—Originals—

The clinical efficacy of neuroendoscope in surgical treatment for deafferentation pain

Takayuki Kitamura and Akira Taramoto

Department of Neurosurgery, Nippon Medical School

Abstract

Spinal cord stimulation (SCS) is one of the most minimally invasive and effective treatments for intractable pain. We report the efficacy of a very small diameter neuroendoscope on setting the electrode to the proper site in the epidural space. Our cases include thalamic hemorrhage, and each patient had unilateral intractable pain on L1 or less as the main complaint. They had been treated for over two years in other hospitals, but no significant relief was achieved. Because each patient had been given frequent epidural blocks, the adhesion in the epidural space was expected. In Group A (3 cases), we used very small diameter neuroendoscope to dissect adhesion in the epidural space and to make optimal space for lead placement under direct vision. Conventional lead placement under fluoroscopy was performed in Group B (3 cases). Medtronic's PISCES lead system was used for SCS. In Group A, stimulation and pain regions matched in all cases, and good pain relief was also achieved. In Group B, however, stimulation and pain regions matched incompletely and the increase in stimulation caused stimulation on the pain-free side. (J Nippon Med Sch 2000; 67: 13—17)

Key words: endoscopy, spinal cord, thalamic hemorrhage, deafferentation pain, electrical stimulation

Introduction

We have given various treatments for intractable pain, and spinal cord stimulation (SCS) is one of the most minimally invasive and effective treatments. Melzack and Wall[1] stimulated new interest in pain research and therapy using electrical modalities. The first electrical stimulation of the spinal cord was reported nearly 30 years ago by Shealy et al[2,3]. Today, spinal cord stimulation (SCS) has become a common and effective method of treating chronic pain. Over time, the results of SCS have improved because of developments in matching electrode placement to pain sites[4-7] and the advent of multipolar stimulation devices to replace unipolar ones[4,8,9].

Incorporation of the trial stimulation period has also improved selection of long-term patients for SCS[4,8-10]. On the other hand, many of the patients with intractable pain received various treatments against pain, and it is often the case that the electrode for spinal cord stimulation cannot be positioned at the proper site due to the adhesion of the epidural space caused by frequent epidural blocks. In the present study, we report how we were able to position the electrodes for spinal cord stimulation at the proper site by using a very small diameter neuroendoscope.

Materials and Methods

1. *Materials*

The causal disease in the subjects was deafferentation pain after thalamic hemorrhage in all cases. SCS

Correspondence to Takayuki Kitamura, Department of Neurosurgery, Nippon Medical School, Sendagi 1–1–5, Bunkyo-ku, Tokyo, 113–8603, Japan

Table 1 Summary of the 6 patients given spinal cord stimulation (SCS)

Case	Age (y.o.)	Sex	Main territory of pain	Period of treatment (yrs)	Type of operation
1	48	M	L2 ～ L5	2.50	Group A
2	57	M	L1 ～ L3	3.75	Group A
3	71	M	L2 ～ S2	4.50	Group A
4	53	M	L1 ～ L3	2.00	Group B
5	64	F	L2 ～ L5	2.75	Group B
6	59	F	L2 ～ L5	4.25	Group B

M : male, F : female.
Group A : Fluoroscopy and a very small diameter neuroendoscope were used to set the electrode in the epidural space, Group B : Only fluoroscopy was used to set the electrode in the epidural space.

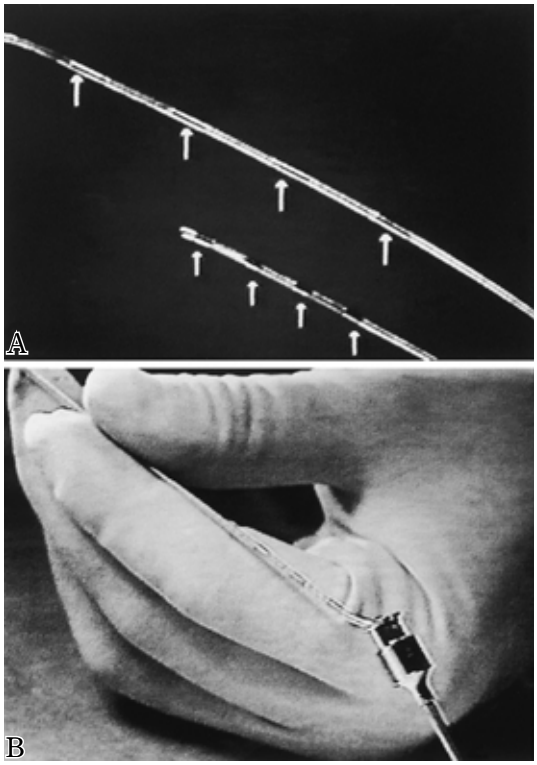

Fig. 1 A: Medtronic Pisces-Quad lead system
B: Percutaneous implantation of Quad-lead

was performed between January 1995 and December 1996, and six patients who were followed up for two years or more and showed improvements above mild degree were selected as the subjects. **Table 1** shows the patients. They were aged between 48 and 71 years mean : (58.7) and consisted of four men and two women. The major pain area was below L1. All the patients had a treatment history of two years or more. These patients underwent various pain relief treatments including anodyne and nerve blocks in other hospitals, but they could not obtain distinct effects. In particular, inflammatory adhesion of the epidural space was caused in these patients by frequent epidural blocks, and proper positioning of the electrode for spinal cord stimulation in the epidural space was expected to be difficult.

2. *Methods*

A Medtronic Pisces-Quad lead system was used as the instrument for spinal cord stimulation. All electrodes were implanted percutaneously (**Fig. 1**). The techniques for implantation have been described previously[10]. Lead implantation must be done under local anesthesia. The key to technical success in the SCS procedure was accurate placement of the stimulating lead, resulting in paresthesia that covered the patient's painful areas. A 15 gauge Touhy needle was introduced under fluoroscopic visualization. The entry level was L1–L2 and the location of the stimulating tips was usually between T9 and T11. If there was no adhesion of the epidural space, a guide wire could be introduced into the epidural space through the Touhy needle. The guide wire was used to gently clear a path for the subsequent introduction of the lead itself.

The electrode was passed through the needle and up the path created by the guide wire under fluoroscopic visualization. But if there was adhesion of the epidural space due to frequent epidural blocks, it was until now very difficult to perform accurate placement of the stimulating lead covering the patient's painful areas. So we used a very small diameter neuroendoscope (Medical science jpn. MS-501 [outer diameter 0.7 mm. 6,000 pixels], MS-551-S outer diameter 1.1 mm, 3,000 pixels, Flexible type) (**Fig. 2**) as

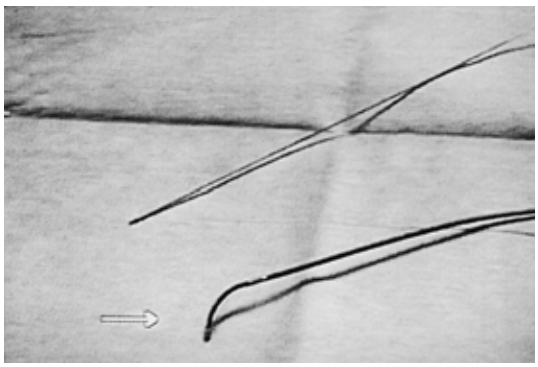

Fig. 2 Very small diameter neuroendoscope. above: Medical science jpn. MS-501 (outer diameter 0.7 mm, 6,000 pixels), below: MS-551-S (outer diameter 1.1 mm, 3,000 pixels, Flexible type)

the tool to dissect the adhesion of the epidural space under direct vision and to create a space for setting the lead in a suitable position. In Group A (3 cases), fluoroscopy and a very small diameter neuroendoscope were used to set the electrode in the epidural space. In Group B (3 cases), only fluoroscopy was used to set the electorode. After initial electrode implantation, all patients were given a 3 to 7 day trial period of stimulation to determine whether satisfactory pain relief could be obtained. In patients who achieved adequate pain relief, the electrodes which were originally implanted were internalized.

The pulse generators used were Medtronic Itrel II systems. Parameter settings were usually 50～60 Hz, with pulse widths of 210 to 300 μs, and amplitude between 1.5 and 6.0 V. The Cycling modes used were variable. Various combinations of multipolar electrodes were used to determine the best pain coverage. Pulse generators were placed in the right illiac fossa below the belt line.

3. Clinical evaluation

Pain relief was scored by personal interviews with a disinterested third party physician who was not involved in the direct care of the patients in this study. The interviews to assess pain relief were performed at 6-month intervals of self-stimulation for each patient. Patients were graded according to their pain control using the following criteria: 1) less than 50% relief (poor); 2) 50 to 75% relief (good); and 3) greater than 75% relief (excellent). Both good and excellent results were considered successful in this study.

Results

Table 2 shows the results of this study. "Good" on the column of "condition of SCS" means that stimulation and pain regions matched very well. "Poor" indicates that stimulation and pain regions matched incompletely, causing stimulation on the pain-free side by elevation of the electrical currency. In Group. A, all of 3 cases showed "good". In Group. B, 1 case showed "good" and 2 cases showed "poor". According to the above-mentioned estimation for "pain relief by SCS", 2 cases were "excellent" and 1 case was "good" in Group A. In Group B, 1 case was good and 2 cases poor. The efficacy of pain relief was apparently correlated with the condition of SCS. **Fig. 3** shows the findings of the extradural space by endoscopy in case no. 2, a 57 yr old male. The efficacy of the very small diameter neuroendoscope in setting the electrode to the proper site in the epidural space

Table 2 Summary of the results of spinal cord stimulation

Case	Age (y.o.)	Sex	Type of operation	Condition of SCS	Pain relief
1	48	M	Group A	Good	Excellent
2	57	M	Group A	Good	Excellent
3	71	M	Group A	Good	Good
4	53	M	Group B	Good	Good
5	64	F	Group B	Fair	Poor
6	59	F	Group B	Fair	Poor

M : male, F : female.
Group A : Fluoroscopy and a very small diameter neuroendoscope were used to set the electrode in the epidural space, Group B : Only fluoroscopy was used to set the electrode in the epidural space.

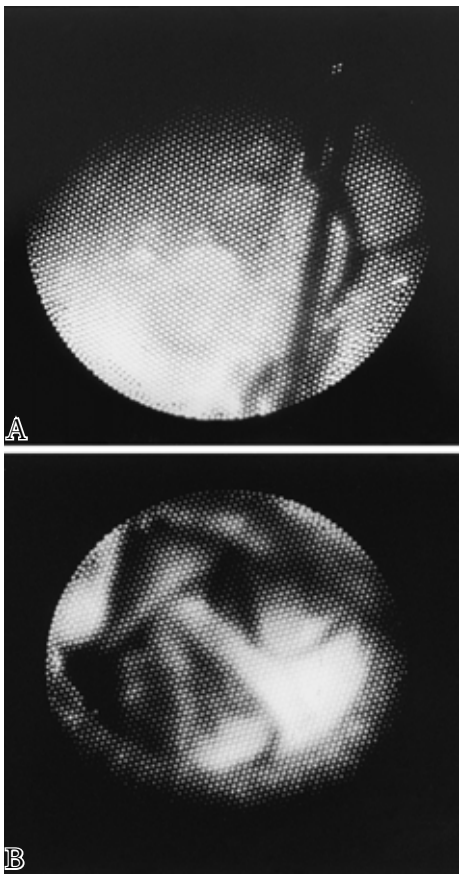

Fig. 3 57 y. o. male. (Case no. 2). He suffered from Rt. thalamic hemorrhage 3.75 years before the operation of SCS. He complained of intractable pain in the L 1～L 3 region.
A: Dilatation of the meningeal artery was observed. (→). B: Adhesion of the epidural space was observed.

was obviously proved.

Discussion

Melzack and Wall[1] stimulated new interest in pain research and therapy using electrical modalities.

Several reviews of spinal cord stimulation for the control of chronic, intractable pain have been performed over the past two decades. Reviews tend to show success rates of 40～60%. These rates are typically calculated by the number or patients receiving implantation and not by the number of patients screened for the procedure. SCS has evolved as better technology developed and a greater knowledge on indications has been accumulated. Percutaneous trial stimulation methods are used in most reports of SCS, but at least two studies have not used a trial period[11,12]. We continue to use the trial stimulation technique as the mainstay of the screening process in deciding which patients will receive permanent implants. We believe that the enhanced predictive value for efficacy in individual patients makes this step worthwhile. The trial stimulation period allows for a period of patient self-education in the presence of a neurosurgical team. During the trial stimulation period, the patient can be followed on an outpatient basis to allow an experimentation program in familiar environments. The positioning of the spinal electrode should be precise to allow overlap of the pain area and paresthesia during trial stimulation. This fact has been shown to be important for long-term efficacy of SCS[4,9,13]. Therefore, we continue to use the trial stimulation period to provide the best possible decision on internalization. The incidence of electrode displacement was much higher in Group B. Tolerance is the best way to express loss of pain control without mechanical failure. Tolerance has also been implicated in deep brain stimulation studies for chronic pain as the main reason for long-term failure[14]. Tolerance is a major factor in long-term failure and is attributable to 1) fibrotic changes surrounding the electrode tip causing insulation electrical signals[4,7,15] ; or 2) plasticity of pain pathways, which has been demonstrated in the spinal cord[15], thalamus[16], and cortex[18] in humans. These patients may be examples of a population whose epidural anatomy in some way obviates correct electrode positioning. In this study, we achieved efficacious treatment by utilizing a very small diameter neuroendoscope to dissect epidural adhesion in order to make optimal space for lead placement. And we demonstrated the advantage of operating under direct vision which would conventionally be done fluoroscopically. More sensitive screening methods might be used perhaps along the lines of somato-sensory evoked potential monitoring[18–20]. Significant differences in responses between males and females have been reported in two studies, with females demonstrating superior results[8,21], whereas other papers have reported no significant difference[22,23]. In our study, there was no significant difference between the sexes. Age did not prove to be a significant determining factor in our series. A striking relationship emerges suggesting that the longer the duration of pain prior to SCS, the poorer the response

to SCS[24]. This suggests that pain becomes firmly established over time, leading to difficulty in modification via SCS. In our practice, this information has become an important prognostic factor in screening patients for SCS.

References

1. Meizack R, Wall D: Pain mechanisms: A new theory. Science 1965; 150: 971–979.
2. Shealy CN, Mortimer JT, Reswick JB: Electrical inhibition of pain by stimulation of the dorsal columns: Preliminary clinical report. Anesth Analg 1967; 46: 489–491.
3. Shealy CN, Mortimer JT, Hagfors NR: Dorsal column electroanaigesia. J Neurosurg 1970; 32: 560–564.
4. Kumar K, Nath R, Wyant GM: Treatment of chronic pain by epidural spinal cord stimulation: A ten-year experience. J Neurosurg 1991; 75: 402–407.
5. Racz GB, McCarron RF, Talboys P: Percutaneous dorsal column stimulation for chronic pain control. Spine 1989; 14–24.
6. Ray CD: Electrical and chemical stimulation of the CNS by direct means for pain control: Present and future. Clin Neurosurg 1981; 28: 564–568.
7. Ray CD: Spinal epidural electrical stimulation for pain control: Practical details and results. Appl Neurophusiol 1982; 45: 160–165.
8. North RB, Kidd DH, Zahurak M, James CS, Long DM: Spinal cord stimulation for chronic intractable pain: Experience over two decades. Neurosurgery 1993; 31: 384–394.
9. North RB, Ewend MG, Lawton MT, Piantadosi S: Spinal cord stimulation for chronic, intractable pain: Superiority of "multichannel" devices. Pain 1991; 44: 119–123.
10. Kumar K, Wyant GM, Ekong CEU: Epidural spinal cord stimulation for relief of chronic pain. The pain Clinic 1986; 1 : 91–99.
11. Koeze TH, Williams AC, Rieman S: Spinal cord stimulation and the relief of chrcnic pain. J Neurol Neurosurg Psychiatry 1987; 50: 1524–1529.
12. Probst C: Spinal cord stimulation in 112 patients with epi/intradural fibrosis following operation for lumbar disc herniation. Acta Neurochir Wien 1990; 107: 147–151.
13. Law JD, Miller LV: Importance and documentation of an epidural stimulating position. Appl Neurophysiol 1982; 45: 461–464.
14. Kumar K, Toth C, Nath RK: Deep brain stimulation for intractable pain: A 15 year experience. Neurosurgery 1997; 40: 736–747.
15. Krainick JU, Thodeu U, Riechert T: Pain reduction in amputees by long term spinal cord stimulation. Longterm follow-up study over 5 years. J Neurosurg 1980; 52: 346–350.
16. Dickenson AH: Central acute pain mechanism. Ann Med 1995; 27: 223–227.
17. Kiss ZH, Dostrovsky JO, Tasker RR: Plasticity in human somatosensory thalamus as a result of deafferentation. Stereotact Funct Neurosurg 1994; 62: 153–163.
18. Flor H, Elbert T, Knecht S, Winbruch C, Pantev C, Birbaumer N, Larbig W, Taub E: Phantom-limb pain as a perceptual correlate of cortical reorganization following arm amputation. Nature 1995; 375: 484–494.
19. Garcia-Larrea L, Sindou M, Mavguiere F: Clinical use of nociceptive flexion reflex recording in the evaluation of functional neurosurgical procedures. Acta Neurochir Suppl (Wien) 1989; 46: 53–57.
20. Garcia-Larrea L, Sindou M, Mavguiere F: Noeiceptive flexor reflexes during a nalgesic neurostimulation in man. Pain 1989; 39: 145–146.
21. Mertens P, Sindou M, Gharios B, Garcia-Larrea L, Mauguire F: Spinal cord stimulation for pain treatment: Prognostic value of somesthetic evoked potentials. Acta Neurochir (Wien) 1992; 117: 90–91.
22. Reynolds AF, Shetter AG: Searring around cervical epidural stimulating electride. Neurosurgery 1983; 13: 63–65.
23. Gonzalez-Darder JM: Spinal electrical stomulation. Current indications and results in a series of 46 patients. Rev Esp Anestesiol Reanim 1992; 39: 86–90.
24. Kupers RC, Van der Oever R, Houdenhove B, Vanmechelen W, Hepp B, Nuttin B, Gybels JM: Spinal cord stimulation in Belgium: A nation-wide "surgery on the incidence, Indications and therapeutic efficacy by the health insurer. Pain 1994; 56: 211–216.

(Received, September 10, 1999)
(Accepted, October 19, 1999)