ORIGINAL ARTICLE

Short-Term Efficacy of Repetitive Peripheral Magnetic Stimulation for Chronic Low Back Pain: A Double-Blinded Randomized Control Trial

Tachit Jiravichitchai, MD, MSc[1], Chitkasem Khamket, MD[1], Peeraya Ruthiraphong, MD, MSc[1]

[1] Department of Rehabilitation Medicine, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

Objective: To evaluate the efficacy of repetitive peripheral magnetic stimulation (rPMS) in alleviating pain and enhancing functional recovery in patients with chronic low back pain.

Materials and Methods: The present study was a double-blinded randomized controlled trial conducted in 30 patients aged 18 to 60 years with chronic low back pain at the outpatient clinic of Department of Rehabilitation Medicine. Patients were randomly assigned to the rPMS group or the sham treatment group, receiving one session per week for three weeks. Visual analog scale (VAS) scores were assessed before treatment, after each session, and one-week post-treatment. The Roland-Morris Disability Questionnaire (RMDQ) and Oswestry Disability Index (ODI) were evaluated before and one week after treatment.

Results: Baseline characteristics and scores for VAS, RMDQ, and ODI, were comparable between groups. VAS scores improved significantly in both groups at one-week post-treatment, with the rPMS group showing better outcomes. The mean VAS score decreased in the rPMS group after the second and third sessions was 2.5 (SD 1.6) and 2.5 (SD 1.4), respectively. A linear mixed-effects model indicated a significant reduction in VAS scores by the third session. The median improvement in RMDQ was 3.0 (IQR 3.0) for the rPMS group versus 2.0 (IQR 2.0) for the sham group (p=0.030). ODI scores improved by 5.6 (SD 3.5) in the rPMS group compared to 2.4 (SD 1.8) in the sham group (p=0.048).

Conclusion: rPMS, combined with exercise and behavioral modifications, reduces pain and disability in chronic low back pain patients. However, the change in VAS scores did not exceed the minimal clinically important difference (MCID), suggesting limited clinical impact.

Keywords: Repetitive peripheral magnetic stimulation; Chronic low back pain; Rehabilitation; Disabilities

Received 28 August 2024 | Revised 16 October 2024 | Accepted 25 October 2024

J Med Assoc Thai 2024;107(11):894-901

Website: http://www.jmatonline.com

Low back pain is a condition characterized by pain in the area between the lower edge of the rib cage or costal margin, and the gluteal fold[1]. It is a very common issue across all age groups worldwide. According to a global study conducted in 195 countries in 2017, low back pain is one of the top three causes of years lived with disability[2]. In Thailand, data from the Ministry of Public Health in 2018 indicated that musculoskeletal and connective tissue diseases ranked fourth among the conditions leading to outpatient visits, with an incidence rate of 390.51 per 1,000 population[3]. High-risk factors for low back pain include occupations that require physical exertion, coexisting physical and mental health conditions, smoking, and obesity[4].

Low back pain can be categorized by the duration of symptoms. Chronic low back pain, where the pain persists for more than six months, is often due to non-specific causes in 85% of cases[5]. Other causes include lumbar spine degeneration, intervertebral disc disease, lumbar spine fractures, spinal infections, and cancer[6]. Chronic pain in the patients leads to impairments in sensorimotor control[7], such as delayed activation of core and deep back muscles and excessive activation of superficial back muscles. This can cause recurrent pain even after initial relief, as the underlying motor control issues persist, making the pain chronic[8]. Studies have shown that altered peripheral nervous system perception, such as joint proprioception[9] and increased pain threshold[10], can lead to changes in brain neuroplasticity. Therefore, treatments that stimulate appropriate neuronal control

Correspondence to:

Jiravichitchai T.

Department of Rehabilitation Medicine, Faculty of Medicine Ramathibodi Hospital, Mahidol University, 270 Rama VI Road, Thung Phaya Thai, Ratchathewi, Bangkok 10400, Thailand.

Phone: +66-91-5542626

Email: tachit.jir@mahidol.ac.th, mewtechi@gmail.com

How to cite this article:

Jiravichitchai T, Khamket C, Ruthiraphong P. Short-Term Efficacy of Repetitive Peripheral Magnetic Stimulation for Chronic Low Back Pain: A Double-Blinded Randomized Control Trial. J Med Assoc Thai 2024;107:894-901.

DOI: 10.35755/jmedassocthai.2024.11.894-901-01419

of muscles might enhance the effectiveness of chronic pain management in these patients.

Conservative treatments, such as back exercise aimed at improving motor control of back muscles, have been shown to reduce pain and improve motor control deficits. Studies have found these treatments to be effective during continuous exercise for eight weeks. However, follow-up after the cessation of exercise indicated that pain and disability persisted up to one year later[11].

Currently, repetitive peripheral magnetic stimulation (rPMS) is increasingly being used in rehabilitation medicine and physical therapy. It is considered a painless, non-invasive modality. One mechanism by which rPMS is believed to work involves the stimulation of the lumbar muscles over a wide area. This stimulation can enhance proprioceptive afferents and directly control muscle activation, as well as indirectly stimulate mechanoreceptors within muscle fibers[12]. Additionally, it is believed that peripheral magnetic waves can stimulate large nerve fibers, or A-beta afferent fibers, and inhibit the conduction of small nerve fibers, which are A-delta and C fibers, that transmit pain signals to the brain. This results in reduced pain and activates the descending inhibitory pathway of the central nervous system[13], without stimulating cutaneous sensory nerves, thereby avoiding additional pain during treatment[14]. Literature reviews have identified studies on the use of peripheral magnetic waves to reduce chronic low back pain[13,15-18], acute low back pain[19], and treat trigger points in myofascial pain syndrome[20,21].

The study by Lo et al.[13] in 2011 found that treating patients with lumbosacral spondylosis who had chronic low back pain using rPMS could reduce pain immediately from the first treatment session. However, this was a single study, not involving patients with chronic back pain from other causes and did not examine the effects on reducing disability. Similarly, the study by Przedborska et al.[18] in 2015 found that using rPMS once a day for ten consecutive days at a frequency of 3 to 30 Hz also reduced pain. It was hypothesized that the peripheral magnetic waves transmitted external signals to the brain, triggering the descending inhibitory pathway of the central nervous system, which significantly lowered the pain visual analog scale (VAS) scores post-treatment.

Masse-Alarie et al.'s study in 2013[16] investigated the effects of a single session of rPMS combined with specific motor training of the deep abdominal muscles in patients with chronic low back pain. The group receiving combined rPMS showed a tendency for greater pain reduction compared to the exercise-only group. Notably, the pain reduction was significant in patients with kinesiophobia, although this was a short-term study without follow-up on long-term effects. In 2017, Masse-Alarie et al.[17] studied the effects of three sessions of rPMS using a figure-8 coil of the multifidus muscle within one week in patients with chronic low back pain, combined with motor training program. The rPMS group showed better pain reduction and improved muscle strength compared to the exercise-only group. Additionally, changes in brain function related to muscle control were observed. The study using transcranial magnetic stimulation and needle electromyography also showed improved muscle activation and cortical excitability in the M1 area, demonstrating positive results.

However, the treatment protocols in each study varied in terms of the type of coil, intensity, and the number of stimulation sessions[17,18]. There is still no clear guideline for the use of peripheral magnetic stimulation devices. Therefore, the present study aimed to investigate the effects of treating chronic low back pain using rPMS combined with conservative treatments such as lower back exercises and appropriate behavior and posture adjustments. The goal is to support the hypothesis that peripheral magnetic stimulation can alleviate pain and reduce disability in patients with chronic low back pain.

The authors chose a round coil for the stimulation as it can reach deep muscles[22,23] and used stimulation over a broad area of the lower back at frequencies ranging from 3 to 30 Hz to enhance joint proprioception and control the function of both superficial and deep muscles. The authors believed that this stimulation method might reduce the number and frequency of treatment sessions needed, providing a guideline for treating patients with this issue.

Materials and Methods

The present study was a randomized, double-blind, controlled trial investigating treatment methods. The study population included patients with chronic low back pain treated at the outpatient clinic of Department of Rehabilitation Medicine, as well as other interested patients with chronic low back pain, between July 2021 and August 2022. Regarding the eligibility criteria, patients aged 18 to 60 years with chronic low back pain for more than six months, having a VAS score of 4 or higher, and given written informed consent to participate in the

present research were included. Patients with non-mechanical low back pain due to malignant or benign tumors, inflammatory arthritis, infection, lumbar spine fractures, low back pain requiring surgical intervention, a history of lumbar spine surgery or epidural steroid injections, previous treatment with rPMS, contraindications to the use of peripheral magnetic stimulation, cancer, inability to read and/or write the questionnaire, and inability to follow up on treatment outcomes were excluded.

The sample size was initially calculated based on a clinically significant difference in VAS pain scores of 2 points, with an alpha of 0.05 and power of 0.8. This resulted in a minimum of 13 participants per group, increased to 15 per group to account for a 10% attrition rate. Therefore, 30 participants were invited into the study.

Upon review, using VAS scores from Lo et al.[13], the required sample size for immediate post-treatment scores would have been seven per group, while the four-day post-treatment scores indicated a much larger requirement of 151 per group. As the present study was intended as a pilot, the smaller sample size limited the power to detect certain effects. However, the findings provided valuable preliminary data for future research with larger cohorts.

The study was approved by the Ramathibodi Human Research Ethics Committee (COA. MURA2020/1174) and was publicly registered in the Thai Clinical Trials Registry (TCTR), an online register of clinical research established in Thailand since 2009 (http://www.thaiclinicaltrials.org; ID: TCTR20210531004).

The equipment used included the Salus Talent® Pro-Electro-Magnetic stimulator by REMED Co., Ltd., with a round coil, a basic information recording form, a VAS pain score recording form[24], which was a 100-millimeter straight line without visible numbers, with the left end labeled "no pain at all" and the right end labeled "pain as bad as it could be", where patients marked their pain level, and the evaluator measured the pain score with a ruler, the Thai version of the Roland-Morris Disability Questionnaire (RMDQ)[25] consisting of 24 items for assessing disability in back pain patients, the Thai version of the Oswestry Disability Index (ODI)[26] consisting of 10 sections, and guidelines for behavioral adjustment, exercise examples, and a logbook for recording exercises and additional pain medications used.

The present study divided the participants into two groups, a magnetic stimulation group and a sham group, using sealed envelopes for randomization. Nurses not involved in the study were responsible for the randomization process. The sealed envelopes were prepared by generating a confidential randomization list and numbering each envelope sequentially to correspond with this list. The treatment allocation information was inserted inside each envelope, sealed securely, and ensured that the contents were not visible from the outside. Basic data collected included age, gender, weight, height, body mass index, medical history, medications taken, and duration of pain. Physical examinations assessed muscle strength and pain perception in both legs. Pain and disability scores were assessed using the VAS, RMDQ, and ODI. Both participants and researchers assessing outcomes were blinded to group allocation to maintain the integrity of the double-blind design.

In the magnetic stimulation group, participants received rPMS with a round coil applied broadly to the lower back to stimulate proprioception and muscle control in a prone position. The frequency was set between 3 to 30 Hz, and the intensity started at 20% of the maximal stimulator output, increasing by 5% increments until participants felt sensations without pain, thus the subthreshold, for 10 minutes. This was followed by stimulating the painful trigger points at 30 Hz, starting at 2% intensity, increasing to subthreshold, delivering pulses for one second with 3-second breaks for five minutes. The sham magnetic stimulation group used the same device but with low intensity, at 5%, and magnetic pulses emitted from the other coil that was not placed on the patient's body. Both groups received three rPMS sessions, once a week. Participants in both groups were informed about the use and potential side effects of rPMS.

Conservative treatment for both groups included education on chronic back pain, risk factors, treatment methods, behavioral modification advice, and home exercise instructions. Exercise examples included four exercises, knee-to-chest exercise, posterior pelvic tilt and deep abdominal muscle exercise, semi-sit up exercise, and hip flexor stretching, performed 10 times per set, twice daily, with participants recording their exercises in a logbook to monitor consistency. Pain severity was assessed using the VAS before and after the first, second, and third treatments, and one week after the final treatment. The RMDQ and ODI were assessed before treatment and one week after the final treatment. The data were then statistically analyzed to compare the differences in measured variables between the magnetic stimulation and the sham groups.

Statistical analysis was conducted using PASW Statistics, version 18.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to analyze the baseline data of both groups, including age, gender, body mass index, duration of symptoms, and VAS, RMDQ, and ODI scores before treatment. The differences in VAS and ODI scores before and after treatment within each group were compared using the Paired T test, and between groups using the independent t-test. Differences in RMDQ scores before and after treatment within each group were analyzed using the Wilcoxon signed-rank test, and between groups using the Mann-Whitney U test. Statistical significance was set at p-value less than 0.05. Additionally, a linear mixed-effects model was used to analyze the data, with time and treatment group as fixed effects and subject as a random effect, to account for repeated measures and individual variability. This approach was an extension of the traditional repeated measures ANOVA, allowing for more complex data structures.

Results

Patients with chronic low back pain treated at the outpatient clinic of the authors' department, and those interested in participating were screened according to the eligibility criteria, resulting in 30 individuals. They were divided into two groups, with 15 patients in each group, using the sealed envelope method. These groups consisted of the peripheral magnetic stimulation group and the sham group, receiving treatment with either genuine or sham peripheral magnetic stimulation (see Figure 1).

The participants in the peripheral magnetic stimulation and sham groups had mean ages (standard deviation, SD) of 43.7 (8.0) and 45.5 (10.1) years, respectively. Their body mass indices were 29.4 (4.9) and 27.1 (4.1) kg/m², respectively. The duration of their pain symptoms was 23.7 (14.5) and 21.6 (7.5) months, respectively. When comparing baseline data, including VAS, RMDQ, and ODI scores before the study, no statistically significant differences were found between the two groups (Table 1).

Comparing VAS scores before treatment and one week after treatment, the mean scores were 6.2 (1.0) and 4.0 (1.0) in the peripheral magnetic stimulation group, and 5.6 (0.8) and 4.5 (1.0) in the sham group. VAS scores within each group decreased significantly compared to before treatment (p=0.001) (see Figure 2). When comparing the difference in VAS scores (ΔVAS) before treatment with those after the first, second, third treatment sessions, and after

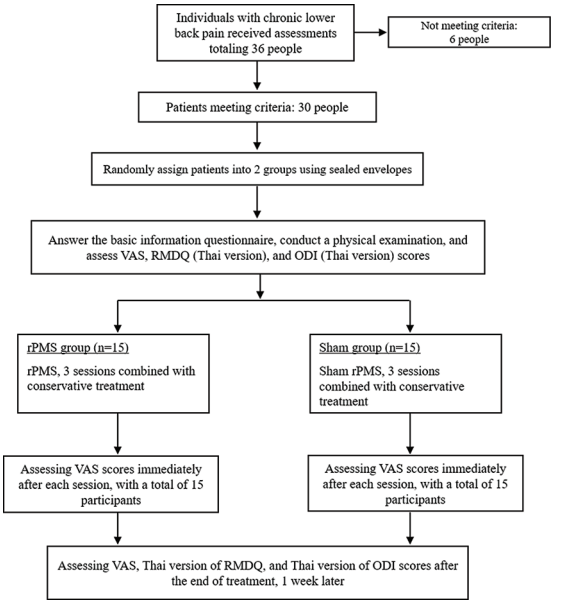

Figure 1. The study process.

Table 1. A comparison of basic data between the rPMS and the sham group

	rPMS group	Sham group	p-value
Female; n (%)	7 (46.7)	10 (66.7)	0.269
Age (years); mean (SD)	43.7 (8.0)	45.5 (10.1)	0.579
Body mass index (kg/m^2); mean (SD)	29.4 (4.9)	27.1 (4.1)	0.184
Pain duration (months); mean (SD)	23.7 (14.5)	21.6 (7.5)	0.625
VAS score#; mean (SD)	6.2 (1.0)	5.6 (0.8)	0.089
RMDQ score; median [IQR]	8.0 [6.0]	9 [11.0]	1.000
ODI score; mean (SD)	15.9 (5.7)	14.6 (4.9)	0.521

rPMS=repetitive peripheral magnetic stimulation; VAS=visual analog scale; RMDQ=Roland-Morris Disability Questionnaire; ODI=Oswestry Disability Index; SD=standard deviation; IQR=interquartile range
# 0=no pain, 10=worst pain imaginable

the end of treatment at one week, the mean values were 1.5 (0.8), 2.5 (1.6), 2.5 (1.4), and 2.2 (1.0), respectively, in the peripheral magnetic stimulation group, and 0.8 (0.8), 1.0 (0.9), 1.2 (0.6), and 1.2 (0.6), respectively, in the sham group, showing statistically significant differences at p=0.005, 0.003, 0.005, and 0.001, respectively. The greatest reduction in VAS scores was observed after the second and third treatment sessions in the peripheral magnetic stimulation group (Table 2).

In the present study, 60% of participants in the rPMS group achieved a clinically meaningful improvement in VAS scores, exceeding the minimal clinically important difference (MCID), compared to 20% in the Sham group. Although the rPMS group demonstrated a higher proportion of improvement,

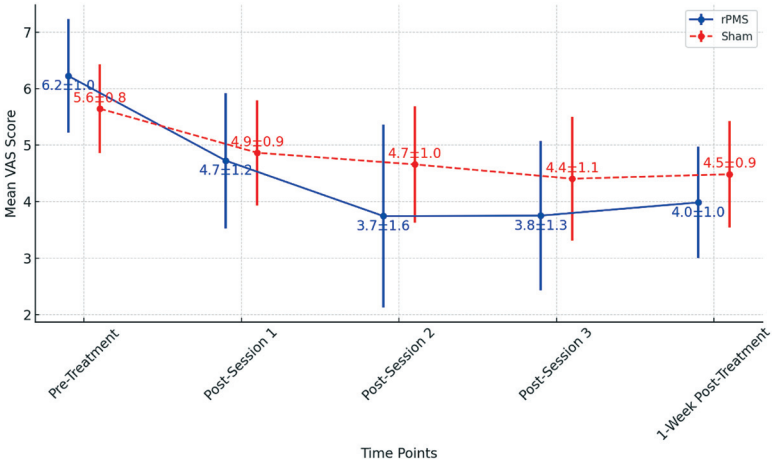

Figure 2. VAS scores before treatment, after each session of rPMS, and one week post-treatment.

rPMS: repetitive peripheral magnetic stimulation

Table 2. Comparison of changes in VAS (ΔVAS), RMDQ (ΔRMDQ), and ODI (ΔODI) scores from baseline between the rPMS and Sham groups

		rPMS group	Sham group	p-value	95% CI
ΔVAS#; mean (SD)	Post 1st treatment	1.5 (0.8)	0.8 (0.8)	0.005	0.10 to 1.30
	Post 2nd treatment	2.5 (1.6)	1.0 (0.9)	0.003	0.53 to 2.47
	Post 3rd treatment	2.5 (1.4)	1.2 (0.6)	0.005	0.49 to 2.11
	1 week after all treatment	2.2 (1.0)	1.2 (0.6)	0.001	0.38 to 1.62
ΔRMDQ; median [IQR]	1 week after all treatment	3.0 [3.0]	2.0 [2.0]	0.030	–0.91 to 2.91
ΔODI; mean (SD)	1 week after all treatment	5.6 (3.5)	2.4 (1.8)	0.048	1.12 to 5.28

rPMS=repetitive peripheral magnetic stimulation; VAS=visual analog scale; RMDQ=Roland-Morris Disability Questionnaire; ODI=Oswestry Disability Index; CI=confidence interval; SD=standard deviation; IQR=interquartile range

ΔDifference; # 0=no pain, 10=worst pain imaginable

the difference between the two groups did not reach statistical significance (p=0.062).

The analysis of VAS scores using a linear mixed-effects model revealed that the baseline VAS score, prior to any treatment, was estimated to be 5.647. Over time, VAS scores demonstrated a decreasing trend, with a non-significant reduction of –0.427 at the second time point compared to baseline (p=0.142), and a significant decrease of –0.900 by the third time point (p=0.005). When comparing the treatment groups, the rPMS group exhibited a non-significant overall increase in VAS scores by 0.580 compared to the sham group (p=0.078). However, the interaction effects showed that the change in VAS scores from the first to the second session was slightly more pronounced in the rPMS group, with a decrease of –0.593, although this was not statistically significant (p=0.149). Notably, the interaction effect between the treatment group and the change in VAS scores from the first to the third session was marginally significant, with the rPMS group experiencing a larger decrease in VAS scores by –0.833 compared to the sham group (p=0.064).

The median [interquartile range, IQR] differences before and after treatment at one week for RMDQ were 3.0 [3] and 2.0 [2] points, respectively, in both the peripheral magnetic stimulation group and the sham group. The mean differences in ODI scores before and after treatment were 5.6 (3.5) and 2.4 (1.8) points, respectively, in both groups. When comparing between the two groups, significant differences were found in both RMDQ and ODI at p=0.030 and 0.048, respectively (Table 2).

Side effects noted in the present study included patients in the peripheral magnetic stimulation group experiencing a thick numb sensation in the lower back area after completing the second treatment session for five minutes, with the sensation persisting for three minutes and disappearing without further treatment.

Discussion

The present study aimed to investigate the

efficacy of treating chronic low back pain using peripheral magnetic stimulation combined with conservative treatment as lower back exercises and appropriate behavioral and postural adjustments, compared to a group receiving sham peripheral magnetic stimulation alongside conservative treatment, supporting the hypothesis that peripheral magnetic stimulation helps alleviate pain and reduce disability in patients with chronic low back pain.

The present study utilized stimulation over the lower back area covering a wide region with frequencies ranging from 3 to 30 Hz and adjusted intensity to a subthreshold level, followed by specific point stimulation at the site of clear pain using a frequency of 30 Hz to reduce pain through the mechanism of inhibiting pain sensation from the central nervous system, descending inhibitory pathway, and muscle relaxation[27]. Immediate pain reduction was observed after the first stimulation session. Patients in the peripheral magnetic stimulation group had significantly decreased VAS pain scores compared to the sham group, along with improved movement after treatment, which aligns with previous studies[13,16].

Furthermore, when administered weekly for three consecutive sessions, there was an average VAS pain score reduction of 2.5 points, exceeding the MCID of 2 points established by Ostelo & de Vet in 2005[28], consistent with previous studies by Massé-Alarie et al.[17] using a figure-8 coil peripheral magnetic stimulation device with a frequency of 20 Hz and intensity of 35% to 40% of maximum intensity for 20 minutes per session, administered three times per week. However, the present study employed lower frequencies, once per week for a total of three weeks, and still found efficacy in reducing pain even at one week after treatment.

The analysis of VAS scores using a linear mixed-effects model also provided insight into the effects of rPMS on pain reduction over time compared to a sham treatment. The results suggest a trend toward greater pain reduction in the rPMS group compared to the sham group, particularly by the third treatment session. Although the overall group effect was not statistically significant, the marginal significance of the interaction between time and treatment group highlights the potential of rPMS to achieve more substantial pain relief over time. The significant decrease in VAS scores by the third session indicates that both groups experienced a reduction in pain, but the rPMS group may have benefitted slightly more, especially toward the later sessions. This finding aligns with previous research suggesting that rPMS can be an effective adjunct to conservative treatment for chronic low back pain.

The present study found significant reductions in disability or muscle function impairment, as indicated by RMDQ and ODI scores, before and after treatment for one week in the peripheral magnetic stimulation group compared to the sham group. The changes in RMDQ and ODI scores in the peripheral magnetic stimulation group in the present study, compared before and after treatment, had mean values of 3.0 and 5.6, respectively, which were clinically significant and exceeded the MCID of RMDQ and ODI, which were 2.5 and 4 points, respectively[29,30]. The reduction in disability was consistent with improved muscle function, aligning with the study by Massé-Alarie et al[17].

Nevertheless, regarding Table 2, the between-group differences in VAS after all treatments, which was ranging from 0.7 to 1.5, did not exceed the MCID of 2, indicating that these changes are not clinically meaningful. Similarly, the difference in RMDQ (1.0) was below the MCID of 2.5, suggesting no significant clinical impact. For ODI, the difference of 3.2 approached but did not exceed the MCID of 4, indicating a borderline clinical relevance. Therefore, while differences were statistically significant, they did not meet the threshold for clinical significance.

The mechanism of peripheral magnetic stimulation, which can reduce pain and improve muscle function in the back, is believed to occur through various mechanisms. Firstly, it stimulates joint perception, enhancing muscle control[12]. Secondly, it inhibits pain sensation from the central nervous system using the descending inhibitory pathway[13]. Thirdly, it alters cortical brain activity, reducing signals in the M1 area but still allowing effective muscle control[17]. This aligns with the reduced disability scores (RMDQ and ODI) in the present study. Part of the reason for this improvement may be that patients with chronic pain often have problems with both sensory perception and movement control, as well as abnormal cortical command, leading to less effective exercise outcomes than expected. Peripheral magnetic stimulation can enhance the effectiveness of exercise, allowing patients to perform daily activities better and follow exercise recommendations more effectively.

The key difference in the present study is the ability to reduce the frequency and number of treatments compared to the previous studies[17,18] with peripheral magnetic stimulation. Patients received

peripheral magnetic stimulation for 15 minutes per session, once a week, consecutively for three weeks, totaling three sessions. The ability to reduce the frequency of stimulation in the present study while still yielding positive results may be partly due to the type of coil used, which was a round coil. The round coil can stimulate muscles more widely and deeply than the figure-8 coil because it can emit magnetic waves deeper and wider[22,23]. Further studies are needed in the future regarding long-term effects and cost-effectiveness compared to other physical therapy tools for reducing various types of pain, including the recurrence rate of pain due to poor muscle function, which is a significant problem in patients with chronic pain.

Regarding side effects of peripheral magnetic stimulation in the present study, one participant experienced transient back numbness, which resolved spontaneously without additional treatment. This is consistent with previous studies on peripheral magnetic stimulation, where all participants were able to tolerate magnetic stimulation for the prescribed duration without experiencing significant side effects, indicating that peripheral magnetic stimulation is a tool that does not induce pain during treatment and has minimal side effects.

Future studies should consider a more personalized therapy approach, considering individual biopsychosocial characteristics. For example, age-related differences may influence treatment responses, potentially leading to better outcomes in younger patients compared to older individuals. Additionally, controlling for confounding factors such as medication use, physical activity, and psychological aspects like kinesiophobia would provide a more nuanced analysis. Subgrouping participants based on prior exercise experience and the underlying cause of chronic back pain is recommended. Furthermore, investigating long-term treatment effectiveness and utilizing objective measures like electromyography would strengthen the findings. To address ethical concerns, it is important that participants in the sham group with baseline VAS scores above 6 receive a more suitable intervention or placebo treatment.

From the results of the present study, peripheral magnetic stimulation with reduced frequency and duration of treatment, combined with exercise and behavioral modifications, significantly reduces pain and disability in patients with chronic lower back pain. However, it is important to note that while the reduction in pain was statistically significant, the difference in VAS scores between the rPMS and Sham groups did not exceed the MCID. This suggests that the clinical impact of the intervention, particularly in terms of pain relief, may be limited. Further studies are needed to explore the long-term clinical relevance of peripheral magnetic stimulation as a treatment option for chronic lower back pain when combined with exercise and behavioral modifications.

What is already known on this topic?

Chronic low back pain is a prevalent condition that significantly impairs quality of life. Conservative treatments like motor control exercises are effective, but their benefits often diminish after cessation. rPMS has shown promise in reducing pain and improving motor control by stimulating proprioception and inhibiting pain pathways, yet there is no standardized protocol for its use in clinical practice.

What does this study add?

This study demonstrates that rPMS, when combined with conservative treatments such as exercise and behavioral modifications, effectively reduces pain and disability in chronic low back pain patients, even with reduced treatment frequency. The use of a round coil was found to enhance muscle control and reduce pain more effectively than sham treatments, providing a potential guideline for integrating rPMS into chronic low back pain management.

Authors' contributions

TJ participated in research design and protocol development. CK and TJ researched the literature and conceived the study. CK participated in the patient recruitment process. CK and TJ participated in data screening, extraction, and analysis. CK wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the last version.

Conflicts of interest

The authors declare no conflict of interest.

References

1. Barr KP, Concannon LG, Harrast MA. Low back pain. In: Braddom RL, editor. Physical medicine & rehabilitation. 5th ed. Philadelphia: Saunders; 2016. p. 711-46.
2. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic

analysis for the Global Burden of Disease Study 2017. Lancet 2018;392:1789-858.
3. Summary report of illnesses in the year 2018 [Internet]. Digital Health Group, Strategy and Planning Division, Office of the Permanent Secretary, Ministry of Public Health of Thailand; 2019 [cited 2024 Aug 16]. Availabel from: https://spd.moph.go.th/wp-content/uploads/2023/04/ill_2561_full_19Nov19.pdf.
4. Borenstein DG. Epidemiology, etiology, diagnostic evaluation, and treatment of low back pain. Curr Opin Rheumatol 2001;13:128-3.
5. Negrini S, Zaina F, Romano M, Atanasio S, Fusco C, Trevisan C. Rehabilitation of lumbar spine disorders: An evidence-based clinical practice approach. In: Frontera WR, Delisa JA, Gans BM, Walsh NE, Robinson LR, editors. Delisa's physical medicine & rehabilitation: Principles and practice. Philadelphia: Lippincott Williams & Wilkins; 2010. p. 837-82.
6. Indahl A. Low back pain: diagnosis, treatment, and prognosis. Scand J Rheumatol 2004;33:199-209.
7. Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis. Spine (Phila Pa 1976) 1996;21:2640-50.
8. van Dieën JH, Selen LP, Cholewicki J. Trunk muscle activation in low-back pain patients, an analysis of the literature. J Electromyogr Kinesiol 2003;13:333-51.
9. Brumagne S, Lysens R, Swinnen S, Verschueren S. Effect of paraspinal muscle vibration on position sense of the lumbosacral spine. Spine (Phila Pa 1976) 1999;24:1328-31.
10. Peters ML, Schmidt AJM, Van den Hout MA. Chronic low back pain and the reaction to repeated acute pain stimulation. Pain 1989;39:69-76.
11. Macedo LG, Latimer J, Maher CG, Hodges PW, McAuley JH, Nicholas MK, et al. Effect of motor control exercises versus graded activity in patients with chronic nonspecific low back pain: a randomized controlled trial. Phys Ther 2012;92:363-77.
12. Beaulieu LD, Schneider C. Effects of repetitive peripheral magnetic stimulation on normal or impaired motor control. A review. Neurophysiol Clin 2013;43:251-60.
13. Lo YL, Fook-Chong S, Huerto AP, George JM. A randomized, placebo-controlled trial of repetitive spinal magnetic stimulation in lumbosacral spondylotic pain. Pain Med 2011;12:1041-5.
14. Zhu Y, Starr A. Magnetic stimulation of muscle evokes cerebral potentials. Muscle Nerve 1991;14:721-32.
15. Kim J, Yoon SH, Rah UW, Cho KH, Hong J. Effect of repetitive magnetic stimulation and transcutaneous electrical nerve stimulation in chronic low back pain: A pilot study. J Korean Acad Rehabil Med 2010;34:725-9.
16. Massé-Alarie H, Flamand VH, Moffet H, Schneider C. Peripheral neurostimulation and specific motor training of deep abdominal muscles improve posturomotor control in chronic low back pain. Clin J Pain 2013;29:814-23.
17. Massé-Alarie H, Beaulieu LD, Preuss R, Schneider C. Repetitive peripheral magnetic neurostimulation of multifidus muscles combined with motor training influences spine motor control and chronic low back pain. Clin Neurophysiol 2017;128:442-53.
18. Przedborska A, Misztal M, Raczkowski JW. Assessment of the therapeutic effectiveness of deep electromagnetic stimulation in patients with chronic low back pain. Ortop Traumatol Rehabil 2015;17:531-41.
19. Lim YH, Song JM, Choi EH, Lee JW. Effects of repetitive peripheral magnetic stimulation on patients with acute low back pain: A pilot study. Ann Rehabil Med 2018;42:229-38.
20. Smania N, Corato E, Fiaschi A, Pietropoli P, Aglioti SM, Tinazzi M. Therapeutic effects of peripheral repetitive magnetic stimulation on myofascial pain syndrome. Clin Neurophysiol 2003;114:350-8.
21. Smania N, Corato E, Fiaschi A, Pietropoli P, Aglioti SM, Tinazzi M. Repetitive magnetic stimulation: a novel therapeutic approach for myofascial pain syndrome. J Neurol 2005;252:307-14.
22. Kanjanapanang N, Chang KV. Peripheral magnetic stimulation. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2022 [cited 2024 Aug 16]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK526087/.
23. Beaulieu LD, Schneider C. Repetitive peripheral magnetic stimulation to reduce pain or improve sensorimotor impairments: A literature review on parameters of application and afferents recruitment. Neurophysiol Clin 2015;45:223-37.
24. Haefeli M, Elfering A. Pain assessment. Eur Spine J 2006;15 Suppl 1:S17-24.
25. Jirarattanaphochai K, Jung S, Sumananont C, Saengnipanthkul S. Reliability of the Roland - Morris Disability Questionnaire (Thai version) for the evaluation of low back pain patients. J Med Assoc Thai 2005;88:407-11.
26. Sae-jung S, Hunzavong T, Jirarattanapochai K. Reliability of Thai version of oswestry quesionairre for the evaluation of low back pain patients. Srinagarind Med J 2002;17:247-53.
27. Tammasse J, Lawing NT, Muis A, Basri MI, Bintang AK. The effect of repetitive peripheral magnetic stimulation on insomnia improving and pain in patients with chronic low back pain. Medicina Clínica Práctica 2021;4:100211.
28. Ostelo RW, de Vet HC. Clinically important outcomes in low back pain. Best Pract Res Clin Rheumatol 2005;19:593-607.
29. Roland M, Fairbank J. The Roland-Morris Disability Questionnaire and the Oswestry Disability Questionnaire. Spine (Phila Pa 1976) 2000;25:3115-24.
30. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine (Phila Pa 1976) 2000;25:2940-52.