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Original article

Effectiveness of L2 spinal nerve infiltration for selective discogenic low back pain patients

Seiji Ohtori, Shinichiro Nakamura, Takana Koshi, Masaomi Yamashita, Kazuyo Yamauchi, Gen Inoue, Sumihisa Orita, Yawara Eguchi, Munetaka Suzuki, Nobuyasu Ochiai, Shunji Kishida, Masashi Takaso, Yasuchika Aoki, Kazuki Kuniyoshi, Junichi Nakamura, Tetsuhiro Ishikawa, Gen Arai, Masayuki Miyagi, Hiroto Kamoda, Miyako Suzuki, Yuzuru Takahashi, Tomoaki Toyone, Masatsune Yamagata, and Kazuhisa Takahashi

Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, 1-8-1 Inohana, Chuo-ku, Chiba 260-8670, Japan

Abstract

Background. It has been reported that rat L5/6 lumbar discs are innervated mainly by L2 dorsal root ganglion neurons. We previously reported that L2 spinal nerve infiltration was effective for discogenic low back pain (DLBP) patients, although the diagnosis was based only on the results of physical examination, plain films, and magnetic resonance imaging (MRI). The purpose of the current study was to evaluate L2 spinal nerve block for DLBP patients retrospectively based on MRI findings and surgical results.

Methods. A total of 62 patients with only LBP and no accompanying radicular pain were investigated. Patients had only one level of disc degeneration on MRI. When pain was provoked during discography, we performed surgery at the next stage (40 patients). In all, 22 patients were excluded owing to negative discography results. Of the 40 patients, we evaluated 25 strictly selected patients suffering from DLBP. DLBP was diagnosed when the patient experienced pain relief at least 2 years after anterior lumbar interbody fusion. Fifteen patients who did not show pain relief after surgery were used for the non-DLBP group. L2 spinal nerve infiltration using 1.5 ml of lidocaine was performed in all 40 patients before surgery. The visual analogue scale (VAS) score after L2 spinal nerve infiltration was recorded, and an association of L2 spinal nerve infiltration and DLBP was explored.

Results. Low back pain scores assessed using the VAS score, the Japanese Orthopedic Association score, and the Oswestry Disability Index score in the two groups were not significantly different. L2 spinal nerve infiltration was effective for 27 patients but not effective for 13 patients; the VAS score after 15 min and 2 h improved in the DLBP group compared with that of the non-DLBP group ($P < 0.05$). L2 spinal nerve infiltration was more effective in DLBP patients (21 patients, 84%) than in the non-DLBP group (6 patients, 40%) ($P < 0.05$).

Conclusions. In the current study, L2 spinal nerve infiltration was effective in 84% of selected DLBP patients and is thought to be a useful tool for diagnosing DLBP. However, we should take into consideration that the L2 spinal nerve infiltration was effective in 40% of non-DLBP patients as well.

Offprint requests to: S. Ohtori
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Introduction

Many studies have described the existence of sensory nerve endings in the annulus fibrosus of the human lumbar intervertebral disc.[1] It is believed that such nerve endings originate from the sinuvertebral nerves branching from the ventral ramus of the spinal nerve and the ramus communicans of the corresponding level in humans.[1] Recent studies in rats have revealed that the dorsal portion of the L5/6 intervertebral disc is multisegmentally innervated by dorsal root ganglia (DRGs) from the T13 to L6 levels.[2,3] Some rat sensory nerve fibers from the L5/6 intervertebral disc pass to upper DRGs via paravertebral sympathetic trunks.[2,3] In humans, the sensory afferent pathway from the lower intervertebral disc has not been clarified.

Nakamura et al. performed an L2 spinal nerve block based on animal sensory innervation and reported that the block was effective in patients suffering from discogenic low back pain (DLBP).[4] However, they diagnosed DLBP only by physical examination, plain films, and magnetic resonance imaging (MRI). Conversely, Mendez et al. reported that unilateral L2 infiltration is not predictive of DLBP compared with the use of discography, and they concluded that L2 spinal nerve infiltration was not effective for DLBP.[5] There was a problem because the reliability of discography in the diagnosis of DLBP has been controversial. A systematic review of discography as a diagnostic test for spinal pain revealed that it is a useful imaging and pain evaluation tool for identifying patients with chronic discogenic LBP.[6] However; positive discography was not highly predictive in identifying bona fide isolated intradiscal lesions primarily causing chronic serious LBP illness.[7]

The purpose of the current study was to evaluate L2 spinal nerve infiltration for DLBP patients retrospectively based on MRI findings and surgical results of anterior lumbar interbody fusion.

Patients and methods

The ethics committee of our institution approved the protocol for the human procedures used in this study. The protocol and publication of the study were approved by our institutional review board.

Patients

A total of 62 patients with only LBP continuing for at least 3 years with no accompanying radicular pain were investigated. Patients had only one-level disc degeneration on MRI. Patients who had severe spondylolysis or disc degeneration with two or multilevel lesions were excluded, as were patients who had spinal stenosis with radicular pain and those who had previously undergone spinal surgery.

Cases were categorized as disc degeneration, bulging, or protrusion, as described by Macnab.[8] Disc degeneration was graded by Thompson's system.[9] The definitions of the type of intervertebral disc and the evaluations were performed by three observers who were blinded to the specifics. If at least two of the observers were in agreement, their classification was used to define the intervertebral disc degeneration.

Indication for surgery using discography

Discography on an intervertebral disc at a single level was performed with a standard posterolateral approach using a 22-gauge needle in all 62 patients (Becton Dickinson, Franklin Lakes, NJ, USA). For discography, the needle was inserted into the center of the disc under fluoroscopic control. Isovist 240 (0.4–3.2 ml) (Schering, Berlin, Germany) was injected into each disc until severe pain was provoked or until contrast medium was seen to leak out of the disc into the spinal canal. When pain was provoked during discography, the patients were added the group who would undergo surgery (40 patients). In all, 22 patients were excluded due to negative discography.

L2 spinal nerve infiltration

Administration was as described in a previous report.[4] On the predominantly painful side, a 22-gauge spinal nerve block needle was advanced obliquely to the corresponding spinal nerve under fluoroscopic control. Then, 0.5 ml of the contrast medium Iotorolan (Schering) was injected to confirm the position of the spinal nerve. Unilateral lidocaine administration (1.5 ml of 1% solution) was then performed. The intensity of low back pain was evaluated before the block using a visual analogue scale (VAS), with scores of 0–100 (a score of 100 indicating the worst pain). The VAS scores were evaluated at 15 min, 2 h, and 7 days after spinal nerve infiltration. We defined the treatment "effective" if at 2 h the patients reduced their VAS score to <60% of the score before nerve infiltration.

Surgery

Patients who met the criteria of one-level disc degeneration on MRI and pain provocation on discography underwent anterior discectomy and fusion surgery. We first performed discectomy, then cut the endplate at a thickness of 2 mm on both sides, and performed interbody fusion using the iliac bone. The VAS score, Japanese Orthopedic Association Score (JOAS) (0 indicating worst pain to 3 indicating no pain), and Oswestry Disability Index (ODI) before and 2 years after surgery were recorded. If the score improved, we accepted that the origin of the low back pain was the intervertebral disc.

DLBP and non-DLBP

We defined the surgery "effective" if patients indicated a reduction in their scores to <60% of the VAS score, JOAS, and ODI at 2 years after surgery compared with before surgery. We defined these patients as having DLBP ($n = 30$). If the patients did not meet at least one of the three criteria (<60% of their preoperative VAS, JOAS, and ODI scores), we defined them as non-DLBP patients ($n = 10$).

Statistical analysis

Data were compared using the nonpaired *t*-test, chi-squared test, and one-way analysis of variance (ANOVA) for repeated measurements. $P < 0.05$ was considered statistically significant.

Results

Figure 1 shows that of the 62 LBP patients 40 had pain provocation on discography. The 40 patients underwent anterior lumbar interbody fusion surgery. Two years after surgery, 25 patients showed good results, and 15 showed unsatisfied results. We defined the 25 patients as DLBP patients. The 15 patients with unsatisfied surgical results were defined as non-DLBP patients.

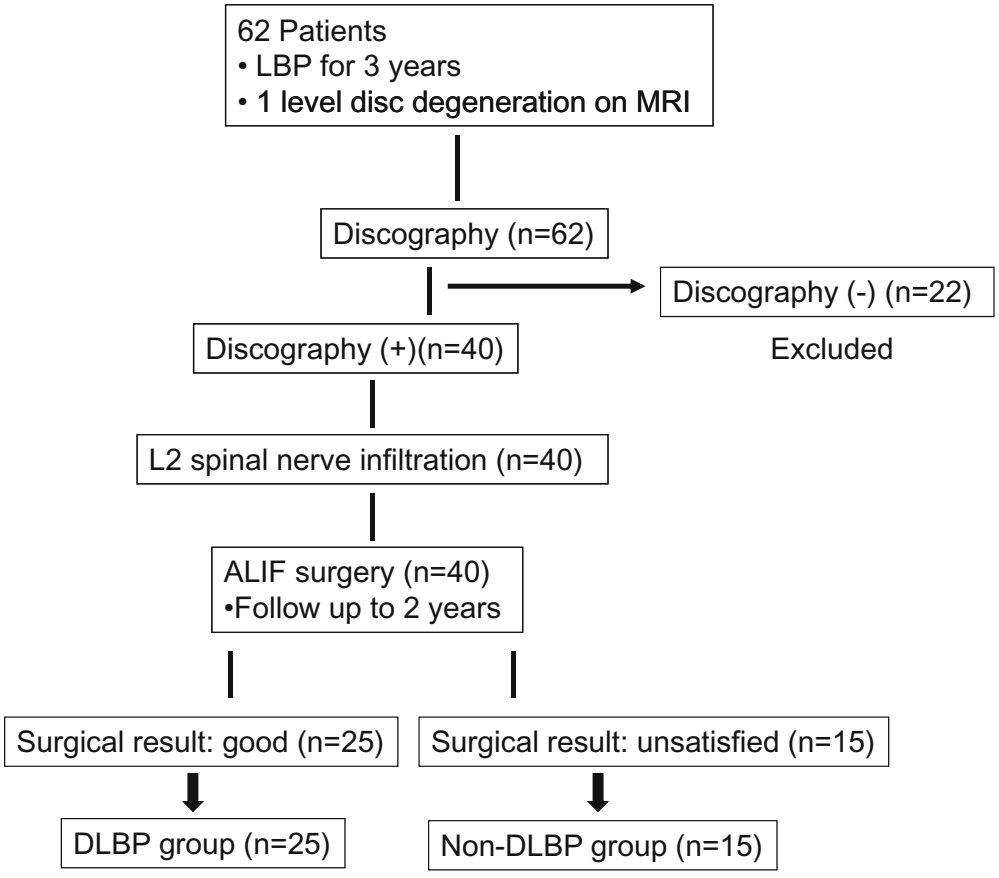

Fig. 1. Details of the method for distinguishing the discogenic low back pain (DLBP) and non-DLBP groups. *LBP*, low back pain; *ALIF*, anterior lumbar interbody fusion

Table 1 shows a detailed background of the 40 patients. There was no significant difference between the two groups with respect to MRI findings or pain scores before surgery. However, there was a significant difference between the two groups with respect to pain scores after surgery.

Table 2 shows the results of L2 spinal nerve infiltration retrospectively. Before L2 spinal nerve infiltration VAS scores between the two groups were not significantly different. At 15 min and 2 h after L2 spinal nerve infiltration, VAS scores in the DLBP group were significantly lower than those in the non-DLBP group ($P < 0.05$). However, the VAS scores 7 days after L2 spinal nerve infiltration in the DLBP group were not significantly different from those in the non-DLBP group.

We defined treatment "effective" if patients indicated a reduction to less than 60% of their VAS score at 2 h compared with before nerve infiltration, as described above. Altogether, 21 patients showed "effectiveness" in the DLBP group (84%), and 6 patients showed "effectiveness" in the non-DLBP group (40%). The ratio of patients showing "effectiveness" was significantly higher in the DLBP group than in the non-DLBP group ($P < 0.05$).

Discussion

The L2 spinal nerve infiltration was effective for 27 patients but not effective for 13 patients. After 15 min and 2 h, the VAS score improved in the DLBP group compared with that in the non-DLBP group ($P < 0.05$). L2 spinal nerve infiltration was more effective in DLBP patients (84%) than in the non-DLBP group (40%) ($P < 0.05$).

Diagnosis of DLBP

Historically, a diagnosis of DLBP has proven difficult, and the method of therapy for DLBP has therefore been controversial. Our previous study into the effectiveness of L2 spinal nerve infiltration for DLBP was insufficient because the diagnosis was determined only by physical examination, radiography, and MRI findings.[4]

Treatment for discogenic pain includes intradiscal electrothermal therapy (IDET), spinal fusions, and artificial discs. The diagnosis of discogenic pain is determined by provocative discography.[10,11] However, the reliability of discography has been controversial.

Table 1. Demographic characteristics

Parameter	DLBP group	Non-DLBP group	*P*
No. of patients	25	15	
Sex (M:F)	17:8	10:5	
Age (years)	18–40 (31 ± 4)	20–45 (33 ± 5)	NS
Symptom duration (years)	5 (2–12)	6 (4–9)	NS
Follow-up after surgery (years)	2.5 (2–4)	2.0 (2–3)	NS
MRI findings			
Level			
L4/5	15	8	NC
L5/S1	10	7	NC
Thompson's grade			
Grade 4	15	12	NS
Grade 5	10	3	NS
Macnab's classification			
Degeneration	8	3	NC
Bulging	14	12	NC
Protrusion	3	0	NC
HIZ	0	0	NC
Pain score (before surgery)			
VAS	65 ± 15	68 ± 18	NS
JOA score	0.52 ± 0.2	0.48 ± 0.2	NS
ODI	66 ± 10	72 ± 12	NS
Pain score (after surgery)			
VAS	15 ± 10	38 ± 14	0.02
JOA score	2.52 ± 0.4	1.48 ± 0.4	<0.05
ODI	15 ± 4	45 ± 12	0.01

Results are the range and mean ± SEM unless otherwise stated
DLBP, discogenic low back pain; HIZ, high-intensity zone; VAS, visual analogue scale; JOA, Japanese Orthopaedic Association; ODI, Oswestry disability index; NC, not compared

Table 2. L2 nerve infiltration for both groups

Parameter	DLBP group	Non-DLBP group	*P*
Pain score (VAS)			
Before L2 nerve infiltration	65 ± 15	68 ± 18	NS
After L2 nerve infiltration			
15 min	23 ± 10	43 ± 14	0.033
2 h	20 ± 11	41 ± 12	0.045
7 days	61 ± 15	60 ± 12	NS
Effective, after 2 h (no. of patients)	21 (84%)	6 (40%)	<0.05

Carragee and coworkers have reported that they compared a group of patients with LBP and a positive, single-level, low-pressure provocative discogram to another group with single-level isthmic spondylolisthesis. Both groups later underwent spinal fusion of the involved level. Almost three-fourths (72%) of the spondylolisthesis group versus 27% of the discogenic pain group met the highly effective success criteria. The authors thought that positive discography was not highly predictive in identifying bona fide isolated intradiscal lesions primarily causing LBP illness.[7]

Another tool for identifying DLBP has been reported. Ploumis and colleagues reported a case of chronic back pain following two-level interbody and posterolateral fusion in the lumbar spine that was evaluated with Marcaine injection into the disc space. Marcaine injection into an apparently fused disc space with an interbody device may be helpful in patients with persistent postsurgical back pain.[12] We have compared discography and discoblock (i.e., pain relief after injection of a small amount of bupivacaine into the painful disc), and we concluded that discoblock was a more useful tool for the diagnosis of DLBP.[13]

In the current study we used of results of anterior lumbar interbody fusion (ALIF) surgery for a final diagnosis for DLBP. These patients all had positive discography. We did not perform discoblock in the current study. Generally speaking, it is difficult to distinguish DLBP from non-DLBP based on several examinations; hence, in the current study we diagnosed DLBP if the

patients indicated that there was a reduction in their VAS, JOAS, and ODI scores at 2 years after surgery to <60% of their scores before surgery.

Effect of L2 spinal nerve infiltration on discogenic pain

In rats and rabbits, sensory nerve fibers from the lower intervertebral disc are thought to be innervated by DRGs at the corresponding level and by DRGs at upper levels multisegmentally.[2,3,14,15] In the nonsegmental innervation, sensory nerve fibers are thought to enter the paravertebral sympathetic trunks and reach the L2 DRGs.[2,3,14]

In humans, the sensory afferent pathways remain unclear. However, some data have suggested the same pattern of sensory nerve innervation. In the case of lumbar intervertebral disc degeneration, blockade of the spinal nerves at the same level has been effective for some patients with discogenic disorders, whereas for other patients blockade of L2 spinal nerves or paravertebral sympathetic trunks is effective.[4,16,17]

Murata et al. have reported a randomized control trial for L2 spinal nerve infiltration (L2 block) in patients with low back and leg pain.[18] They looked for changes in pain originating from intervertebral disc, facet joints, and nerve roots after L2 block. An L2 block was significantly useful in reducing LBP. However, the therapeutic value of an L2 block is occasionally insufficient to alleviate pain completely because of the short duration of its effect. Their data supported those in the current study, but they did not strictly examine the origin of low back pain.

Mendez et al. reported that they compared the results of L2 spinal nerve infiltration and discography. Their data do not support the effectiveness of unilateral L2 infiltration as a therapeutic modality in the relief of DLBP.[5] They concluded that the rat intervertebral disc is innervated multisegmentally, so high variability in the anatomical innervation of the human disc may explain the variability of response to unilateral L2 nerve block when discogenic pain is present as proven by discography.[5] As mentioned above, discography has been controversial as a diagnostic tool for DLBP, and further study is needed to evaluated L2 spinal nerve infiltration.

Limitations of this study

- We did not perform spinal nerve infiltration at all levels and did not perform a control block.
- This study was a retrospective study, and the number of patients was small.
- Diagnosis is a most important issue. We defined "DLBP patients" as those who indicated that their VAS, JOAS, and ODI scores after surgery were reduced to <60% of their scores before surgery. However, it is difficult to distinguish between discogenic pain and nondiscogenic pain using a number of methods, so in the current study we used the results of surgery.
- In the current study, we could not exclude nerve root pain, muscle pain, or facet joint pain. L2 spinal nerve infiltration was effective in 40% of non-DLBP patients in the current study. It has been reported that L5/6 facet joints, the L5 vertebra, and the multifidus muscle at the L5 level are innervated by the L2 DRG in rats.[19–21] If this innervation applies to humans, it may explain why L2 spinal nerve infiltration was effective in non-DLBP patients. Further study is needed to explore negating this pain with anesthetic infiltration into these structures.

We need to carry out a further study to clarify these points.

Conclusion

We evaluated L2 spinal nerve infiltration for 25 strictly selected discogenic low back pain (DLBP) patients and 15 non-discogenic low back pain (non-DLBP) patients. Retrospectively, L2 spinal nerve infiltration was more effective in DLBP patients than in the non-DLBP group. However, we should take into consideration that the L2 spinal nerve infiltration was effective for 40% of non-DLBP patients.

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