In conventional laminectomy for lumbar canal stenosis (LCS), bilateral paraspinal muscles are dissected and detached extensively from the spinous process and laminae. Furthermore, the posterior midline ligaments such as the supra- and interspinous ligaments lose their original attachments when the spinous processes are removed. Such intraoperative damage to these posterior lumbar supporting structures can lead to atrophy of paraspinal muscles, which causes trunk extensor weakness and possibly failed–back surgery syndrome.

In 2001, the authors developed a new procedure for lumbar laminectomy, the lumbar spinous process–splitting laminectomy (LSPSL). In this new procedure, the spinous process is split longitudinally in the middle and then divided at its base from the posterior arch, leaving the bilateral paraspinal muscles attached to the lateral aspects. Ample working space for laminectomy is obtained by retracting the split spinous process laterally together with its attached paraspinal muscles. After successfully decompressing nerve tissues, each half of the split spinous process is reapproximated using a strong suture. Thus, the supra- and interspinous ligaments are preserved, as is the spinous process, and damage to the paraspinal muscles is minimal.

Eighteen patients with LCS underwent surgery in which this new technique was used. Twenty patients in whom conventional laminectomy was undertaken were chosen as controls. At 2 years, the clinical outcomes (as determined using the Japanese Orthopaedic Association [JOA] scores and recovery rate) and the rate of magnetic resonance imaging–documented paravertebral muscle atrophy were evaluated and compared between the two groups. The mean JOA score recovery rates were 67.6 and 59.2%, respectively, for patients treated with LSPSL and conventional laminectomy; the mean rates of paravertebral muscle atrophy were 5.3 and 23.9%, respectively (p = 0.0005).

Preservation of posterior supporting structures and satisfactory recovery rate after 2 years indicated that this technique can be a useful alternative to conventional decompression surgery for lumbar canal stenosis.

**Key Words** • decompression surgery • laminectomy • lumbar spine • spinal canal stenosis • spinous process
tional laminectomy, while minimizing damage to posterior supporting structures.9

In the present study, we describe the LSPSL technique and report clinical outcome data obtained during a minimum follow-up period of 2 years. We compare outcomes observed in LSPSL-treated patients with those of conventional laminectomy–treated control patients.

Clinical Material and Methods

Patient Population

Thirty-eight patients with symptomatic LCS underwent surgery for relief of symptoms (Table 1). Since January 2001, the LSPSL procedure was performed in 18 patients (eight men and 10 women), whose mean age at the time of operation was 67.3 years (range 51–79 years). The mean follow-up period was 29 months (range 26–33 months). Since January 1998, a conventional laminectomy was performed in 20 patients (10 men and 10 women), whose mean age at the time of operation was 70 years (range 57–76 years). The mean overall follow-up period was 38.7 months (range 24–70 months). Patients with degenerative spondylolisthesis and spinal instability were excluded from the study. In the LSPSL group, decompression was performed at single level in 10 cases and at two levels in eight. In the conventional laminectomy group, decompression was performed at single level in 10 cases and at two levels in 10 (Table 1). In all patients surgery was performed by the senior author (T.H.).

Surgical Technique. We describe the technique for one-level L4–5 decompression performed via spinous process splitting.

Operative Exposure. The patient is placed in the prone position on a Hall frame. A posterior midline skin incision is made between the L-3 and L-5 spinous processes to expose the tip of L-4 spinous process. The L-4 spinous process is split longitudinally in the middle using a high-speed drill running a fine 2-mm diamond-tipped burr; the structure is then divided at its base from the L-4 lamina, leaving the bilateral paraspinous muscles attached to the lateral aspect of the split spinous process. The supra- and interspinous ligaments between L3–4 and L4–5 are also split longitudinally using a scalpel. The muscles attached to the L-4 lamina are gently dissected using an elevator. Ample working space for laminectomy is obtained by retracting the split spinous process laterally together with its attached paraspinous muscles (Fig. 1A and B).

Decompressive Procedure. The L-4 lamina and the cephalad half of the L-5 lamina are removed using a high-speed drill; the L4–5 ligamentum flavum is then excised in the L4–5 interspace. The ligamentum flavum beneath the anterior aspect of the L-5 lamina is removed using a small curved curette or a fine oblique Kerrison rongeur. If the working space and visualization for decompression are inadequate, the medial one third of the L4–5 facet joint is removed to widen the operative space. Thus, good access to the lateral recesses and the entry zone of the intervertebral foramina is obtained. In obese patients the surgical microscope is used as it is when adhesion between the nerve tissues and surrounding tissues exists. After the affected nerve roots and the thecal sac are successfully de-compressed, each half of the split L-4 spinous process is reaproximated using a strong nonabsorbable suture (Fig. 1C and D). Thus, a one-level posterior L4–5 decompression is accomplished by removing the L-4 lamina and preserving the supra- and interspinous ligaments of L3–4 and L4–5, as well as the L-4 spinous process, with minimal damage to the paraspinous muscles (Fig. 1E and F). The patient is allowed to sit up and walk on the 1st postoperative day with a soft lumbar support.

Quantitative Analysis of the Paraspinal Muscles

To evaluate the magnitude of surgical damage to the back muscles, the cross-sectional area of the paraspinous muscles was measured on pre- and 2-year postoperative T1-weighted axial MR images obtained using the MCID imaging system (Imaging Research, Inc., St. Catharines, ON, Canada). The axial images were obtained at the intervertebral level. The rate of muscle atrophy was calculated using the following formula: atrophy rate (%) = (1 – postoperative area/total preoperative area) × 100.

Recovery Rate

All patients were examined postoperatively by independent orthopedic surgeons, and low-back pain JOA scores were recorded.1 The highest JOA score was 29. The 2-year recovery rate was calculated using the following formula: recovery rate (%) = (2-year postoperative JOA score – preoperative JOA score)/(29 – preoperative JOA score) × 100. A recovery rate of 75% or greater was regarded as excellent, 50 to 74.9% as good, 25 to 49.9% as fair, and less than 25% as poor.

Results

In the LSPSL group, the mean preoperative JOA score

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TABLE 1

Summary of clinical data obtained in 38 patients with LCS

<table>
<thead>
<tr>
<th>Factor</th>
<th>LSPSL</th>
<th>Conventional Laminectomy</th>
</tr>
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<tbody>
<tr>
<td>sex</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>female</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>age (yrs)*</td>
<td>67.3 ± 8.9</td>
<td>70.0 ± 5.7</td>
</tr>
<tr>
<td>follow up (mos)*</td>
<td>29.0 ± 2.9</td>
<td>38.7 ± 14.3</td>
</tr>
<tr>
<td>op level</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>JOA score*</td>
<td>12.9 ± 4.7</td>
<td>12.5 ± 4.1</td>
</tr>
<tr>
<td>preop</td>
<td>24.2 ± 2.9</td>
<td>22.2 ± 4.1</td>
</tr>
<tr>
<td>postop</td>
<td>67.6 ± 19.2</td>
<td>59.2 ± 20.9</td>
</tr>
<tr>
<td>recovery rate (%)</td>
<td>67.6</td>
<td>59.2</td>
</tr>
<tr>
<td>grade</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>excellent</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>good</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>fair</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>poor</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>paraspinal muscle atrophy rate (%)†</td>
<td>5.3 ± 6.6</td>
<td>23.9 ± 17.5</td>
</tr>
</tbody>
</table>

* Difference not significant. Values presented as the means ± standard deviations.
† Statistically significant difference (p = 0.0005). Values presented as the means ± standard deviations.
Lumbar spinous process–splitting laminectomy

Fig. 1. Illustrations, intraoperative photographs, and radiographs depicting the technique for one-level L4–5 decompression after L4 spinous process splitting. A and B: The L4 spinous process is split longitudinally in the midline and then divided at its base from the L-4 posterior arch, leaving the bilateral paraspinal muscles attached to the lateral aspects of the split spinous process. The supraspinous and interspinous ligaments between L3–4 and L4–5 are also split longitudinally using a scalpel. The muscles attached to the L-4 lamina are gently dissected. The full exposure of the L-4 lamina is now obtained by retracting the split spinous process laterally together with its attached paraspinal muscles. C and D: After the affected nerve tissues are successfully decompressed, each half of the split L-4 spinous process is reaproximated using a strong suture. The intraoperative photographs (B and D) show the split spinous process (s) and the exposed dura (d) after decompression. E and F: Postoperative anteroposterior (E) and lateral (F) radiographs revealing the split and preserved spinous processes.

Fig. 2. Axial computerized tomography scan obtained 6 months postoperatively revealing union of the split spinous process.

was 12.9 (range 7–20) and the mean 2-year-postoperative JOA score was 24.2 (range 18–28); thus, the mean recovery rate was 67.6% (range 30–94.4%); the recovery rate was excellent in seven, good in nine, and fair in two patients (Table 1). In the conventional laminectomy group, the mean preoperative JOA score was 12.5 (range 7–19) and the mean 2-year-postoperative JOA score was 22.2 (range 11–26), yielding a mean recovery rate of 59.2% (range 10–81.8%); the recovery rate was excellent in six, good in nine, fair in three, and poor in two patients (Table 1). There was no significant intergroup difference. In no patient did MR imaging demonstrate recurrence of stenosis at the 2-year follow-up examination. Furthermore, postoperative computerized tomography scanning revealed successful union of the split spinous processes in all LSPSL-treated patients (Fig. 2).

In the LSPSL group, MR images acquired 2 years postoperatively (Fig. 3A) revealed more optimal preservation of the paraspinal muscles than that obtained in the conventional laminectomy group (Fig. 3B). The mean atrophy rates of the paraspinal muscles 2 years after surgery were 5.3% (range 6–18%) in the LSPSL group, and 23.9% (range 6.4–67.7%) in the conventional laminectomy group (p = 0.0005).

Discussion
The LSPSL procedure offers the advantages of a wider surgical working space and optimized visualization while producing less muscular damage. In the LSPSL procedure, wide visualization of the central canal and lateral recess can be obtained by retracting split spinous processes and attached ligaments bilaterally, allowing unimpeded access to the nerves. The preserved midline osteoligamentous structures sometimes limit access to the nerve tissues, disturbing visualization and decompression of the nerve roots in fenestration and laminotomy.
In conventional laminectomy wide dissection and retraction of the paraspinal muscles are sometimes required; this manipulation can irreversibly damage the paraspinal muscles and result in atrophy. Analysis of our results demonstrated that the muscle atrophy rate was significantly lower in the LSPSL group than in the conventional laminectomy group, which underscores the LSPSL’s less invasive treatment of the paraspinal muscles. Several authors reported abnormal imaging and/or electromyographic study findings when assessing the paraspinal muscles in patients who have undergone laminectomy.3,4 Sihvonen, et al.,7 correlated the aforementioned abnormalities with the development of failed–back surgery syndrome. In LSPSL, the muscular attachments to the spinous process are preserved, and the medial rami of dorsal ramus, which are very vulnerable to traction, may be preserved because less paraspinal muscle manipulation is required. Additionally, the interposition of the split spinous processes and supra- and interspinous ligaments acts as a mechanical buffer to reduce retraction pressure against the paraspinal muscles. Taken together, these advantages may lead to minimal injury of the paraspinal muscles.

Conclusions

The LSPSL procedure for LCS allows for better visualization and a wider working space while minimizing damage to posterior lumbar supporting structures. In our study, the short-term outcomes were satisfactory at 2 years. Standardized comparative studies in which LSPSL is compared with other decompression procedures are necessary to verify the advantages of this procedure.

References


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