ISSN (Print) 1226-1750
ISSN (Online) 2233-6656
Journal of Magnetics 26(1), 111-115 (2021) https://doi.org/10.4283/JMAG.2021.26.1.111

Effects of Repetitive Peripheral Magnetic Stimulation on Pain, Disability, and Quality of Life in Chronic Low Back Pain Patients

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(Received 21 December 2020, Received in final form 21 January 2021, Accepted 22 January 2021)

This study examined the effects of repetitive peripheral magnetic stimulation on pain, disability, and quality of life in chronic low back pain patients. Thirty subjects were randomly assigned to experimental and control groups, and rPMS was applied to the experimental group for 10 minutes per day, 5 times a week for a total of 4 weeks. The subject's was evaluated by a VAS test, KODI test, and SF-36 test. In the experimental group, significant decrease was observed in the VAS test and the KODI test after treatment ($p < .05$), and there was significant difference in the VAS test and the KODI test compared to the control group ($p < .05$). The results of this study suggest that rPMS applied effects the pain and disability in low back pain patients.

Keywords : repetitive peripheral magnetic stimulation, magnetic field, pain, disability, quality of life, chronic low back pain

1. Introduction

Low back pain is a symptom most commonly experienced by 70 % of people worldwide, and the number of people complaining of low back pain is increasing due to the industrial development of the modern society and the decrease in body activity [1]. Low back pain generally appears around the lower back and the sacrum, and radiating pain that progresses below the knee may occur due to stimulation of the nerve roots. In addition, low back pain leads to decreased muscle strength, endurance and flexibility, and sensory abnormalities, limiting body activity [2]. Most of these low back pains improved within 2 weeks, but 20 % of them were reported to persist and develop into chronic low back pain [3]. It has been reported that this chronic low back pain makes people feel uncomfortable in performing daily life and social activities, and leads to an increase in disability and a decrease in quality of life [4].

As such, in clinical practice, surgery treatment, medicine treatment, and physical therapy are used to treat chronic low back pain. Particularly, among physical therapy methods, Repetitive Magnetic Stimulation (rMS) is a method of periodically stimulating magnetic stimulation waves by repetition, and is effective in enhancing sensory function and motor function. rMS can be classified into Repetitive Transcranial Magnetic Stimulation (rTMS) and Repetitive Peripheral Magnetic Stimulation (rPMS). In general, rTMS has been reported to have the effect of treatment on stroke or depression patients through magnetic stimulation of cerebrum [5, 6]. In addition, rPMS has been reported to have a therapeutic effect in urinary system diseases such as urinary incontinence and prostate disease by strengthening the pelvic floor muscles [7].

Recently, research is being conducted on whether rPMS can be used as a non-invasive, safe and useful treatment method for chronic pain patients. According to previous studies, it was reported that rPMS treatment can directly stimulate the deeper structure non-invasively and is effective in pain control [8]. In addition, it has been reported that nerves can be stimulated without direct skin contact, no tissue damage caused by electricity, and less discomfort for patients [9]. However, according to previous studies, it was reported that the effect of rPMS treatment on musculoskeletal pain is uncertain [10]. In other words, research on the effect of rPMS treatment in musculoskeletal pain treatment is insufficient, and there is room for controversy. In addition, most of the previous studies have focused on the effect of rPMS treatment on the change of pain, and studies on the change of disability

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and quality of life due to pain are insufficient. Therefore, the purpose of this study is to investigate the effect on Pain, Disability, and Quality of Life by applying rPMS to chronic low back pain patents. We would like to present the evidence necessary for an efficient and objective treatment method for chronic pain control.

2. Materials and Methods

2.1. Participants

This study was conducted on 30 patients who visited the neurosurgery clinic in D city for 4 weeks and were diagnosed with chronic low back pain by a specialist. The specific criteria for selecting subjects are those who complain of low back pain for more than 3 months, and according to previous studies, those with less than 5 points in the Oswestry Disability Index reported that they rarely see the effect of treatment. A person with a score of 5 or higher in the Korean Oswestry Disability Index was selected [11]. Patients who are pregnant or lactating, patient who have implanted pacemakers or internal electrical devices, and suspected malignant tumors and thrombosis, were excluded. The purpose of the study and the details of the experiment were explained to the subjects, and their voluntary consent to participate was obtained. This research was approved by the Daegu University Bioethics Committee.

2.2. Study design

Thirty patients who met the selection criteria were randomly assigned 15 patients to the repetitive peripheral magnetic stimulation group (experimental group) and the general physical therapy group (control group). During the experiment, 13 subjects in the experimental group and 12 subjects in the control group completed the final experiment, excluding 5 patients with discontinued treatment. Evaluation to determine the treatment effect of all subjects was performed before and after treatment. In addition, all evaluations were conducted in a double-blind, randomized design that did not know any information about patients randomly assigned to two groups.

2.3. Intervention

In the experimental group, rPMS treatment was applied once a week for 10 minutes for 4 weeks. Neuro MSL magnetic stimulator (MR Inc., Korea) was used as the rPMS treatment device in this study (Fig. 1). Also round coil is more effective in stimulating the structure of deep layers such as spinal muscles, and in this study, a round coil was used. Stimulation site was determined based on patient's most trigger point. And the coil was placed at a flat tangential orientation targeting the most painful lumbar region in prone position. This is the orientation that enables the coil to be positioned parallel to the body surface, thereby maximizing effects of magnetic stimulation applied to the target area. This allows the coil to be

Neuro MSL magnetic stimulator

Fig. 1. Repetitive peripheral magnetic stimulation therapy device.

Montage of rPMS application

Fig. 2. Application of rPMS in the lumbar region to patients with chronic low back pain.

positioned parallel to the body surface, maximizing the effect of magnetic stimulation on the target area [12]. Each session lasted 10 minutes and entailed an intermittent stimulation protocol consisting of 5 seconds of stimulation at a frequency of 20 Hz followed by 2 seconds of resting. The total number of stimuli over 10 minutes amounted to 1,400 times [13]. The intensity of stimulation was performed at the intensity that the patient feels comfortable, and the intensity was gradually increased (Fig. 2). In the control group, general physical therapy was applied once a week for 10 minutes for 4 weeks. For general physical therapy, Interferential Current Therapy (ICT) was applied. In addition, heat therapy was applied for 20 minutes to relax the muscles before each treatment in both the experimental group and the control group. The treatment application both groups were conducted by experienced physical therapist.

2.4. Outcome measure

2.4.1. Visual Analogue Scale

Visual Analogue Scale (VAS) was used to determine the pain level of back pain. A 100 mm horizontal ruler is defined as a very comfortable state with no pain at the left end and extreme pain at the right end. This is a method to indicate the degree of subjective back pain that the subject feels. VAS is one of the most widely used methods for measuring the degree of pain in clinical practice, and is a useful evaluation tool for determining the treatment effect [14].

2.4.2. Korean Oswestry Disability Index

The Korean Oswestry Disability Index (KODI) was used to evaluate the degree of dysfunction due to back pain. KODI is a self-cognitive tool that is sensitive to changes in dysfunction and is a method widely used in the management of spinal diseases in clinical settings. The total score is 45 points, and the higher the score, the more severe the dysfunction due to back pain [15].

2.4.3. Short Form 36-items

Short Form 36-items (SF-36) were used to examine the change in quality of life. It is composed of items that evaluate physical health such as physical function, physical role limitation, physical pain, general health-physical composition and vitality, social function, emotional role limitation, mental health-mental composition such as mental health. It consists of 8 items and 36 questions, and you can choose from 2 to 6 points for each question. The higher score, the higher the quality of life.

2.5. Statistical analysis

A Shapiro-Wilk test was conducted to determine the normal distribution of each measurement item, and all items were normally distributed. The results of the experiments obtained in this study were described as mean ± standard deviation (Mean ± SD). An Independent Sample T-test was performed to examine the differences between groups for the general characteristics of the subjects. Paired T-test was performed to verify the difference before and after treatment within each group, and Independent Sample T-test was performed for comparison between groups. SPSS statistics version 22.0 was used for the data obtained in this study, and the statistical significance level was set to .05.

3. Results and Discussion

Table 1 summarizes the demographics and medical history of the subjects; there were no statistically significant differences between the two groups. The VAS scores and KODI scores showed significant differences after treatment in the experimental group ($p < .05$), but not in the control group ($p > .05$). After treatment, there was a significant difference in VAS score and KODI score between the experimental group and the control

Table 1. General characteristics of subjects.

	EG	CG
Sex (male/female)	3/10	4/8
Age	34.93 ± 11.51[a]	39 ± 13.11
Height (cm)	165.4 ± 7.62	166.4 ± 9.36
Weight (kg)	56.66 ± 11.36	63.66 ± 14.91

[a]Mean ± SD, EG: Repetitive Peripheral Magnetic Stimulation Group, CG: General Physical Therapy Group

Table 2. Comparison of change in variables in each group.

Variables	Group	Pre	Post	p
VAS	EG	4.8 ± 1.52[a]	2 ± 0.08	.002*
	CG	4.8 ± 1.26	4.2 ± 1.14	.070
	p	1.000	.000*	
KODI	EG	17.86 ± 6.25	9.93 ± 3.67	.001*
	CG	14.6 ± 5.57	14.2 ± 5.47	.288
	p	.142	.019*	
SF-36	EG	74.8 ± 6.65	75.06 ± 6.72	.307
	CG	75.73 ± 5.53	74.73 ± 6.92	.657
	p	.914	.665	

[a]Mean ± SD, *$p < .05$, EG: Repetitive Peripheral Magnetic Stimulation Group, CG: General Physical Therapy Group, VAS: Visual Analogue Scale, KODI: Korean Oswestry Disability Index, SF-36: Short Form 36-items

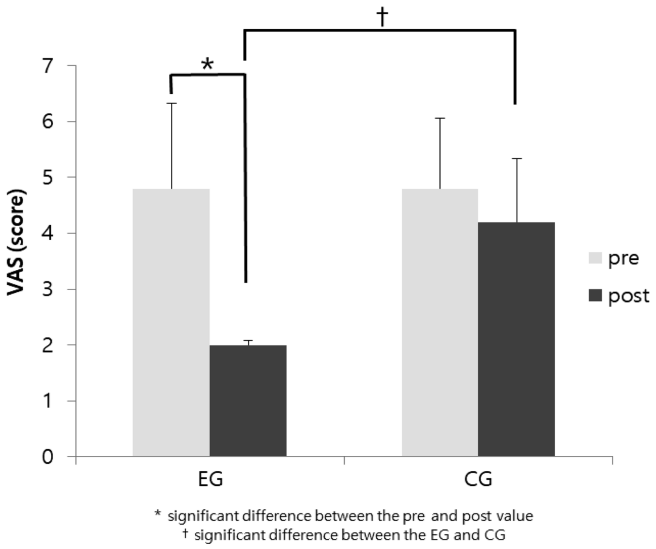

Fig. 3. Comparison of pre-value and post-value VAS between the groups.

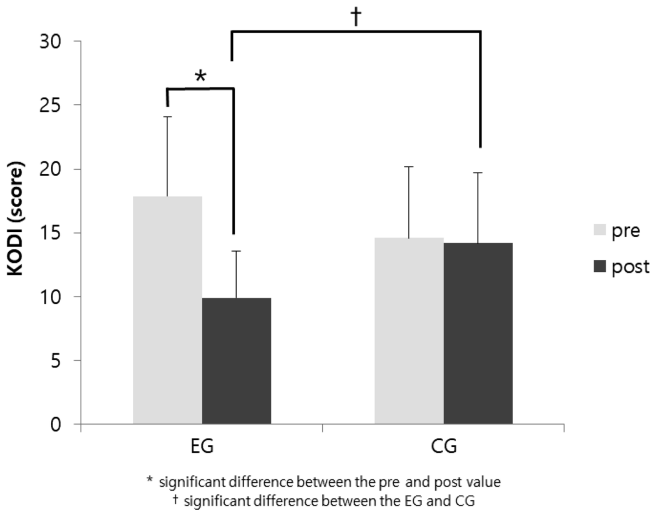

Fig. 4. Comparison of pre-value and post-value KODI between the groups.

group ($p < .05$) (Table 2). The results are shown in Fig. 3, 4. The SF-36 scores showed no significant differences after treatment in the both groups ($p > .05$). After treatment, there was no significant difference in SF-36 score between the experimental group and the control group ($p > .05$) (Table 2). The results are shown in Fig. 5.

The purpose of this study, for four weeks repetitive peripheral magnetic stimulation were conducted to decrease pain and disability, increase quality of life in chronic low back pain patients. Each variable was measured before, after treatment to evaluate the effects of repetitive peripheral magnetic stimulation on VAS, K-ODI, SF-36 test.

In this study, the VAS was significantly decreased in

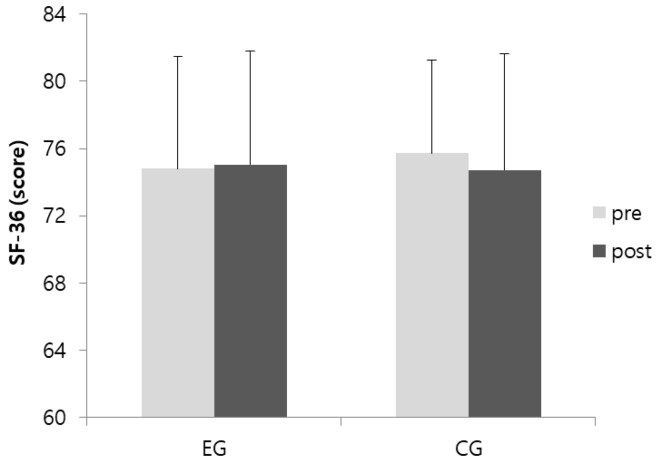

Fig. 5. Comparison of pre-value and post-value SF-36 between the groups.

experimental group, and the VAS was significantly decreased in the experimental group more than in the control group. According to previous studies, the results of rPMS treatment of lumbar Radiculopathy patients twice a day for 2 weeks were consistent with the reported results of a significant pain relief [16]. In addition, the results of rPMS treatment in patients with acute back pain were consistent with the results of the study showing that there was a decreased in the VAS scores [12]. This research result is considered to be the result of gate control theory. The electric field formed by magnetic stimulation can depolarize the large-diameter myelinated Aβ afferent fibers due to the high conduction rate, thereby inhibiting the depolarization of the relatively small diameter Aδ and C nerve fibers, blocking the transfer of pain signals to the brain [17]. Also, according to previous studies, magnetic stimulation was reported to decrease the expression of c-Fos protein, a pain factor [18]. In other words, it was confirmed that rPMS is effective in pain relief.

In this study, the K-ODI was significantly decreased in experimental group, and the K-ODI was significantly decreased in the experimental group more than in the control group. These results are thought to have led to a decrease in the oswestry disability index due to pain relief. According to previous studies, it was reported that low back pain and oswestry disability index are highly correlated [19]. In addition, it is believed that motor control was improved by brain plasticity, leading to an improvement in the oswestry disability index. rPMS activates muscles, proprioceptive afferents are generated through two pathways. This proprioceptive input into the brain causes cortical plasticity [20].

In this study, the SF-36 was no significantly differenced in the both groups, and the SF-36 was no significantly

differenced in the experimental group and control group. Previous studies did not agree with the results of studies that showed that rPMS was effective in improving the quality of life when applied to low back pain patients [21]. This study result is considered to be the result of the difference in treatment period and treatment time. In this study, the treatment time was shortened to 10 minutes by applying treatment to outpatients. In addition, because it had a short treatment period of 4 weeks, it was considered that there was a time limit to determine the effect of quality of life.

The limitations of this study are as follows. First, the dropout rate was higher than the number of subjects selected. This is believed to be the result of the discontinuation of treatment by conducting research on patients who are admitted to the outpatient clinic, not patients admitted to the hospital. In future studies, it is thought that it is necessary to select subjects in anticipation of a high dropout rate. Second, it is difficult to generalize the results of the study to all patients with chronic low back pain by selecting patients diagnosed with general chronic back pain as subjects. In future studies, it is considered necessary to classify specific causes and types of chronic back pain, and to find out the effect of treatment. Third, the duration of treatment was short. In future studies, it is considered necessary to study the effects of quality of life and activities of daily living in patients with low back pain by extending the duration of treatment.

4. Conclusion

To summarize the results of this study, it was found that rPMS are effective in relieving pain and dysfunction in patients with chronic low back pain. In addition, long-term rPMS treatment may be effective in recovering Qol or ADL in chronic low back pain patients. Through this study, rPMS can be suggested as an effective method for non-pharmaceutical and non-surgical treatment of chronic low back pain. In the future, research on pain treatment using magnetic fields is needed for patients with pain in various body areas.

Acknowledgement

This work was supported by the Sun Moon University Research Grant of 2020.

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