Spinal nerve root electroacupuncture for symptomatic treatment of lumbar spinal canal stenosis unresponsive to standard acupuncture: a prospective case series

Motohiro Inoue,1 Miwa Nakajima,1 Tatsuya Hojo,2 Hiroshi Kitakoji,1 Megumi Itoi3

ABSTRACT
Objective To study the effectiveness of electroacupuncture of the spinal nerve root using a selective spinal nerve block technique for the treatment of lumbar and lower limb symptoms in patients with lumbar spinal canal stenosis.

Methods Subjects were 17 patients with spinal canal stenosis who did not respond to 2 months of general conservative treatment and conventional acupuncture. Under x-ray fluoroscopy, two acupuncture needles were inserted as close as possible to the relevant nerve root, as determined by subjective symptoms and x-ray and MRI findings, and low-frequency electroacupuncture stimulation was performed (10 Hz, 10 min). Patients received 3–5 once-weekly treatments, and were evaluated immediately before and after each treatment and 3 months after completion of treatment.

Results After the first nerve root electroacupuncture stimulation, scores for lumbar and lower limb symptoms improved significantly (low back pain, p<0.05; lower limb pain, p<0.05; lower limb dysesthesia, p<0.01) with some improvement in continuous walking distance. Symptom scores and continuous walking distance showed further improvement before the final treatment (p<0.01), and a significant sustained improvement was observed 3 months after completion of treatment (p<0.01).

Conclusion Lumbar and lower limb symptoms, for which conventional acupuncture and general conservative treatment had been ineffective, improved significantly during a course of electroacupuncture to the spinal nerve root, showing sustained improvement even 3 months after completion of treatment. The mechanisms of these effects may involve activation of the pain inhibition system and improvement of nerve blood flow.

INTRODUCTION
In most cases, lumbar spinal canal stenosis is due to degeneration of the vertebra and vertebral disc causing compression of the cauda equina and nerve root inside the spinal canal, resulting in lumbar and lower limb symptoms. One characteristic symptom is intermittent claudication, which is thought to be the result of reduced blood flow to the cauda equina, nerve root and sciatic nerve due to spinal canal stenosis. We previously developed methods of electroacupuncture of the spinal nerve root as a new acupuncture therapy for treating lower limb symptoms associated with radicular sciatica and lumbar spinal canal stenosis, and have reported their effectiveness for treating cases that do not respond to general conservative treatment.1,2 Electroacupuncture of the spinal nerve root employs a selective spinal nerve block technique for inserting acupuncture needles. After inserting two needles as close as possible to the relevant nerve root under x-ray fluoroscopy, low-frequency electroacupuncture was performed using the needles as electrodes. The aim this time was to clearly show the effectiveness of electroacupuncture of the relevant spinal nerve root for the treatment of lumbar and lower limb symptoms due to lumbar spinal canal stenosis. For this reason, we performed electroacupuncture of the relevant spinal nerve root in 17 patients with lumbar spinal canal stenosis that did not respond to general conservative treatment even when combined with acupuncture treatment.

METHODS
Subjects
The trial was conducted at Meiji University of Integrative Medicine Hospital. A total of 17 patients (nine men) were included, of mean age 70.1±7.1 years diagnosed with lumbar spinal canal stenosis that did not respond to 2 months of general conservative treatment (non-steroidal anti-inflammatory drugs, hot packs, physiotherapy, etc), and conventional acupuncture performed once weekly in muscle near a lumbar spine disorder, the route of the damaged peripheral nerve or in muscle innervated by damaged nerves. Symptoms of lower limb pain, dysesthesia and intermittent claudication were observed in all cases, but low back pain was clearly observed in 13 of the 17 patients.

Electroacupuncture method

The relevant nerve root was determined from symptoms, physical findings and imaging findings (plain x-ray, MRI). Using a procedure similar to that used for spinal nerve root block, with the patient in the prone position, two disposable acupuncture needles (90 mm long, 0.25 mm in diameter, Seirin Co, Shizuoka, Japan) were inserted as close to the relevant nerve root as possible under x-ray fluoroscopy. Low-frequency electroacupuncture was then conducted using the two needles as electrodes (stimulation frequency 10 Hz, stimulation time 10 min, stimulation strength a tolerable level for the patient; figures 1 and 2). The verification of the proximity of the needles to the relevant nerve root was performed by approximate positioning by x-ray and comments by patients where stimulation could be felt in an area supplied by the damaged nerve. Treatment was performed once a week. If symptoms were determined to have completely resolved 1 week after the previous treatment, that day was taken as the final day of treatment, with five being the maximum number of treatments.

Evaluation

Evaluation was conducted before and after each electroacupuncture stimulation of the nerve root and 3 months after completion of treatment. Low back pain, lower limb pain and lower limb dysaesthesia were each evaluated on a visual analogue scale (VAS) consisting of a 100 mm horizontal line with the worst imaginable symptoms at the right end and no symptoms at all at the left end. Continuous walking distance during daily activities was based on reports by the patients themselves, while the distance after the first treatment was measured by the experimenter in the clinic. Continuous walking distances of >500 m were recorded as 500 m.

Figure 1 Schematic diagram of nerve root acupuncture stimulation sites. Yellow circles indicate the points at which the needles were inserted.

Figure 2 x-Ray image of left L5 and S1 nerve root electroacupuncture.

Statistical analysis

All values presented are mean±SD. Repeated measures analysis of variance (ANOVA) was performed for changes in the symptom score after repeated electroacupuncture stimulations. After performing one-way ANOVA for changes in evaluation scores, a multiple comparison test was performed for VAS scores and continuous walking distance at the time of each evaluation (comparison of baseline values and values at the time of each evaluation, immediately after the first treatment, immediately before the final treatment and 3 months after completion of final stimulation) using the Bonferroni/Dunn method. All statistics were performed using Statview 4.5 (SAS Institute Japan, Tokyo, Japan). The results were considered significant when p<0.05.

RESULTS

In this study, evaluation before the third stimulation showed that lower limb pain had completely disappeared in two of the 17 patients. Up to the final evaluation, which was 3 months after completion of treatment, there were no dropouts from the study and no adverse events were observed during the stimulations or period of evaluation.

Of the 17 patients who received selective electroacupuncture stimulation of a relevant nerve root, all showed a significant improvement over time in low back pain, lower limb pain, lower limb dysaesthesia and continuous walking distance (p<0.01 for all parameters). Individual changes in low back pain, lower limb pain and lower limb dysaesthesia are shown in figures 3–5 and the mean values are summarised in table 1. The VAS scores for low back pain, lower limb pain and dysaesthesia show that clinically significant improvements occurred after the first treatment and were maintained at 3-month follow-up.

Continuous walking distance improved from 66.5±45.5 m to 148.8±145.7 m immediately after the first treatment, although the difference did not reach statistical significant
After completion of treatment, the continuous walking distance was 242.4±227.2 m, showing a further improvement compared with immediately after the first stimulation (p<0.01), which was maintained even at follow-up 3 months after the completion of treatment (227.6±211.6 m, p<0.01; figure 6).

Improvement of ≥50% from baseline in lower limb pain and lower limb dysaesthesia immediately before the final treatment was observed in more than half of the patients (10/17 and 12/17, respectively), while few cases showed no remarkable changes (improvement of ≤20%). No case showed deterioration (ie, increase in the score). These improvements were maintained even at 3 months after completion of the treatment (table 2).

The continuous walking distance immediately before the final stimulation had improved (increase of ≥200 m...
from baseline) in 7/17 cases and remained unchanged (increase of ≤100 m) in 9/17 cases, with no deterioration observed in any of the cases. These improvements were mostly maintained at 3 months after completion of treatment (table 1, 2).

**DISCUSSION**

First-line treatment for symptoms of spinal canal stenosis is conservative treatment with anti-inflammatory agents, administration of prostaglandin E1, epidural block, nerve root block or orthotic treatment. When these treatments are ineffective or when the patient is not sufficiently satisfied, the invasive procedures of decompression laminectomy or decompression laminoplasty are performed. However, these procedures involve various risks and, in the event of a relapse, reoperative surgery is difficult. For these reasons, the development of more effective conservative treatments is an important issue.

Acupuncture therapy is a form of conservative treatment. Although there are a comparatively large number of reports of randomised controlled trials and other research concerning the effectiveness of acupuncture for treating low back pain, there are few reports on acupuncture treatment for lumbar and lower limb symptoms resulting from lumbar disorders. In this study we investigated the effect of electroacupuncture of the relevant spinal nerve root in 17 patients with lumbar and lower limb symptoms due to lumbar spinal canal stenosis that did not respond to 2 months of general conservative treatment and conventional acupuncture.

The results showed that, compared with baseline, there was a significant improvement in low back pain, lower limb pain and lower limb dysaesthesia immediately after the first treatment, as well as a tendency for continuous walking distance to increase. Symptoms also showed further improvement at the time of the last treatment. These results indicated the immediate effectiveness of nerve root electroacupuncture and its cumulative effect after repeated treatments. A significant sustained improvement of symptoms was also observed even 3 months after the completion of treatment, and many of the patients showed no sign of exacerbated symptoms, with sustained effectiveness of the treatment over a comparatively long period.

Table 1  Mean±SD symptom VAS scores throughout treatment and follow-up

<table>
<thead>
<tr>
<th></th>
<th>Low back pain (N=13)</th>
<th>Lower limb pain (N=17)</th>
<th>Lower limb dysaesthesia (N=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>56.5±16.7</td>
<td>78.1±11.9</td>
<td>74.8±18.3</td>
</tr>
<tr>
<td>Directly after first treatment</td>
<td>42.0±11.0*</td>
<td>34.4±19.4**</td>
<td>42.0±22.7**</td>
</tr>
<tr>
<td>After completion of treatment</td>
<td>33.1±12.8**</td>
<td>27.8±21.2**</td>
<td>29.6±17.4**</td>
</tr>
<tr>
<td>3 Months after completion of treatment</td>
<td>36.8±14.8**</td>
<td>30.5±22.9**</td>
<td>34.0±19.8**</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01 vs baseline.

VAS, visual analogue scale.
nerves. Anglister et al., Belardetti et al. and Hill speculate that impulses generated at the site of stimulation are conducted and transmitted to both central and peripheral nerves, and pain is inhibited by the action on both central and peripheral nerves. Impulses conducted to the central nervous system activate the pain inhibitory system in the spinal cord and descending inhibitory control, and inhibit the transmission of pain. Antidromic impulses conducted to peripheral nerves excite the cell membranes of nerve endings. It is thought that, if the excitation is sustained, hyperpolarisation occurs due to activation of the Na⁺/K⁺ pump which causes the concentration of Na⁺ and Ca²⁺ ions inside the cells to increase, inhibiting spontaneous excitation. Since a feeling of stimulation was also obtained in the affected area by the electrical stimulation used in the treatment, it is possible that impulses from the stimulation site were conducted and transmitted bilaterally. The activation of descending inhibitory control, the inhibition system in the spinal level and the inhibition of spontaneous excitation due to hyperpolarisation at damaged nerve endings are thought to be involved in the inhibition of pain and dysesthesia.

It is believed that cauda equina intermittent claudication is due to ischaemia of the cauda equina, nerve root, sciatic nerve and other areas as a result of stenosis of the spinal canal compressing the cauda equina. This study confirmed that nerve root electroacupuncture increased continuous walking distance, suggesting that it may influence blood flow to the cauda equina, nerve root and sciatic nerve. Animal experiments with rats show that electrical stimulation of the ventral and dorsal roots influences sciatic nerve blood flow. It has also been confirmed that electrical

![Continuous walking distance](image)

**Figure 6** Effect of electroacupuncture of the nerve root on patient-reported continuous walking distance. Data are expressed as mean±SD. **p<0.01 vs before treatment.

<table>
<thead>
<tr>
<th></th>
<th>After completion of treatment</th>
<th>3 Months after completion of treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low back pain</td>
<td>Lower limb pain</td>
</tr>
<tr>
<td>Improvement</td>
<td>4/13</td>
<td>10/17</td>
</tr>
<tr>
<td>No change</td>
<td>4/13</td>
<td>2/17</td>
</tr>
<tr>
<td>Deterioration</td>
<td>0/13</td>
<td>0/17</td>
</tr>
</tbody>
</table>

Improvement: improvement of ≥50% in VAS or increase of ≥200 m in the continuous walking distance from baseline.
No change: improvement of ≤20% in VAS or increase of ≤100 m in the continuous walking distance from baseline.
Deterioration: increase in VAS and decrease in the continuous walking distance from the baseline.

VAS, visual analogue scale.
stimulation of the sciatic nerve increases sciatic nerve blood flow.2 These results support the conclusion that the treatment in this study influenced the improvement in intermittent claudication due to spinal canal stenosis.

In general, conservative treatment is safer than invasive treatment. Furthermore, since conventional acupuncture mainly involves insertion of needles into superficial muscle, it is believed to be a comparatively safe method of treatment. On the other hand, since nerve root electroacupuncture involves the insertion of needles as far as the nerve root, it is a treatment that carries risks such as possible neurological symptoms due to the formation of haematomas. Consequently, it is believed that this method of treatment could be tried in cases that do not respond to general conservative treatment or conventional acupuncture treatment. Having obtained favourable results in this study, it is now necessary to conduct randomised comparative studies with various controls.

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