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Adhesiolysis and targeted steroid/local anesthetic injection during epiduroscopy alleviates pain and reduces sensory nerve dysfunction in patients with chronic sciatica

Tetsuya Sakai, Hiroshi Aoki, Minoru Hojo, Masafumi Takada, Hiroaki Murata, and Koji Sumikawa

Department of Anesthesiology, Nagasaki University School of Medicine, 1-7-1 Sakamoto, Nagasaki 852-8501, Japan

Abstract
Purpose. The aim of this study was to evaluate the effect of adhesiolysis followed by the injection of steroid and local anesthetic during epiduroscopy on sensory nerve function, pain, and functional disability in patients with chronic sciatica.
Methods. Epidural adhesiolysis, using epiduroscopy, followed by the injection of steroid and local anesthetic, was scheduled in 19 patients with chronic sciatica refractory to lumbar epidural block. Sensory nerve function in the legs was tested with a series of 2000-Hz (Aβ-fiber), 250-Hz (Aδ-fiber), and 5-Hz (C-fiber) stimuli, using the current perception threshold (CPT), and CPT values and intensity of pain and Roland Morris Disability Questionnaire (RMDQ) scores were assessed before and 1 and 3 months after the epiduroscopy.
Results. At all frequencies, the CPT values in the affected legs of patients before the epiduroscopy were significantly higher than those in the unaffected legs. Epidural adhesiolysis was successfully performed in 16 of the 19 patients. In these patients, the CPT values at 2000 and 250 Hz, and the pain and RMDQ scores 1 and 3 months after the epiduroscopy were significantly lower than those before the epiduroscopy, while the CPT value at 5 Hz did change.
Conclusion. Epidural adhesiolysis followed by the injection of steroid and local anesthetic during epiduroscopy alleviated pain, and functional disability, and reduced dysfunction of Aβ and Aδ fibers in patients with chronic sciatica.

Key words Epiduroscopy · Sensory nerve function · Chronic sciatica · Adhesiolysis · Current perception threshold

Introduction

Recently, epiduroscopy has been shown to offer significant diagnostic and therapeutic interventions for patients with chronic low back pain and sciatica [1]. Although previous studies have shown that adhesiolysis in the epidural space and targeted steroid injection during epiduroscopy is useful for pain relief in these patients [2–4], to date there are very few studies that show the effect of these procedures on sensory nerve function.

It is known that current perception threshold (CPT) testing can evaluate sensory nerve fibers in both a quantitative and selective manner: CPTs at 2000-, 250-, and 5-Hz stimuli directly represent the functions of Aβ, Aδ, and C fibers, respectively [5,6]. Recent clinical studies have demonstrated that CPT testing is useful for the quantitative evaluation of sensory function associated with diabetic neuropathy [7,8], toe-to-digit transplantation [9], lumbar radiculopathy [10], and postherpetic neuralgia [11].

The present study was carried out to evaluate the effect of adhesiolysis followed by the injection of steroid and local anesthetic during epiduroscopy on sensory nerve function (using CPT testing), pain, and functional disability in patients with chronic sciatica refractory to lumbar epidural block.

Patients, materials, and methods

Patients

After institutional approval was obtained, along with written informed consent, 19 patients with chronic sciatica were recruited for this study. Although all of the patients had received lumbar epidural local anesthetic (4 ml of 1% mepivacaine) and dexamethasone sodium phosphate (4 mg) at the L4-5 or L5-S1 level before the study, the duration of pain relief was less than 1 day. Sciatica was defined as pain in the distribution of a lumbar nerve root, accompanied by neurosensory and motor deficits [12]. All of our patients had unilateral

Address correspondence to: T. Sakai
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single radiating leg pain (L5 or S1) and low back pain with or without a history of previous back surgery. Patients who had obstructive arteriosclerosis, arachnoiditis, or coagulopathy were excluded from the study.

One week before epiduroscopy, each patient had received an epidural injection, consisting of 16 ml of a 1:1 diluted contrast medium (iotrolan, Isovist; Schering, Tokyo, Japan) mixed with local anesthetic (1% mepivacaine), administered via the sacral hiatus under fluoroscopy, in order to evaluate the degree of epidural adhesion.

The epiduroscopy technique

Patients were positioned prone on a translucent X-ray operating table, with a pillow placed under the abdomen. Patients were then sedated with propofol ($2\ mg \cdot kg^{-1} \cdot h^{-1}$). Under aseptic conditions, and following local anesthesia with 1% mepivacaine 5 ml, a Touhy needle was inserted into the sacral canal. The placement of the tip of the needle in the sacral canal was confirmed by the injection of X-ray contrast medium (iotrolan 5 ml, Isovist; Schering, Tokyo, Japan). A guidewire was introduced through the Touhy needle, and the needle was replaced by a dilator. Then, a video-guided catheter (2000; Mylotec, Ruswell, GA, USA) with a 0.9-mm endoscope (3000E; Mylotec) was slowly advanced to the target area under direct vision and fluoroscopy. Adhesions in the epidural space were torn using the tip of the epiduroscope and intermittent flushing with saline. After adhesiolysis, dexamethasone sodium phosphate (4 mg) and 1% mepivacaine (4 ml) were injected. Then, epidurography was performed close to the intervertebral foramen of the affected nerve root.

Assessment before and after epiduroscopy

Leg pain and low back pain were evaluated, separately using a numerical rating scale (NRS), from 0 to 10, in which 0 = no pain and 10 = excruciating pain. Functional disability caused by low back and leg pain was assessed using the Japanese version of the Roland Morris Disability Questionnaire (RMDQ), which was modified by adding the phrase, "my back or leg problem" at the ends of all 24 questions [13,14].

The Neurometer CPT/C (Neurotron, Baltimore, MD, USA) was used to measure the current perception threshold at 2000, 250, and 5 Hz. Current perception threshold (CPT) testing was performed at the midpoint of the leg below the knee corresponding to the distribution of the affected nerve root, and at an identical location on the unaffected leg. The exact placement of the testing electrode was based upon the dermatome map developed by Bonica [15]. The methods of CPT testing were similar to those described previously [11,16].

Sensory deficits were evaluated using a hairy brush stroke applied in the same area as that used for the CPT testing. Subjects reported the intensity of touch sensation in the affected leg as the relative intensity compared to that in the unaffected leg. Sensory deficits in the affected leg were graded as severe (50% and more decrease compared with the unaffected leg), mild (<50% and >20% decrease), slight (<20% decrease), and none.

Patients were allowed to continue to receive conservative therapies, including oral medications and physiotherapy, but they were not allowed to start new oral medications or have a neural block. The intensity of pain, the RMDQ score, the CPT value, and sensory deficits were assessed before and 1 and 3 months after the epiduroscopy.

Data analysis

For repeated measures over time, the Friedman test was used. When significance was found, the Wilcoxon signed rank test was used for post-hoc testing. The Spearman rank correlation was used for correlation analysis between the severity of sensory deficit and the CPT value at 2000 Hz in the affected leg. Values for results were expressed as medians, and $P < 0.05$ was considered statistically significant.

Results

Epidurography before the epiduroscopy revealed that the epidural space surrounding the affected nerve root could not be filled with contrast medium, whereas that surrounding the unaffected nerve root was successfully filled in all of the patients.

In 16 of the 19 patients, adhesions were found close to the intervertebral foramen of the affected nerve root within the epidural space, and epidural adhesiolysis followed by the injection of steroid and local anesthetic, was successfully performed. The affected nerve root, suspected by neurological examination and preoperative epidurography, was identified by reproducing pain when the tip of the epiduroscope gently touched the nerve root. Epidurography after the adhesiolysis showed that the epidural space surrounding the affected nerve root was filled with contrast medium. In the remaining 3 patients, extensive adhesions were found around L5 and S1, and epiduroscopic adhesiolysis was given up because of hard adhesions. Therefore, 16 patients completed the study. The characteristics of these 16 patients are shown in Table 1. The total volume of saline infused during the epiduroscopy was

Table 1. Patient characteristics ($n = 16$)

Age (years)	71.5 (41–84)
Male/Female (*n*)	7/9
Duration of symptom (months)	71 (5–156)
Intensity of leg pain (NRS)	7 (3–9)
Intensity of low back pain (NRS)	6 (2–9)
Sensory deficit	
Severe	4
Mild	4
Slight	8
None	0
Previous back surgery (*n*)	4
Level of pathology	
L5 (*n*)	10
S1 (*n*)	6
Pain treatment	
Nonsteroidal anti-inflammatory drug (*n*)	15
Antidepressant drug (*n*)	1
Antiarrhythmic drug (*n*)	1
MRI findings on the side associated with clinical symptoms	
Degenerative disc (*n*)	12
No abnormalities (*n*)	4

Values are medians (ranges) or absolute counts
NRS, numerical rating scale; MRI, magnetic resonance imaging

Table 2. Pain, Roland Morris Disability Questionnaire score, and severity of sensory deficit before and after epiduroscopy

	Before	1 Month after[a]	3 Months after[a]
Pain			
Leg (NRS)	7 (3–9)	3.5 (0–8)*	3 (0–7)*
Low back (NRS)	6 (2–9)	3 (0–7)*	5 (0–8)*
RMDQ score	15 (6–18)	11 (1–16)*	10 (0–20)*
Sensory deficit			
Severe	4	0*	0*
Mild	4	4	4
Slight	8	4	4
None	0	8	8

* $P < 0.05$ compared with before epiduroscopy
Values are medians (ranges) or absolute counts
NRS, numerical rating scale; RMDQ, Roland Morris Disability Questionnaire
[a] After epiduroscopy

30–70 ml. The whole procedure was finished within 1 h in all of the patients.

At 2000, 250, and 5 Hz, the CPT values in the affected legs of patients before the epiduroscopy were significantly higher than those in the unaffected legs (302 vs 188.5, 56.5 vs 50.5, and 43.5 vs 26, respectively). The CPT values at 2000 and 250 Hz in the affected legs, measured 1 and 3 months after the epiduroscopy, were significantly lower than those measured before the epiduroscopy (2000 Hz, 192.5 at 1 month, 200.5 at 3 months, and 302 before; 250 Hz, 35, 44, and 56.5, respectively (Fig. 1A,B). The CPT value at 5 Hz in the affected leg, measured 1 and 3 months after epiduroscopy, was lower than that before the epiduroscopy (22.5 at 1 month, 30.5 at 3 months, and 43.5 before), but statistically significant differences were not observed (Fig. 1C). In 3 patients, the CPT values at 5 Hz in the affected legs before the epiduroscopy were more than 100. The CPT value in the unaffected leg did not change at any frequency during the study period.

The severity of sensory deficits after epiduroscopy was significantly lower than that before epiduroscopy (Table 2). Sensory deficits in the affected leg were alleviated after the epiduroscopy in 15 patients. Significant correlations between the severity of sensory deficit and the CPT value at 2000 Hz in the affected leg were observed before and 1 and 3 months after the epiduroscopy (Fig. 2A–C).

NRS scores for leg pain and low back pain, and the RMDQ scores, assessed 1 and 3 months after the epi-

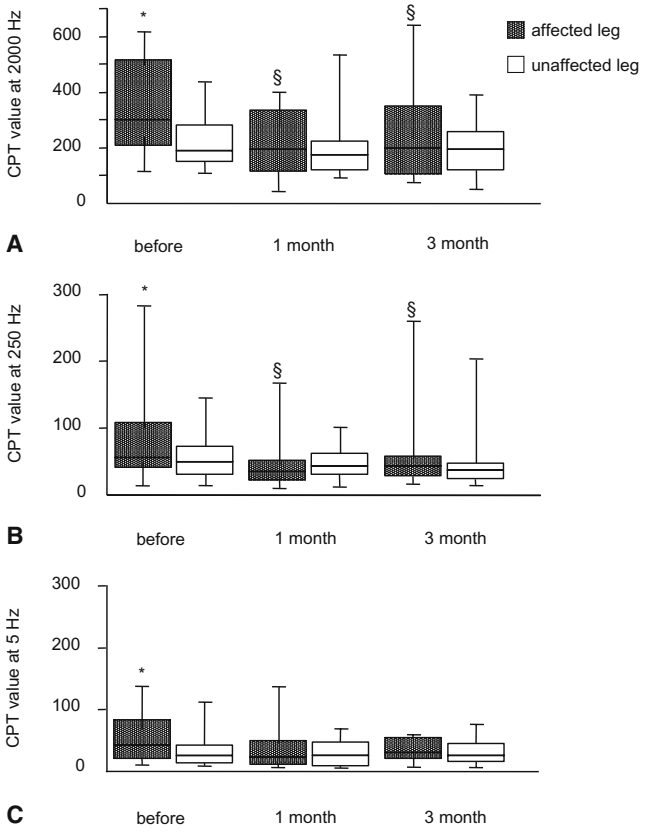

Fig. 1A–C. The current perception threshold (*CPT*) values in the unaffected and affected legs at 2000 (**A**), 250 (**B**), and 5 Hz (**C**) before and 1 and 3 months after epiduroscopy. CPT values in the affected leg at all frequencies were significantly higher than those in the unaffected leg before epiduroscopy ($*P < 0.05$). CPT values in the affected leg at 2000 and 250 Hz 1 and 3 months after epiduroscopy were significantly lower than those before epiduroscopy ($^{\S}P < 0.05$). The CPT value at 5 Hz did not change in either leg during the study period. Data values are presented as medians, 25th and 75th percentiles and ranges

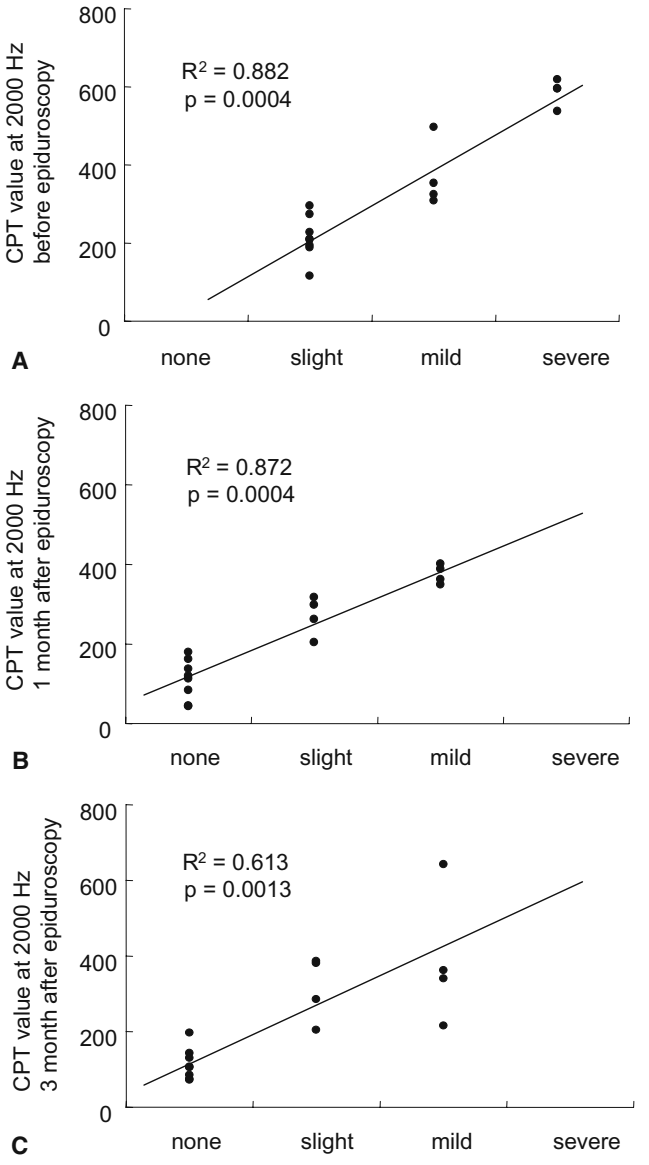

Fig. 2A–C. Relationship between severity of sensory deficit and current perception threshold (*CPT*) values in the affected leg at 2000 Hz before and 1 and 3 months after epiduroscopy. A significant correlation between the severity of sensory deficit and the CPT value in the affected leg at 2000 Hz was observed before, and 1 and 3 months after the epiduroscopy

duroscopy, were significantly lower than those before the epiduroscopy (Table 2). None of our patients experienced operative or postoperative complications.

Discussion

The present study demonstrated that adhesiolysis followed by the injection of steroid and local anesthetic during epiduroscopy could provide pain relief, improvement of nerve function, and reduced functional disability in patients with chronic sciatica refractory to lumbar epidural block.

The Neurometer CPT/C produces constant-current sine-wave stimulation at 2000, 250, and 5 Hz. The sine waves at 2000, 250, and 5 Hz correspond to depolarization periods of 0.25, 2, and 100 ms, respectively. The electrical stimulus selectively excites distinct subpopulations of nerve fibers as a function of the sinusoid frequency [17,18]. Correlations between the CPT value at 2000 Hz and large-fiber function, and between the CPT values at 250 and 5 Hz and small-fiber function have been demonstrated by thermal perception threshold testing and quantitative vibration testing, respectively [7,8,19]. Thus, large myelinated A (Aβ), small myelinated A (Aδ), and unmyelinated C (C) nerve fibers are evaluated with a series of 2000, 250, and 5 Hz stimuli, respectively.

In our study, the CPT values at all frequencies in the affected legs of patients before the epiduroscopy were significantly higher than those in the unaffected legs. Several studies have investigated quantitative sensory testing in patients with sciatica, and they demonstrated that the thresholds of Aβ, Aδ, and C fibers were increased in the affected dermatome compared with the unaffected dermatome [10,20,21]. These findings are consistent with our results.

In our study, the CPT testing demonstrated that the CPT values at 2000 and 250 Hz in the affected legs after epiduroscopy were significantly decreased as compared with those before the epiduroscopy. We found that all of our patients had adhesions close to the intervertebral foramen of the affected nerve root. Epidural adhesions are known to develop as a result of extrusion of the nucleus pulposus, chronic chemical radiculitis, and nerve root inflammation [22,23]. Adhesions around the nerve root may lead to reduced microcirculation in the nerve root, resulting in ischemic pain and abnormalities in nerve conduction [23]. We speculate that demyelination caused by ischemia associated with the epidural adhesions of nerve roots may have been responsible for the elevated CPT values seen at 2000 and 250 Hz in the affected leg before the epiduroscopy in our study.

On the other hand, the CPT value at 5 Hz in the affected leg after the epiduroscopy was not significantly lower than that before the epiduroscopy. Nygaard et al. [24] examined quantitative sensory testing in patients with lumbar radiculopathy before and after surgical decompression. They demonstrated that the preoperative warmth detection threshold (mediated by C fibers) was significantly higher in the patients with a poor result than in the patients with a good result. In our study, the CPT value at 5 Hz, and the pain and RMDQ scores in the three patients who had high a CPT value at 5 Hz before the epiduroscopy did not change. This indicates that damage to C fibers before epiduroscopy may be a negative prognostic factor.

Recently, Dashfield et al. [25] demonstrated, in a randomized controlled study, that epiduroscopy did not show improved outcome compared with traditional epidural steroid injection in patients with sciatica. However, most of their patients did not have adhesions in the epidural space. In contrast, all of our patients had adhesions close to the intervertebral foramen of the affected nerve root. For this reason, we included patients with previous back surgery and/or long-lasting symptoms.

In our study, pain and RMDQ scores were decreased 1 and 3 months after the epiduroscopy. Remyelination after adhesiolysis may also contribute to the alleviation of pain [26] and the reduction of functional disability. Further, the injected steroid possibly worked at the affected nerve root; this was implied by the epidurography after epiduroscopy showing that the epidural space surrounding the affected nerve root was filled with contrast medium. Steroids reduce edema in an injured nerve root and improve intraneural blood flow [27].

Lumbar epidural block with steroid and local anesthetic before the epiduroscopy provided only limited effects in all of our patients. Epidurography also revealed that the epidural space surrounding the affected nerve root could not be filled with contrast medium before the epiduroscopy, whereas these spaces were successfully filled in all of the patients after the epiduroscopy. These results imply that the epidural steroid given before the epiduroscopy could not have reached the affected nerve roots because of the adhesion. Therefore, it seems possible that the adhesiolysis achieved with the epiduroscopy would improve the effect of epidural steroid injection.

We recruited 19 patients with chronic sciatica for our study, and epidurography before epiduroscopy demonstrated that all of them had deficits in the epidural space surrounding the affected nerve root. In 3 of these 19 patients, we could not achieve adhesiolysis because of the presence of hard, extensive adhesions. Therefore, it is possible that our method of patient selection, according to physical symptoms and epidurography, may lead to the overlooking of patients in whom adhesiolysis is difficult.

In conclusion, when patients with chronic sciatica had adhesions close to the intervertebral foramen of the affected nerve root within the epidural space, adhesiolysis, followed by the injection of steroid and local anesthetic during epiduroscopy, alleviated pain and reduced functional disability and sensory nerve dysfunction in Aβ and Aδ fibers in the affected legs.

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