid accumulation in one patient; after the placement of a lumbar drain (Epidural Minipack System 1; Portex Ltd., Kent, UK) and bed rest, the patient’s status normalized. Postoperative wound pain was classified as mild in 14 patients (77.8%), moderate in two (11.1%), and severe in two (11.1%). The postoperative stay in the hospital was 4 days or fewer in 14 patients (77.8%), 5 to 7 days in two (11.1%), and longer than 7 days in two (11.1%). At last examination during a follow-up period that ranged from 12 to 16 months, all patients had improved clinically, and outcome was classified using the modified Macnab criteria. Outcome (pain, mobility, and return-to-work status) was excellent in 11 patients (61.1%), good in five (27.8%), and fair in two (11.1%). Dynamic radiography revealed no increased spinal instability or worsening of preexisting spondylolisthesis (Fig. 2). Postoperative CT scanning demonstrated an increase in lumbar canal size compared with preoperative size. A mean 4.2 ± 1.7-fold (range 2–6.8-fold) increase in the cross-sectional spinal canal area was observed. Representative cases are illustrated in Fig. 3. Of the two patients with a fair outcome, in the one (83 years of age) who underwent L3–5 surgery, the canal size was found to have increased 5.5-fold. The other fair-outcome patient (78 years of age) underwent L2–5 surgery and the canal size was found to have increased 3.8-fold. In these two patients preoperative spondylolisthesis was absent.

Discussion

Lumbar decompression is a common procedure for spinal disorders including lumbar stenosis and spondylolisthesis. Although it is conventional open surgery techniques, such as laminectomy, that remain the gold standard for treatment of such disorders, problems with extensive soft-tissue dissection, paraspinal musculature denervation and devascularization, and resulting lumbar instability hinder the success of these techniques. The tissue injury that occurs during various surgi-
cal approaches can result in heightened postoperative pain, increased recovery time, and impaired spinal function. In the present study a new minimally invasive technique, chimney sublaminar decompression, was used to treat lumbar canal stenosis. Within 24 hours of surgical intervention, 77.8% of our 18 patients were ambulatory, and their postoperative LOS was shortened to 4 days or fewer. Additionally, in 88.9% of patients outcomes were excellent or good. In a search of the literature we were unable to find any data about the interval between operation and ambulation in patients who have undergone laminectomy; however, in our patients who had undergone chimney sublaminar decompression, the operation–ambulation interval and the LOS were shorter than those demonstrated in 34 patients who had undergone laminectomy in our hospital during the same period (operation–ambulation interval 1.9 ± 0.8 days; 14.7% of patients ambulatory at or within 1 day of operation; and postoperative LOS 10.1 ± 2.8 days [S.M. Lin, et al., unpublished data]). In addition, the outcome in our 18 patients was better than that reported in patients treated with laminectomy. In two patients in the present study, outcome was fair. These patients were the oldest in the cohort, and three or four of their spinal segments required decompression. Although other factors may have played a role, we believe that age and extensive segment involvement were the most important factors contributing to their unsatisfactory outcome.

Because laminectomy requires a wide exposure of the posterior osseous structures of iatrogenic paravertebral muscle, injuries are difficult to avoid. In the muscle-stripping aspect of the technique, hemostatic coagulation and retraction will result in various histopathological, histochemical, electrophysiological, and imaging evidence of muscle injury. Stripping of the paraspinal muscles from the spine causes denervation and devascularization of the muscles; retraction of the muscles further compromises regional blood flow and induces progressive muscle fiber edema with increased oxidative stress, inflammatory cell infiltration, and increased expression of nuclear factor–κB-regulated cyclooxygenase-2. The newly developed chimney sublaminar decompression technique does not require paravertebral muscle stripping and retraction, thereby reducing substantially the extent of postoperative wound pain. Furthermore, the early ambulation and shortened LOS associated with this technique lower the risk of embolism and the incidence of urinary tract infection associated with use of a urinary catheter.

For decompression of spinal stenosis, laminectomy should extend across all levels of compromise observed on the preoperative imaging studies. The loss of the posterior osseous elements of the spine and the resultant laminectomy-related violation of muscles increase the possibility of spinal instability. Various laminoplasty techniques have been developed to treat lumbar spondylosis and lumbar stenosis. These postdecompression techniques either allow the preservation or reconstruction of the lamina to restore the anatomy or even enlarge the spinal canal; however, stripping of the paraspinal muscles from the spinal segments is needed in these procedures. Recently, a lumbar spinous process–splitting laminectomy, a procedure similar to our chimney sublaminar decompression, has been performed to treat lumbar canal stenosis. In this technique one splits the spinous process to provide the space for laminectomy and decompression; however, the muscles are damaged because they must be detached from the lamina during laminectomy. In contrast, in our chimney sublaminar decompression procedure, one removes only the critical pathological entities that encroach the roots, such as the inner laminar layer, hypertrophic ligamenta flava, and sections of hypertrophic facet joints at the lateral recess and intervertebral foramen.
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The outer one-third thickness of laminae and major portions of facet joints are well preserved, and no increase in spinal instability is observed during short-term follow up. In addition, the fact that a postoperative body brace need not be worn means that the patient’s quality of life during the recuperation period is much improved. Many minimally invasive techniques involving neural decompression have been developed to treat one or two spinal segments. These techniques, however, become merely seminvasive with respect to both bone and muscle when multiple segments are involved.1,5,9,17–19,24,28,36 By contrast, the chimney sublaminar decompression remains minimally invasive when treating as many as four spinal segments and is likely to prove minimally invasive even in cases in which more than four segments are treated during a single operation. Furthermore, the midline approach involved in our technique allows simultaneous bilateral complete decompression without difficulty. When using the unilateral approach required in many endoscopic surgeries, however, decompression on the side contralateral to the unilateral approach may be incomplete.7,16 Additionally, the chimney sublaminar decompression does not require expensive equipment, and it is more cost effective than endoscopic surgery or other minimally invasive operations requiring a three-dimensional navigation system.

Conclusions

The aforedescribed chimney sublaminar decompression technique is highly effective for neural decompression in patients with degenerative lumbar spinal stenosis. Because the technique is minimally invasive, its benefits include less postoperative wound pain, a shorter postoperative LOS, earlier recovery, and an improved quality of life during the recuperation period compared with conventional laminectomy. This new technique may prove applicable to the treatment of spondylotic cervical canal stenosis and certain intraspinal tumors, but such applications will be more technically demanding. This surgical technique was recently combined with percutaneous transpedicle screw fixation in seven patients with Grade I spondylolisthesis (S.M. Lin, et al., unpublished data). This approach reduced significantly the degree of muscle invasion associated with other approaches involving transpedicle screw fixation.3,11

References


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