Clinical Results of Radiofrequency Dorsal Root Entry Zone Coagulation for Paraplegic Pain

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Objective: Dorsal root entry zone (DREZ) operation has been the most common surgical treatment for paraplegic pain in the past, but the results differ according to the patients. In this study, we attempt to analyze the results from the patients by the different patterns of the pain before the surgery.

Methods: A total of twelve paraplegic patients have undergone a total of thirteen radiofrequency DREZ coagulation procedures between April 1994 and March 2003. The patients were divided depending on patients’ subjective description on the character, frequency, and range of pain.

Results: The patients were divided into two groups, postoperatively: improvement of more than 75% of pain was defined as treatment success, and any level less than 75% of improvement was defined as treatment failure. Eight of the ten mechanical pain group cases were regarded as treatment success, and remaining two cases with thermal type of pain as treatment failure. Also, one case with combined pain failed to obtain any favorable outcome. Intermittent pain group (6 of 7 cases), continuous pain group (2 of 6 cases), and localized pain group (7 of 11 cases) showed treatment success, respectively. However, diffuse pain group (1 of 2 cases) resulted in poor outcome.

Conclusion: Radiofrequency DREZ coagulation is more effective in managing intermittent and/or mechanical pain than continuous and/or thermal pain in the paraplegic patients following spinal cord injury.

KEY WORDS: Dorsal root entry zone · Mechanical pain · Thermal pain · Paraplegic pain.

Introduction

Paraplegic pain occurs in many patients after spinal injury. It mostly occurs in weeks after spinal injury, but sometimes in months or years. Surgical operations are done to treat these kinds of pain, but the results differ greatly among patients. Since Sindou succeeded in curing the neuropathic pain by DREZ (dorsal root entry zone)otomy in the 1970s, the method destroying neural tissues related to the pain in DREZ of spinal cord using various instruments has been tried by many surgeons. Also Nashold introduced a radiofrequency (RF) coagulation on DREZ for the control of neuropathic pain, and his reports showed this procedure was helpful to control the paraplegic pain. Although coagulation therapy using laser is introduced recently, there is still a controversy on the effect of the method. It has been difficult to estimate the result of pain control after DREZ lesioning, because the postoperative results differ variously. Therefore, we attempted to analyze the results, from our patients who have undergone RF DREZ coagulation, by the different patterns of the pain that occurred after spinal injury.

Materials and Methods

Patient population
A total of twelve patients underwent a total of thirteen RF DREZ coagulations to treat with paraplegic pain after spinal injury. There were 11 males and 1 female, aged between 32 to 68. The mean age was 49.5 ± 10.6 years (Table 1). One man, who had underwent the procedure for pain after cauda equina injury, underwent second procedure owing to spastic bladder pain. The cause for the spinal injury was falling down in 8 cases, struck by stone in one case, hit by a metallic object for one, injured by falling rocks in one case, hit by a stone on the back in one case, and hit by a car when crossing the street in one case. Different types of pain occurred over various time period, some right after the injury, some 20 years after. Actual neurological and functional classification of patients was according to American Spinal Injury Association (ASIS): A-no sensory and no motor function.
DREZ Coagulation for Paraplegic Pain

Clinical features of pain
We divided patient’s subjective description of pain into three categories. When patients described their natures of pain as ‘burning’, ‘boiling’, ‘hot’, ‘cold’, we called it as thermal pain, and for descriptions as ‘constriction’, ‘stabbing’, ‘cutting’, ‘throbbing’, we regarded it as mechanical pain. When they complained both types of pain together, we called it as combined pain. We classified the intensity of the pain by using visual analogue scale (VAS). When the pain occurred over all distal location below the level of injury, we classified it as diffuse pain. When the pain occurred in neural segments of limited area, we classified it as localized pain. We also classified the pain by its frequency, into paroxysmal pain and continuous pain (Table 2).

Previous pain treatment trials
Spinal fixation was performed immediately after the spinal injury in all 13 patients. Additionally, before the RF DREZ coagulation, some patients underwent epidural block, DREZ lesioning, and adhesiolysis.

Operation method
During 24 hours prior to surgery, patients were medicated for steroid and antacids every 6 hours. Operation was done in prone position under general anesthesia. Laminectomies were performed at corresponding levels to expose above and below the injured spinal cord. The dura mater and arachnoid membrane were opened under microscopic magnification. Arachnoidal and pial maters were thick and adhesive because of varying degree of arachnoiditis at the injured level. Microscopic visual inspection of the cord revealed the dorsolateral sulcus of cord and this identification of the DREZ was confirmed by gentle retraction of rootlets.

The thermocoupled Nashold electrode, 2mm in tip and 0.125mm in diameter, was introduced into the DREZ to a depth of 2mm. When the Impedence was in the region of 850~1200Ohms, RF DREZ coagulation was made at intervals 1~2mm and the temperature 75°C for 15 seconds. RF DREZ coagulation was made both side at dorsolateral sulcus of upper two or three cord level from injured level from injured level. Also, in one case in which the patient (Case 8) had undergone a RF DREZ coagulation on L4-S1...
spinal cord level, patient complained severe spastic bladder pain and we tried RF DREZ coagulation on L4-S1 and microsurgical DREZotomy on S2-3 spinal cord level (Case 10) due to preserving motor function of bladder. Occasionally, bleeding was encountered from small pial vessels, but this was usually controlled with pressure without bipolar coagulation. The dura mater was then closed in a watertight fashion followed by usual closure of the muscle, subcutaneous layers and skin with interrupted sutures. All patients received postoperative corticosteroids to prevent neurologic damage.

### Results

#### Clinical characteristics of pain

A total of thirteen operations were done in twelve paraplegic pain patients. There were 10 operations done due to the mechanical pain. In 6 cases, patient appealed paroxysmal and localized pain, in 3 cases continuous and localized pain, in 1 case paroxysmal and diffused pain. There were 2 cases of thermal pain, one of them was continuous and localized pain, the other was continuous and diffused pain. There was one case of combined pain (Table 2).

#### Surgical result after the operation

We could perform follow-up interviews in all cases (mean duration: 30.5 months). We considered the results as ‘good’ when there was more than 75% of the pain reduction, and ‘fair’ if above 25% and under 75%, and ‘poor’ if there was less than 25% of pain reduction.

When the result was good, we called it a treatment success, and fair or poor, was considered as treatment failure. Eight cases showed ‘good’ result, four cases ‘fair’ result, and one case ‘poor’ result (Table 2).

In all cases, there was no improvement in motor power, but in one case in which the patient had undergone second operation owing to severe spastic bladder pain, he gained the capacity to void by himself, but no sense of bladder filling.

Relation between the characteristics of pain and the operation

Eight out of 10 operations due to the mechanical pain were treatment success. In 6 out of those successful 8 cases, the pain was paroxysmal, and in the other 2, the pain was continuous. In 5 out of 6 cases, which the pain was paroxysmal, the patient had localized pain, in 1 patient showed diffused pain. In remaining 2 cases which the pain was continuous, the pain was localized. Among cases which the pain were mechanical, 2 cases resulted in treatment failure, 1 case which the pain was continuous and localized, and 1 case which was paroxysmal and localized. However, 2 patients who had thermal pain resulted in treatment failure. The pain was all continuous, 1 localized and 1 diffused. In one case which the pain was combined resulted in treatment failure. Pain was continuous and localized.

Relation between the frequency of pain and the operation

Six out of 7 cases with paroxysmal pain resulted in treatment success. The pain was mechanical in all 6 cases. In 5 out of 6 cases, the pain was localized, in 1 case the pain was diffused. In 1 of 7 case, which resulted in treatment failure, the pain was mechanical and localized. On the other hand, 2 out of 6 cases with continuous pain resulted in treatment success. The pain was localized and mechanical in both of case. In 4 cases with treatment failure, the nature of pain was mechanical and localized in one case, thermal and diffused in one case, thermal and localized in one case, combined and localized in one case.

#### Table 2. Results according to the characteristics of pain

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<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>L</td>
<td>P</td>
<td>pain relieved by more than 75%</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>L</td>
<td>C</td>
<td>little pain relieved</td>
<td>poor</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>L</td>
<td>C</td>
<td>pain disappeared on L2 end zone, pain relieved by more than 50% on S1</td>
<td>fair</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>L</td>
<td>C</td>
<td>pain relieved entirely</td>
<td>good</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>L</td>
<td>P</td>
<td>no pain</td>
<td>good</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>L</td>
<td>C</td>
<td>almost no pain</td>
<td>good</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>L</td>
<td>P</td>
<td>no pain on L1, 2</td>
<td>good</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>L</td>
<td>P</td>
<td>leg pain disappeared, but severe bladder pain developed, one month postoperatively</td>
<td>fair</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>L</td>
<td>P</td>
<td>pain relieved entirely</td>
<td>good</td>
</tr>
<tr>
<td>10</td>
<td>T</td>
<td>L</td>
<td>C</td>
<td>pain relieved, no sense of bladder filling, voiding every 3 hours</td>
<td>fair</td>
</tr>
<tr>
<td>11</td>
<td>M</td>
<td>L</td>
<td>P</td>
<td>pain relieved entirely</td>
<td>good</td>
</tr>
<tr>
<td>12</td>
<td>T</td>
<td>D</td>
<td>C</td>
<td>50% of pain still remaining, coldness and numbness coexist</td>
<td>fair</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>D</td>
<td>P</td>
<td>no pain</td>
<td>good</td>
</tr>
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</table>

* Char.: Characteristics; M: mechanical pain, T: thermal pain, C: combined pain. ** Ran.: Range; L: localized pain, D: diffuse pain, *** Fre.: frequency; P: paroxysmal pain, C: continuous pain
Relation between the range of pain and the operation

Seven out of 11 cases with localized pain resulted in treatment success. In 7 cases with treatment success, the pain was mechanical. In 5 out of 7 cases, the pain was paroxysmal, and in 2 cases, the pain was continuous. In 4 cases with treatment failure, the nature was mechanical and continuous in one case, mechanical and intermittent in one case, thermal and continuous in one case, combined and continuous in one case. In 1 out of 2 cases with diffuse pain resulted in treatment success. The pain was mechanical and paroxysmal. In 1 case with treatment failure, the pain was continuous and diffuse.

Relation between the injured site and the operation

Nine cases occurred after spinal cord injury, 3 after cauda equina injury. Of RF DREZ coagulation done on 9 cases of spinal cord injury, 6 cases resulted in treatment success, and on the pain was mechanical. In 3 cases which resulted in treatment failure, the pain was mechanical, thermal, and combined. In all 3 cases, the pain was continuous. Two out of 3 cases from cauda equina injury resulted in treatment success, and the pain was from mechanical. In 1 cases which resulted in treatment failure, the pain was mechanical and after RF DREZ coagulation, he complained thermal pain and visceral pain.

Discussion

The exact pathway related to the transmission of pain is not clear yet, but there seems to be several mechanisms which are responsible. Anatomically, afferent fibers of the pain pass through the DREZ and ascend along the spinothalamic tract. DREZ consists of central part of dorsal spinal roots, Lissauer’s tract, superficial layers of dorsal horn. Dorsal horn can be divided into many laminae, and nociceptive small myelinated A-delta and unmyelinated C fibers relay on lamina I or lamina II and V. In a physiological view, if there is a noxious stimulus, various changes of neurotransmitters including substance P, which can excite dorsal horn neurons, are observed, and these changes are also observed after the spinal injury. In general, the pain is generated when ectopic impulse occurs at the proximal part of the injured site after the spinal injury, and becomes transmitted along the spinothalamic pathway. The pain can be dealt with by destroying the deafferented second-order neuron by such procedure as RF DREZ coagulation. This was partially evidenced in animal experiments.

Sindou performed micorsurgical DREZotomy to deal with neuropathic pain which occurred after spinal injury in 37 cases. There were good results in 68% of the patients who had segmental pain, however, no improvement for predominant infraslesional pains. There were 88% of good results when pain was paroxysmal, whereas only 26% when continuous. In another study, there were 90% of successful results when pain was mechanical, paroxysmal, and localized, but no improvement was observed when pain was thermal, continuous, and diffuse. The result was excellent when the pain was paroxysmal. This can be explained that paroxysmal pain occurs by convulsive neurogenic mechanism (electrical signals are discharged in segmental dorsal horn neuron), and in continuous pain the massive loss of sensory input changes the functional status and brings new functional level. There was a similar result in other study, that the DREZotomy worked fine when paraplegic pain was paroxysmal and localized after spinal injury, and didn’t work fine when pain was continuous and diffused. In our study, 6 out of 7 cases (85%) in which the pain was paroxysmal resulted in success, 2 out of 6 cases (33%) with continuous pain resulted in success. In 2 cases which resulted in success, the pain was mechanical and localized. There was no difference between pains that occurred according to spinal level. In overall, the cases resulted in success when pain was mechanical and paroxysmal, whereas cases resulted in failure when pain was thermal and continuous. There are reports that the pain occurred by the injury at conus medullaris was more severe and result was bad than that of the injury at thoracic cord, but it was not possible to verify that in this study. An interesting result from this study was that even if it was a continuous neurogenic pain, RF DREZ coagulation worked well when it was a mechanical pain.

In general, RF coagulation has advantages having that it lessens counter results by operating at accurate site measuring the temperature of the electrode, is easy to fix the electrode in precise anatomical positions, and is fixed as deep as 2–3mm along the dorsolateral fissure, which can affect all the neural cells related with pain. Also, its border is distinct and clear.

At present, operations for DREZ is common owing to improvement of related equipments and technology. How-ever, complications such as cerebrospinal fluid leaking, infection, hematoma and transient neurologic deficits may occur and results can vary between patients. Thus meticulous surgical technique and caution is necessary in every operation.
Conclusion

It is suggested that RF DREZ coagulation for the paraplegic pain due to the spinal injury has a better results in patients whose pains are paroxysmal or mechanical compared with patients whose pains are continuous or thermal.

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References