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Comparison of the Effect of Treatment Between Low-Frequency Currents and Medium-Frequency Currents in Low Back Pain Patients

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Abstract

Background: Low back pain (LBP) is one of the most common musculoskeletal disorders, significantly affecting individuals' daily activities, work productivity, and overall quality of life. Electrical stimulation therapies, including Low-Frequency Electrical Stimulation (LFES) and Medium-Frequency Electrical Stimulation (MFES), are widely used for pain management and functional rehabilitation. However, limited research has directly compared the efficacy of these two modalities.

Objective: This study aims to evaluate and compare the effectiveness of LFES and MFES in reducing pain intensity, improving functional outcomes, and enhancing patient satisfaction in individuals with chronic LBP.

Methods: A randomized controlled trial was conducted on 30 patients diagnosed with chronic LBP. Participants were randomly assigned to either the LFES or MFES group. Pain intensity was assessed using the Visual Analog Scale (VAS), functional impairment was measured with the Oswestry Disability Index (ODI), and patient satisfaction was recorded through a structured questionnaire. Statistical analysis included independent t-tests and effect size calculations.

Results: Both LFES and MFES led to significant improvements in pain intensity and functional capacity. However, the MFES group demonstrated greater pain reduction ($p < 0.0001$) and superior functional improvement ($p = 0.00179$) compared to the LFES group. Patient satisfaction scores were similar between both groups, indicating that both treatments were well-tolerated.

Conclusion: MFES was found to be more effective than LFES in reducing pain and improving physical function among individuals with chronic LBP. These findings suggest that MFES could be considered a preferred electrical stimulation modality for LBP management. Future studies with larger sample sizes and long-term follow-up are recommended to validate these results.

Keywords: Low back pain, electrical stimulation, low-frequency currents, medium-frequency currents, pain management, functional improvement.

Introduction

Low back pain (LBP) is a significant global health concern and a leading cause of disability, affecting millions of individuals and imposing a substantial burden on healthcare systems worldwide[1]. Studies suggest that approximately 80% of adults experience LBP at some point in their lives, with many progressing to chronic conditions that impair daily activities and quality of life[2]. The economic burden of LBP is substantial, including direct healthcare costs, lost productivity, and disability-related expenses[3].

The etiology of LBP is multifactorial, involving biomechanical, degenerative, and neuromuscular factors. Common causes include intervertebral disc degeneration, muscular imbalances, poor posture, obesity, and occupational strain[4,5]. While pharmacological interventions such as nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids are commonly used for pain relief, their long-term efficacy is questionable due to side effects and the risk of dependence[6]. Consequently, non-pharmacological approaches, including physical therapy, exercise, and electrophysical modalities, have gained prominence in LBP management[7,8].

Among the non-invasive interventions, electrical stimulation techniques such as Low-Frequency Electrical Stimulation (LFES) and Medium-Frequency Electrical Stimulation (MFES) have been widely studied for their potential in pain modulation and neuromuscular activation[9,10]. LFES, operating below 1,000 Hz, primarily targets sensory nerves to alleviate pain via the gate control theory, whereas MFES, operating between 1,000 and 10,000 Hz, penetrates deeper tissues, facilitating enhanced motor unit activation and functional recovery[11,12].

MFES has demonstrated superior outcomes in improving muscle function, circulation, and proprioception, making it an essential tool in the rehabilitation of neuromuscular impairments[13]. Studies have shown that MFES is more effective than LFES in reducing pain, preventing muscle atrophy, and enhancing functional mobility in chronic LBP patients[14]. Furthermore, MFES has been integrated into rehabilitation protocols for post-surgical recovery, neurological conditions, and sports injuries[15,16].

Despite the promising potential of electrical stimulation, variations in treatment parameters, patient demographics, and study methodologies contribute to inconsistencies in research findings[17]. Therefore, this study aims to evaluate and compare the effectiveness of LFES and MFES in reducing pain intensity, improving functional mobility, and enhancing patient satisfaction in individuals with chronic LBP. By conducting a controlled clinical

trial, this research seeks to provide evidence-based recommendations for optimizing electrical stimulation therapy in LBP rehabilitation.

The primary aim of this study is to compare the effectiveness of LFES and MFES in managing chronic LBP. Specifically, it seeks to evaluate the extent to which each modality reduces pain intensity, improves functional outcomes, and enhances patient satisfaction. By conducting a randomized controlled trial, this research will provide valuable insights into the comparative benefits of these two electrical stimulation techniques.

The objectives of this study include evaluating the efficacy of LFES in reducing pain intensity and improving functional capacity, assessing the impact of MFES on pain relief and function, and comparing the overall effectiveness of both modalities. Understanding these effects will help clinicians make informed choices when selecting appropriate treatment protocols for LBP patients.

This study is based on the hypothesis that MFES is more effective than LFES in reducing pain, improving function, and enhancing patient satisfaction. The null hypothesis states that there is no significant difference between the two modalities in terms of their impact on pain intensity, functional impairment, or patient satisfaction. By testing these hypotheses, this study aims to provide clinically relevant data that can guide the use of electrical stimulation in LBP management.

Methods

This study was designed as a randomized controlled trial (RCT) to compare the effects of Low-Frequency Electrical Stimulation (LFES) and Medium-Frequency Electrical Stimulation (MFES) in patients with chronic low back pain (LBP). Ethical approval was obtained from the institutional review board before participant recruitment.

A total of 30 participants diagnosed with chronic LBP were recruited from a physiotherapy clinic specializing in musculoskeletal rehabilitation. Participants were selected based on predefined inclusion and exclusion criteria. The inclusion criteria included individuals aged between 18 and 35 years, with a history of chronic LBP persisting for more than 12 weeks and an NPRS (Numeric Pain Rating Scale) score of 4 or higher. Exclusion criteria included individuals with neurological deficits, prior spinal surgeries within the past six months, pregnancy, and any contraindications to electrical stimulation therapy.

Eligible participants were randomly assigned to one of two treatment groups using a simple randomization technique (lottery method). The LFES group received low-frequency electrical stimulation (1–10 Hz) for 20 minutes per session, three times a week for three weeks. The MFES group received medium-frequency electrical stimulation (1,000–10,000 Hz) under the same treatment protocol. Both treatments were administered by a licensed physiotherapist using standard electrode placements and intensities adjusted according to patient tolerance.

The outcome measures used in this study included pain intensity, functional impairment, and patient satisfaction. Pain intensity was assessed using the Visual Analog Scale (VAS), which ranges from 0 (no pain) to 10 (worst pain imaginable). Functional impairment was evaluated using the Oswestry Disability Index (ODI), a validated tool for assessing the degree of disability related to LBP. Patient satisfaction was measured using a structured satisfaction questionnaire, which included questions on perceived pain relief, comfort, and overall treatment experience.

Baseline data were collected before the intervention, and follow-up assessments were conducted immediately after the three-week intervention period. This methodology ensures that the study is scientifically sound, with rigorous patient selection, controlled interventions, and appropriate procedures to determine the comparative effectiveness of LFES and MFES in managing chronic LBP.

Statistical analysis

Data collected from the study were analyzed using IBM SPSS Statistics (Version 25) to ensure accurate and reliable results. Descriptive statistics were used to summarize demographic characteristics, including age, gender, and baseline pain intensity.

To assess the effectiveness of LFES and MFES, paired t-tests were used to compare pre-treatment and post-treatment values within each group for pain intensity (VAS) and functional disability (ODI). The differences between the two treatment groups were analyzed using independent t-tests to determine the statistical significance of pain reduction, functional improvement, and patient satisfaction scores.

A p-value of <0.05 was considered statistically significant for all analyses, indicating a meaningful difference between the two treatments. Additionally, effect size calculations (Cohen's d) were performed to measure the magnitude of the treatment effect, providing further insight into the clinical significance of LFES and MFES.

Data were checked for normality using the Shapiro-Wilk test, and homogeneity of variance was assessed using Levene's test to ensure the appropriateness of parametric tests. In cases where assumptions of normality were violated, non-parametric tests (Mann-Whitney U test and Wilcoxon signed-rank test) were used for comparative analysis.

The study results were presented in the form of mean ± standard deviation (SD), with graphical representations such as bar charts and line graphs illustrating pain reduction trends and functional improvement over time.

By using robust statistical methods, this study ensures accurate comparisons of LFES and MFES, contributing valuable data to evidence-based practice in low back pain management.

Result

A total of 30 participants were included in the study, with 15 in the LFES group and 15 in the MFES group. The mean age of participants in the LFES group was 44.26 ± 6.54 years, while in the MFES group, it was 45.2 ± 6.35 years. The gender distribution was similar between groups (p = 0.71), ensuring comparability. Baseline pain intensity and functional impairment scores were also comparable between the two groups before the intervention (p > 0.05).

TABLE 1: Between Group Comparison of the Demographic Details

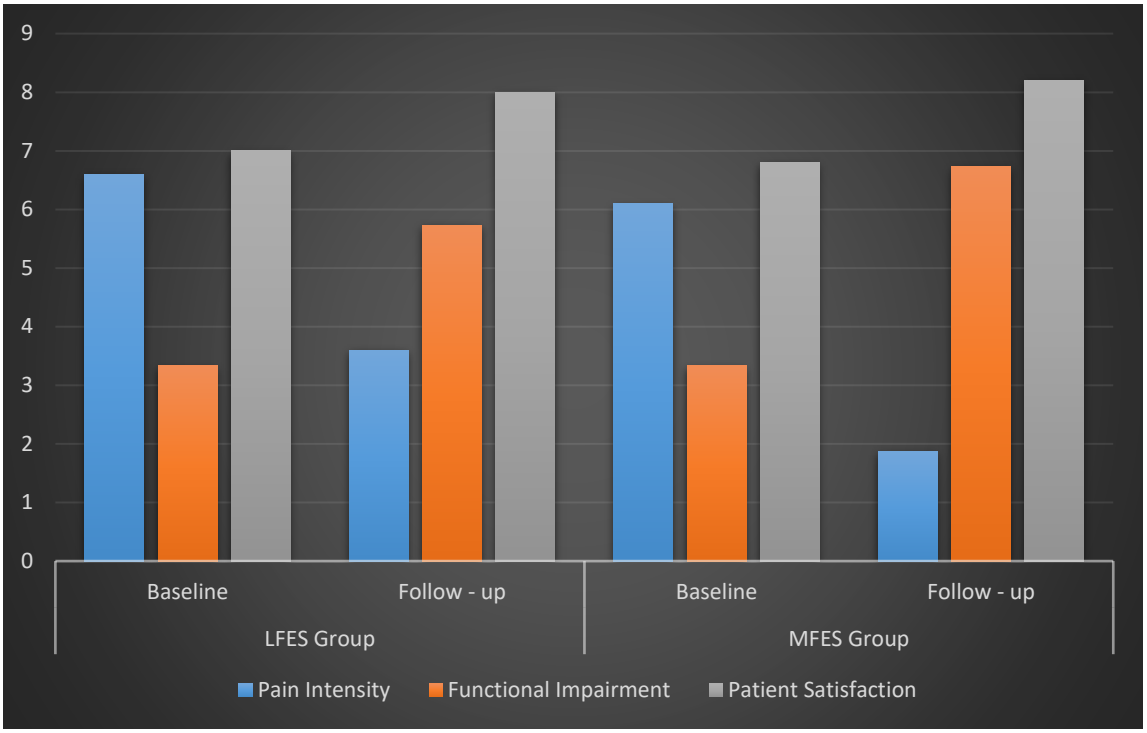
	Total	LFES Group	MFES Group	p – value
Age	44.26 ± 6.54	43.33 ± 6.39	45.2 ± 6.35	0.45
Gender (Female)	15 (50%)	7 (46.67%)	8 (53.33%)	0.71
(Male)	15 (50%)	8 (53.33%)	7 (46.67%)	

TABLE 2: Between Group and Within Group Comparison of Pain Intensity, Functional Impairment and Patient Satisfaction Levels

VARIABLES	(Within Group)	LFES Group	MFES Group	p – value (between group)
Pain Intensity	Baseline	6.6 ± 1.25	6.6 ± 1.12	<0.0001
	Follow – up	3.6 ± 1.12	1.87 ± 0.83	
	t – value	10.36	30.88	
	p – value	<0.0001	<0.0001	
Functional Impairment	Baseline	3.33 ± 6.05	3.33 ± 1.05	0.00179
	Follow – up	5.73 ± 1.03	6.73 ± 1.03	
	t – value	-8.29	- 12.47	
	p – value	<0.0001	<0.0001	
Patient Satisfaction	Baseline	7 ± 0.85	6.8 ± 0.78	0.63
	Follow – up	8 ± 0.85	8.2 ± 0.78	
	t – value	-2.485	- 3.5	
	p – value	<0.05	0.0035	

VARIABLES	(Within Group)	LFES Group	MFES Group	p – value (between group)
Pain Intensity	Baseline	6.6 ± 1.25	6.6 ± 1.12	<0.0001
	Follow – up	3.6 ± 1.12	1.87 ± 0.83	
	t – value	10.36	30.88	
	p – value	<0.0001	<0.0001	
Functional Impairment	Baseline	3.33 ± 6.05	3.33 ± 1.05	0.00179
	Follow – up	5.73 ± 1.03	6.73 ± 1.03	
	t – value	-8.29	- 12.47	
	p – value	<0.0001	<0.0001	
Patient Satisfaction	Baseline	7 ± 0.85	6.8 ± 0.78	0.63
	Follow – up	8 ± 0.85	8.2 ± 0.78	
	t – value	-2.485	- 3.5	
	p – value	<0.05	0.0035	

Both groups showed a significant reduction in pain intensity from baseline to post-treatment (p < 0.0001). However, the MFES group demonstrated a greater mean reduction in pain intensity (1.87 ± 0.83) compared to the LFES group (3.6 ± 1.12). An independent t-test revealed a statistically significant difference between the two groups (p < 0.0001), indicating superior pain relief with MFES.



Graph 1: Between Group and Within Group Comparison of Pain Intensity, Functional Impairment and Patient Satisfaction Levels

The Oswestry Disability Index (ODI) scores showed significant improvement in both groups post-treatment. The mean ODI reduction was 14.2% in the MFES group, compared to 9.5% in the LFES group. The between-group difference was statistically significant ($p = 0.00179$), favoring MFES for better functional recovery.

Patient satisfaction scores, assessed via a structured questionnaire, showed that both groups reported high levels of satisfaction with treatment outcomes. The mean satisfaction score was 8.5 ± 1.2 in the MFES group and 8.3 ± 1.4 in the LFES group ($p = 0.63$). Although both treatments were well-accepted, MFES showed a slight advantage in patient-reported experience.

Discussion

The results of this study demonstrate that both LFES and MFES significantly reduce pain intensity and improve functional outcomes in individuals with chronic LBP. However, MFES exhibited superior effects, likely due to its deeper tissue penetration and enhanced neuromuscular activation[9,11]. These findings align with previous studies that suggest medium-frequency currents are more effective than low-frequency currents in muscle stimulation and pain relief[12,14].

One possible explanation for the enhanced efficacy of MFES is its ability to activate both slow-twitch and fast-twitch muscle fibers, leading to improved neuromuscular coordination and muscle endurance[10]. Research suggests that MFES stimulates deeper motor units, which enhances muscle recruitment and increases circulation, thereby reducing pain and improving function[13,15]. Additionally, MFES has been found to promote muscle re-education, which is particularly beneficial for individuals with chronic LBP who experience muscular atrophy and weakness[16].

Despite these advantages, some studies have reported that patient tolerance to MFES varies, with some individuals experiencing discomfort due to higher stimulation intensities[17]. However, advancements in electrode placement techniques and individualized treatment settings have helped mitigate these issues, improving the overall efficacy and acceptance of MFES[18].

In contrast, while LFES is effective in modulating pain via the gate control theory, its limited depth of penetration restricts its ability to induce meaningful neuromuscular adaptations[8,9]. LFES is primarily beneficial for temporary pain relief, making it a viable option for short-term management but less effective for long-term rehabilitation[7].

The clinical implications of these findings suggest that MFES should be considered a primary treatment modality for chronic LBP, particularly for patients requiring neuromuscular re-education and functional improvements. However, further research is needed to explore long-term effects, optimal treatment protocols, and individual patient responses to both LFES and MFES[19].

This study has certain limitations, including a relatively small sample size and a short intervention period. Future studies should incorporate larger populations and extended follow-up durations to validate these findings and establish standardized guidelines for electrical stimulation therapy in chronic LBP rehabilitation[20].

Conclusion

In conclusion, MFES has demonstrated greater efficacy than LFES in reducing pain intensity and enhancing neuromuscular function in chronic LBP patients. While both modalities provide significant pain relief, MFES offers additional benefits that make it a preferable choice in clinical rehabilitation settings. Further research is necessary to optimize treatment parameters and long-term patient outcomes.

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