Japanese Acupuncture - Current Research

Clinical Study of Low Frequency Electroacupuncture Therapy (EAT) for Treatment of Cervical Radiculopathy

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I. Introduction

Low frequency electroacupuncture, where the inserted needles are used as electrodes, is a treatment form using low frequency electrical stimulation, and as such, one variant of acupuncture therapy. Currently, low frequency electroacupuncture is most frequently used in clinics for diseases and symptoms in the field of orthopedics and here, in particular, nerve pulse treatment has in recent years found wide application[1,2,3,4,5)]. Originally, low frequency electroacupuncture based on muscle pulse therapy, was used for these diseases and symptoms. For conditions in which muscle pulse therapy remained ineffective, the application of electroacupuncture on the damaged nerves reportedly resulted in improvements of the symptoms[3)], so that this nerve pulse therapy was proposed to be effective and thus started to come into general use. When low frequency electroacupuncture is performed in daily clinical practice, muscle pulse therapy is usually the treatment of first choice based on the degree of difficulty of the needling. In case the muscle pulse therapy is ineffective, the method is switched to the nerve pulse therapy. However, this decision is largely based on experience and it is thus desirable to provide constant evaluation criteria for the decision.

Yet, there have been no reports examining the clinical aspects of both muscle pulse therapy and nerve pulse therapy. We have investigated the clinical effects of both muscle pulse therapy and nerve pulse therapy in the treatment of patients with cervical radiculopathies.

II. Materials and Methods

1) Materials

Subjects of the study were 41 patients diagnosed with cervical radiculopathy based on their subjective symptoms, positive findings of the physical examination as well as x-p and MRI findings. In the patients with cervical radiculopathies included in this study, head compression tests like the Jackson or Spurling tests reproduced the pain in the arm. Patients who had loss of muscle power, weakened tendon reflexes, dysaesthesias and similar neurologic anomalies were observed. Those in whom the head compression test was negative, or who presented only neck pain, were excluded from the study.

2) Selection criteria for either muscle pulse therapy or nerve pulse therapy during the application of low frequency electroacupuncture

The first choice of treatment for all 41 patients was muscle pulse therapy. In patients in whom the pain score dropped to less than 5 points after one month of continuous treatment (10-point system), muscle pulse therapy was continued (muscle pulse therapy group). Yet, for patients in whom the pain score improved only down to 6 points, the therapy was switched to nerve pulse therapy and then continued (nerve pulse therapy transition group). The consent of the patients was obtained for the switchover from the muscle pulse therapy to the nerve pulse therapy.

As a result, in the end the muscle pulse therapy group included 24 and the nerve pulse therapy transition group 17 patients. No significant differences regarding patient age or duration of morbidity among the groups were observed. Table 1 shows the profiles for both groups.

	Muscle-EAT n=24	Nerve-EAT n=17
Sex	male 15, female 9	male 11, female 6
Age	51.6±10.8	48.3±9.2
Duration (days)	99.9±152.8	71.5±88.5
Head compression test	24	17
Sensory disturbance	8	7
Muscle weakness	5	0
Abnormality in deep tendon reflex	4	1

Table 1: Profile of the patients

3) Low frequency electroacupuncture for the treatment of cervical radiculopathy

In order to apply low frequency electroacupuncture for the treatment of cervical radiculopathy, the level of the responsible lesion was determined based on the subjective symptoms as well as the findings of physical examination and diagnostic imaging. The treatment was then performed with the purpose of achieving a change in muscle tension and circulation in the vicinity of the affected nerve root. Regarding this therapy, the muscle pulse therapy consisting of needling the spaces between the spinous processes directly lateral and superior to the level of the affected nerve root as well as choosing distal points on the affected side, using the needles as electrodes for the application of a low frequency electrical stimulation, has also been called the "acupuncture anesthesia method"[6]. For example, during application of an electric current to needles placed immediately lateral and inferior to the 5th cervical spinous process and the point Gokoku (Hegu, LI4) between the thumb and index finger for stimulation of the sixth cervical nerve, mild muscle contractions of the fingers of the hand were observed (Fig. 1-A). For the nerve pulse therapy, the needles are inserted into close proximity of the nerve root and then used as electrodes for the application of a low frequency electrical stimulation (Fig.1-B). Needles with a length of 50 mm and a diameter of 0.2 mm (Japanese-made 1 sun 3 bu, No.3 needles) were used. For the nerve pulse therapy[7] the needles were inserted in the same way as for the muscle pulse therapy into the spaces between the transverse processes with another needle (needle serving as an indifferent electrode). After obtaining referred pain within the region of the innervation of the particular nerve root, current was applied to the needle inserted in the neck. The current was applied, after confirming, that mild contractions of the peripheral muscles innervated by that nerve were observed.

Figures 2-A, B show needling of what was considered to be the region of the nerve root C_6, applying a low frequency current of 1 Hz and after confirmation of the induction of mild contractions of the thumb the position of the needle tip was ascertained through CT imaging. Based on the results, Ebraheim[8] classified three compartments of the sulcus for the spinal nerve root (medial, central and lateral compartment), according to which the needle tip can be confirmed to be positioned in the lateral compartment of the exit of the intervertebral foramen. For the low frequency electrical stimulation used for the muscle and nerve pulse therapies, a frequency of 1 Hz was used and applied over a period of 15 minutes. Treatment frequency was one to two times per week.

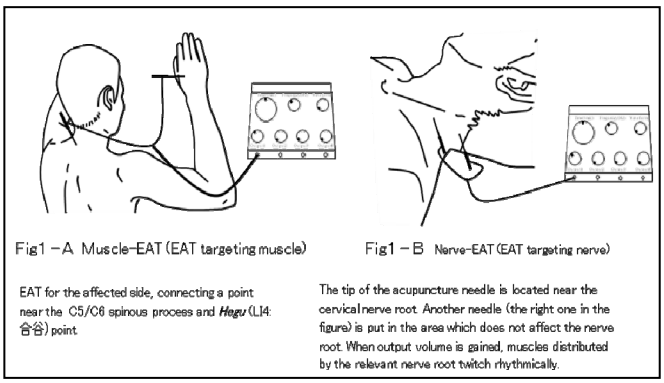

Fig1 – A Muscle-EAT (EAT targeting muscle)

EAT for the affected side, connecting a point near the C5/C6 spinous process and *Hegu* (LI4: 合谷) point.

Fig1 – B Nerve-EAT (EAT targeting nerve)

The tip of the acupuncture needle is located near the cervical nerve root. Another needle (the right one in the figure) is put in the area which does not affect the nerve root. When output volume is gained, muscles distributed by the relevant nerve root twitch rhythmically.

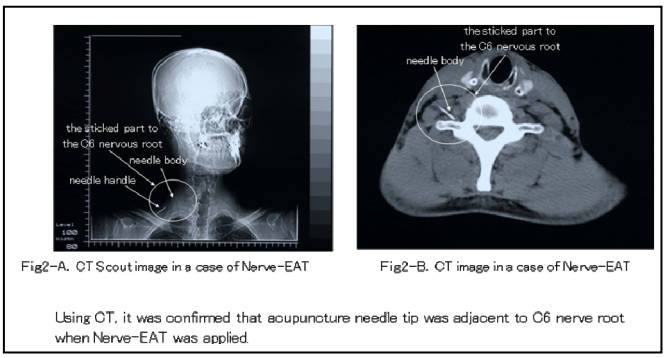

Fig2-A. CT Scout image in a case of Nerve-EAT

Fig2-B. CT image in a case of Nerve-EAT

Using CT, it was confirmed that acupuncture needle tip was adjacent to C6 nerve root when Nerve-EAT was applied.

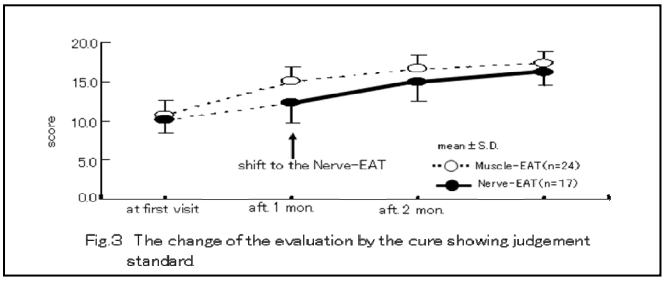

Fig.3 The change of the evaluation by the cure showing judgement standard

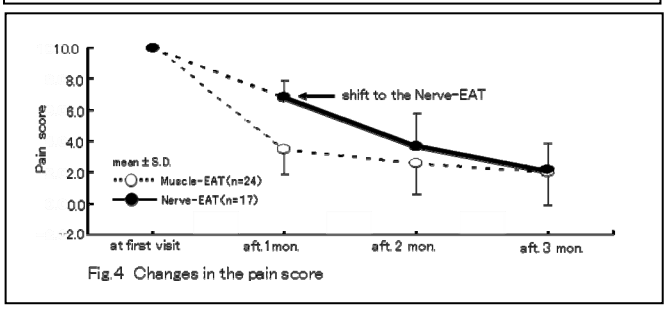

Fig.4 Changes in the pain score

4) Evaluation

Evaluation of the acupuncture treatment for radiculopathy follows the evaluation criteria for the therapeutic results of treatment for cervical radiculopathies[9] proposed by Tanaka et al. of Tohoku University, evaluating the condition monthly from the first visit until after the third month. The evaluation criteria proposed by Tanaka et al. comprise a total score of 20 points, including the following four items: subjective symptoms (0-8 points), ability to work or do household chores (0-3 points), functions of the hand (-2-0 points), objective symptoms (0-8 points).

Moreover, since Tanaka et al. consider improvement of the subjective symptoms in patients with radiculopathies to be very important[15], these were also evaluated with a pain score.

Statistical processing

The Mann-Whitney U-test was used for the testing of group differences, while the Bonferroni/Dunn method was used for the analysis of the values obtained at the initial stage and at each following examination for a multiple comparison test. Stat View 4.5 was used as the statistical software and the level of significance defined as $p<0.05$, $p<0.01$.

III. Results

1) Evaluation based on the evaluation criteria for the therapeutic results of treatment for cervical radiculopathies

Fig. 3 shows the results of muscle pulse therapy and nerve pulse therapy obtained from the initial visit until after the third month based on the evaluation criteria for the therapeutic results of treatment for cervical radiculopathies. The figure shows, that in the muscle pulse therapy group, the score at the first visit was 10.7±2.0 points (mean ± standard deviation), after 1 month the score improved to 15.0±1.9 points and after 3 months to 16.9±1.1 points ($p<0.05$). On the other hand, in the nerve pulse therapy transition group, the score at the first visit was 10.1±1.7 points, after 1 month the score improved to 12.3±2.6 points and after 3 months to 16.9±1.1 points, indicating a significant improvement between the initial test and the test after 3 months ($p<0.05$). Subsequent examination of the differences between the groups showed that while no significant difference was observed in the test results at the first visit, relevant significant changes ($p<0.05$) were observed after one month. However, after 3 months no significant changes were observed. In other words, 1 month after initiation of the treatment in the muscle pulse therapy group and nerve pulse therapy transition group, a difference in therapeutic results was observed, that disappeared again after 3 months of treatment, so that after 3 months the same therapeutic effects were obtained in both groups.

2) Variations in the pain score

Fig. 4 shows the variations in the pain score. In all patients the average pain score after 1 month was 5.2±2.5 points and thus showed a significant ($p<0,05$) improvement over the score at the first visit. Yet, if both groups were examined separately, the score in the muscle pulse therapy group was 3.5±1.6 points and in the nerve pulse therapy transition group 6.8±1.0 points. Improvement in the nerve pulse therapy transition group when compared to the muscle pulse therapy group was not as significant. A significant difference ($p<0,05$) was observed between the two groups. Although after one month of continuous therapy in the nerve pulse therapy transition group, an effective improvement had been achieved by the muscle pulse therapy as described above. In the group switched to the nerve pulse therapy the score after one month was naturally higher than in the muscle pulse therapy group. Yet, one month after switching to the nerve pulse therapy, that means 2 months after the first visit, the pain score in the muscle pulse therapy group was 2.6±2.0 points and in the nerve pulse therapy transition group 3.7±2.1 points, indicating a reduction in the difference between the two groups. After three months (that is two months after switching to the nerve pulse therapy) the score in the muscle

pulse therapy group was 2.0±2.1 points and in the nerve pulse therapy transition group 2.2±1.7 points, indicating that in both groups the same effect had been achieved.

IV. Discussion

Tanaka et al.[9] used their own evaluation criteria for the therapeutic results to examine the effects of conservative therapy in 43 patients with cervical radiculopathies. The results showed a score of 6.0 points at the first visit, that reportedly increased after three months of treatment to 11.9 points and after 4 months to 13.1 points. Yet, for patients who had 4 months of treatment and a score of less than 8 points continued conservative treatment, could not be expected to result in a subsequent favorable outcome. The authors stated that for patients with scores ranging between 9-13 surgery could also be considered.

We investigated the therapeutic results obtained with low frequency electroacupuncture based on the evaluation criteria of Tanaka et al. and found in the muscle pulse therapy group after 3 months an improvement of the score to 16.9 points and in the nerve pulse therapy transition group to 15.9 points. The condition could be regarded as having improved so far that surgery was not necessary. Yet, looking at the score at the first visit showed that Tanaka et al. patients had a score of 6.0, while the patients of the muscle pulse therapy group in this study had a score of 10.7 points and in the nerve pulse therapy transition group of 10.1 points. While Tanaka et al. excluded patients, who underwent treatment at other medical facilities, and included only those in whom the condition had developed within the last 2 months, the present study also included patients in whom the condition had lasted longer than 2 months and who were treated otherwise prior to the treatment with low frequency electroacupuncture. The difference in the score at the first visit probably reflects these circumstances. In either case, the patients included in this study were presented with milder conditions than those observed by Tanaka et al. Moreover, Tanaka et al.[10] observed among their cases with radiculopathy, a high ratio of patients with dysaesthesias, loss of muscle power and decreased tendon reflexes, reporting a ratio of 86% of dysaesthesia, 69% of loss of muscle power and 67% decreased tendon reflexes respectively among their 300 patients with radiculopathies. In contrast, dysaesthesias were found in as few as 15 (37%) out of the 41 cases included in this study, loss of muscle power in 5 patients (12%) and decreased tendon reflexes also only in 5 patients (12%), revealing that the neurologic findings too were of lesser severity than those reported by Tanaka et al. Based on these findings a comparison with the results of the conservative treatment implemented by Tanaka et al. was considered to show that the results of the low frequency electroacupuncture were better.

Regarding the effects of the muscle pulse therapy and the nerve pulse therapy, examination of the pain score revealed that the score after one month of treatment in the muscle pulse therapy group was 3.5±2.2 points and in the nerve pulse therapy transition group 6.2±1.8 points. At this point in time a significant difference between the two groups was observed, showing a clearly higher score in the nerve pulse therapy transition group. In other words, the score difference between the groups shows that in patients with higher scores, the treatment was switched from the muscle pulse therapy to the nerve pulse therapy, rendering these results inevitable. Yet, after 3 months of treatment, significant differences between the muscle pulse therapy group and the nerve pulse therapy transition group were no longer observed. These findings suggest that the condition in patients who showed resistance towards muscle pulse therapy, may be improved by nerve pulse therapy. The same thing may be said about the application of evaluation criteria for the therapeutic results.

Regarding the mechanism of onset of root pain, Hirabayashi[11] suggested, that it may be due to mechanical stimulation (pressure + friction) →

circulatory disturbances (edema) → radiculitis. Moreover, the nerve roots together with the ganglia are said to be characterized by their high vascular permeability, so that the influence of circulatory disturbances on nerve and connective tissues may elicit edema induced swelling of the nerve fibers. These lesions may then lower the stimulation threshold so that even minimal stimuli will elicit pain.

Also, Kobayashi et al.[12,13] created in animal (dogs) experiments a model of the pathology of entrapment neuropathy and observed lesions of the nerve roots. The results showed a marked decrease in radicular blood flow and conductivity in association with mechanical compression, making it clear that edema develops within the roots. Moreover, stagnation of intraaxonal flow and accumulation of SP (substance P) and CGRP in primary afferent fibers were observed and disturbances of the axoplasmic flow reported. The capillaries of the nerve root are innervated by nerve fibers containing SP and various other types of nerve activating substances. Since these substances are involved in radicular blood flow regulation, the accumulation of SP and CGRP and similar substances due to decreased axoplasmic flow causes inflammation and thus conceivably promotes the development of intraradicular edema. Also, Takahashi et al.[14] observed the blood flow in the lumbar spinal cord and nerve roots with a temperature gradient tissue blood flow meter following stimulation of the sciatic nerve using 20 Hz, 20 V, 0.5msec pulses in animal (dogs) experiments. The results revealed a reactive increase in blood flow in this region. Also, based on the results of these experiments, this research attempted to apply transdermal electrostimulation of peripheral nerves for ischemia of the cauda equina and nerve roots as one of the symptomatic manifestations and found this treatment to be effective in 56 out of 67 (83%) patients with radicular pain[15].

Consideration of the modes of action of the nerve pulse therapy, based on the hypotheses of Hirabayashi et al. and Kobayashi as well as the experimental results from Takahashi et al., allows to assume, that one of the mechanisms, namely the improvement of the nerve blood flow, is related to the alleviation of the symptoms. There are no reports dealing with low frequency electroacupuncture induced variations in nerve blood flow in humans, but in animal experiments the low frequency electroacupuncture stimulation of nerves reportedly led to a significant improvement of the nerve blood flow[16,17]. Moreover, Kasuya[4] and Inoue[5] et al. reported that application of low frequency electroacupuncture to the nerves or nerve roots to be effective for the improvement of refractory pain and numbness caused by lumbar spinal canal stenosis. Regarding this mechanism, the authors agree with Inoue et al., who mentioned the increased nerve blood flow.

Concerning the use of muscle pulse therapy and nerve pulse therapy based on the above described results, the application of muscle pulse therapy in cases of cervical radiculopathies was the first treatment stage, and if this did not produce certain clinical effects, switching to nerve pulse therapy was considered to be appropriate.

V. Conclusions

1) Comparison of muscle pulse therapy and nerve pulse therapy for the treatment of cervical radiculopathies showed in both groups a significant improvement between the first visit and after 3 months of treatment, the improvement being of approximately the same degree in both groups.

2) The nerve pulse therapy transition group refers to those patients in whom, in spite of one month of continuous treatment with the muscle pulse therapy, no effects were obtained. One month after treatment began there was a significant difference between the groups, but after 3 months approximately the same degree of improvement had been achieved in both groups.

3) This suggests, that in patients in whom treatment with muscle pulse therapy had been ineffective, improvements of the symptoms can be achieved by application of nerve pulse therapy.

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