

doi: 10.63360/ipmm.v2.e23

Randomized Controlled Trial

Influence of Percutaneous Microelectrolysis in the Upper Trapezius on Pressure Pain Threshold and Surface Electromyography: A Randomized Sham-Controlled Pilot Trial

Carlos Eduardo Girasol¹  0000-0002-3901-582X

Nathaly Escobar Durán²  0000-0002-9965-0059

Santiago Marcelo D'Almeida²  0000-0003-1854-1756

Oscar Ariel Ronzio²  0000-0002-0004-5992

¹University of São Paulo, Brazil.

²Maimónides University, Argentina.

ABSTRACT

Background: Myofascial pain syndrome is a non-inflammatory disorder that manifests as referred pain and stiffness, with its primary feature being the presence of myofascial trigger points (MTrP). Several methods exist to treat this syndrome, and one of the earliest described techniques involves the invasive use of direct current.

Study design: A randomized, double-blind, sham-controlled pilot trial.

Participants: Adults (18–48 years) with active myofascial trigger points (MTrPs) in the upper trapezius were recruited. Exclusion criteria included prior shoulder or neck surgery, fibromyalgia, anticoagulant use, pregnancy, or BMI > 28 kg/m².

Interventions: Participants were randomly allocated to a low-intensity galvanic current group or a sham group. The active group received static percutaneous microelectrolysis with a 0.3 × 25 mm acupuncture needle and current intensities ranging from 0.12 mA to 0.6 mA (2.53 mA/cm²) for three 60-second cycles. In the sham group, the needle was inserted superficially (up to 3 mm) over the upper trapezius region without reaching the muscle, and no electrical current was applied.

Objectives: To compare the effects of low-intensity galvanic current on pressure pain threshold levels and electromyographic pattern (basal and peak) in individuals with myofascial trigger points in the upper trapezius muscle.

Materials and Methods: Pressure pain threshold (PPT) and surface electromyographic (EMG) (basal and isometric peak and RMS) were measured at baseline, 1 minute, and 10 minutes post-intervention. Independent-sample t-tests and effect sizes (Cohen's d) were calculated ($p < 0.05$).

Results: Sixteen participants were randomized, with eight allocated to each group. No statistically significant differences were observed between groups for PPT or EMG variables. However, medium effect sizes were observed for resting and isometric root mean square (RMS) EMG activity at 1 minute post-intervention, and a large effect size for resting peak EMG activity at 1 minute.

Conclusions: In this pilot trial, no statistically significant between-group differences were observed. Although moderate-to-large effect sizes were observed for some EMG variables immediately post-intervention, these results should be interpreted cautiously. Larger trials with longer follow-up are needed.

Keywords: galvanic current; pain; surface electromyography.

1. Introduction

Myofascial pain syndrome is a musculoskeletal condition characterized by regional muscle pain, often perceived as deep and diffuse, arising from hyperirritable trigger points within taut bands of skeletal muscle⁽¹⁻³⁾. Numerous diagnostic components exist, but the primary criterion is muscle irritability that occurs when the muscle is stressed by pressure or stretching, producing a localized sore spot or referred pain. A palpable muscle band may be observed, indicating a spasm in a small portion of the muscle^(1,4). These changes can lead to local ischemia⁽⁵⁾, triggering the release of pro-inflammatory substances, nociceptive stimulation, and increased muscle tone, creating a self-perpetuating cycle⁽⁶⁾. Some studies have indicated autonomic and microcirculatory alterations surrounding a myofascial trigger point (MTrP)⁽⁵⁾. The pain is typically constant and deep, and myofascial pain is a prevalent condition, often serving as an initial entry point into healthcare services⁽⁷⁾.

The clinical features include local hyperalgesia; referred or irradiated pain that intensifies with pressure (active MTrPs); taut bands; occasional local twitch responses; muscle weakness; reduced range of motion; and altered movement patterns, often associated with central sensitization. Manual muscle palpation is an important procedure for the clinical assessment of MTrPs^(4,6,8). However, its diagnostic accuracy is limited by the absence of a gold standard and the difficulty of quantifying hypersensitivity. These limitations can be partially overcome by pressure algometry, which applies increasing force over a constant surface to quantify the minimum pressure that induces pain or discomfort, known as the pressure pain threshold (PPT), typically reported in kg/cm² or kilopascals (kPa)^(9,10). The upper trapezius fibers are most commonly affected and are considered the most sensitive muscle to pressure based on algometry studies involving various muscles of the shoulder girdle⁽¹¹⁾. The identification of reduced PPT values over MTrPs has been shown to be a reliable procedure in their clinical assessment⁽¹²⁾.

Surface electromyography (sEMG) studies have reported detecting spontaneous electrical activity in regions identified as MTrP. Electromyography measures musculoskeletal bioelectrical activity using invasive or non-invasive methods^(13,14). sEMG is preferred because it is non-invasive and allows analysis during movement. The data obtained are considered in physical examination and help verify neuromotor integrity⁽¹⁵⁾.

Several methods exist to treat this syndrome, including electrophysical agents⁽¹⁶⁻¹⁸⁾. One of the earliest described currents is direct current (DC) or galvanic current, characterized by its unidirectional nature, where the accumulated energy in the stimulated biological tissues promotes electrochemical changes⁽¹⁸⁾. These effects are termed polar effects. In contrast, a relatively new and increasingly prominent rehabilitation technique involves the invasive use of DC⁽¹⁹⁾, such as percutaneous microelectrolysis (MEP)⁽²⁰⁾. MEP is a minimally invasive procedure where low-intensity DC (up to 0.98 mA) is delivered via acupuncture needles, generating a high current densi-

ty (approximately 3.8 mA/cm^2)⁽²¹⁾. In addition to local analgesia, it is expected to induce a locally controlled inflammatory process that promotes tissue repair. These effects reinforce its mechanism of action in the rehabilitation of individuals with myofascial trigger points, particularly in the trapezius muscle, commonly associated with neck pain⁽²²⁾.

However, evidence on immediate electromyographic responses following percutaneous microelectrolysis at myofascial trigger points remains scarce and inconclusive, particularly in randomized, sham-controlled designs. Therefore, the aim of this randomized pilot trial was to analyze the effect of percutaneous microelectrolysis on myofascial trigger point activity and pain pressure threshold in the upper trapezius muscle in healthy adults. It is hypothesized that percutaneous microelectrolysis will reduce MTrP activity and increase the pain pressure threshold compared to baseline.

2. Materials and Methods

2.1 Study design

This was a randomized, double-blind, sham-controlled pilot trial. Participants were randomly assigned to two groups (Sham or Static Percutaneous Microelectrolysis) using a computer-generated sequence. The study methodology followed all the guidelines established by the Consolidated Standards of Reporting Trials (CONSORT)⁽²³⁾, and the Recommendations from the International Society of Physiotherapy Journal Editors⁽²⁴⁾.

Assessments were performed at baseline and at 1- and 10-minute post-intervention. The primary outcome was MTrP activity assessed by sEMG (MyoPlus Pro, NeuroTrac, UK). sEMG variables included resting peak activity (Resting EMG Peak), resting root mean square (Resting EMG RMS), isometric peak activity during voluntary contraction (Isometric EMG Peak), and isometric root mean square (Isometric EMG RMS). Secondary outcomes included pain pressure threshold (PPT), measured using an FDX® 25 algometer (Wagner Instruments, Greenwich, USA). The algometer tip (1 cm^2) was positioned perpendicular to the upper trapezius fibers above the MTrP, and compression was applied at approximately $0.5 \text{ Kg/cm}^2/\text{s}$ until the participant reported pain. Each point was measured three times, and the average value was recorded.

2.2 Ethics

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Universidad Maimónides (protocol code A-01-CEBBAD-20, approved on October 6, 2020). This study was registered as a clinical trial on ClinicalTrials.gov (NCT05478928). The volunteers were properly informed about the research project, its objectives, and its characteristics, and all of them signed the informed consent form.

2.3 Participants

To be included in the trial, participants of both sexes aged between 18 and 48 years were required to present active myofascial trigger points (MTrPs), either unilateral or bilateral. Trigger point diagnosis was performed according to the clinical criteria described by Simons et al.⁽¹⁾ and Gerwin et al.⁽²⁵⁾. These included a palpable taut band in the skeletal muscle, a hypersensitive

spot within the taut band, reproduction of the patient's typical referred pain with compression (up to 3.0 kg/cm^2), and a possible local twitch response. Consistent with contemporary consensus recommendations⁽⁸⁾, the presence of a cluster of core criteria (taut band, hypersensitive spot, and reproduction of referred pain) was considered essential for MTrP diagnosis, while additional findings, such as the local twitch response, were considered supportive but not mandatory. Trigger point localization was performed through standardized manual palpation prior to needle placement. These criteria have demonstrated acceptable inter-rater reliability⁽²⁵⁾.

Participants with a history of neck and shoulder surgery, needle phobia, temporomandibular dysfunction, use of anticoagulants, receiving other treatments for myofascial trigger point, fibromyalgia, endocrine disorders, pregnancy, or obesity with a body mass index (BMI) greater than 28 kg/m^2 were excluded.

The following data were collected: personal data (name, phone number, gender, age, upper limb dominance), body mass, height, BMI, previous diseases, drug use, and current history of surgery, physical therapy, or physical training. During the physical examination, the PPT was measured.

2.4 Randomisation and blinding

The research team conducted recruitment. The researcher responsible for the analyses and the participants did not know which group would be allocated to. Two other researchers conducted the assessments and intervention protocols, and another was responsible for data processing and analysis.

The eligible participants were randomized to one of two groups: low-intensity galvanic current or sham. Randomization was performed by an investigator who was not involved in data collection and outcome assessment, using a digital software (Excel, Microsoft Corporation by Impressa Systems, Santa Rosa, California, United States of America), and the secrecy of allocation was maintained by opaque envelopes that were sealed and only opened by the researchers responsible who applied the intervention, after the evaluation and before the intervention. The investigator was responsible for evaluations, and the patients were blinded to their group allocation throughout the study period.

2.5 Intervention

For the active group (Static Percutaneous Microelectrolysis), a Sveltia DC (Sveltia, Argentina) device was used, attached to a dispersing electrode (area: 28.26 cm^2) and an acupuncture needle ($0.3 \times 2.5 \text{ cm}$). The circuit was closed by placing the dispersing electrode in the arm contralateral to the trapezius muscle to be treated. The current intensity was progressively delivered to the needle between 0.12 mA and 0.6 mA (current density: 2.53 mA/cm^2). If the participant reported discomfort, the procedure was interrupted and resumed only after the discomfort ceased, in a total of three 60-second cycles of active therapy (total dose of 108 mC). An interval of 30 seconds was provided between active cycles, resulting in a total therapy time of 240 seconds. No needle movement occurred. The electrolysis protocol was selected based on previously described clinical applications of percutaneous microelectrolysis⁽²⁶⁾. Finally, for the control group, a $0.3 \times 25 \text{ mm}$ acupuncture needle was inserted perpendicularly to a superficial depth of up to 3 mm .

in the skin overlying the upper trapezius region, without reaching the muscle tissue or the myofascial trigger point, and remained in place for the same duration as in the active group. No electrical current was applied. All procedures were performed by the same researcher to ensure greater reliability. All proposed parameters are shown in Table 1.

Table 1. Parameters proposed for intervention.

Parameters	Sham	Percutaneous Microelectrolysis
Needle	0.3×2.5 cm	0.3×2.5 cm
Dispersive Electrode Area	28.26 cm ²	28.26 cm ²
Frequency of movements	Static	Static
Current Intensity	Off	0.6 mA
Cycle	3	3
Active Time	0	60
Total Time	240 sec	240 sec
Total Dose	-	108 mC
Intervention Place	Perpendicular to the trigger point of the upper trapezius muscle	

2.6 Outcomes

The primary outcome was the change in MTrP electrical activity assessed by surface electromyography, including resting peak activity, resting root mean square (RMS), isometric peak activity, and isometric RMS. The secondary outcome is the change in pain pressure threshold, measured with an algometer (FDX® 25) at baseline, 1 minute, and 10 minutes post-intervention.

2.7 Statistical analysis

To analyze the relationship of the variables, initially, the distribution of the data was observed through the Shapiro-Wilk test. Descriptive statistics were used to present the means, standard deviations, and 95% of Confidence Interval (CI) of the participant characteristics. Independent-sample t-tests were used to assess whether there were significant differences between the groups, with outcomes presented as mean differences and 95% CIs for the group-time relationship. The p-value was set at 0.05. An additional analysis was also used, where the bootstrapping technique was performed simulating a sample size of n1000, with 95% CI and Bias-corrected and accelerated (BCa)⁽²⁷⁾. The effect size was determined by Cohen's d, and the interpretation of the values was based on the classification established by Cohen⁽²⁸⁾: lower than 0.2 as a small effect, around 0.5 as a moderate effect, and above 0.8 as a large effect. Given the exploratory nature of this pilot trial, effect sizes were emphasized alongside p-values. Statistical processing was performed using SPSS® software, version 20.0 (Chicago, IL, USA). Analyses were conducted according to the intention-to-treat principle, as all randomized participants completed the intervention and follow-up assessments and were analyzed according to their original group allocation.

3. Results

3.1 Participants flow and baseline characteristics

A total of 16 participants were assessed for eligibility and met the inclusion criteria. All eligible participants were randomized and allocated to one of two groups: the Low-Intensity Galvanic Current group (n = 8) or the Sham group (n = 8). No participants were excluded after randomization, and no losses to follow-up or missing outcome data were observed.

No adverse events were reported during or after the intervention in either group. The flow of participants through each stage of the randomized trial is presented in Figure 1, in accordance with CONSORT guidelines. Baseline demographic and clinical characteristics of the participants are summarized in Table 2, showing comparable values between groups at study entry.

Table 2. Descriptive and clinical characteristics of participants.

Outcomes	Sham					Percutaneous Microelectrolysis				
	Mean	SD	Median	1 st Qt.	3 rd Qt.	Mean	SD	Median	1 st Qt.	3 rd Qt.
PPT - Pre	1.84	0.85	1.56	1.25	2.53	2.06	0.43	2.18	1.61	2.39
PPT - Post 1 min	2.33	0.82	2.22	1.60	3.15	2.46	0.73	2.66	1.73	2.95
PPT - Post 10 min	2.64	1.17	2.26	1.64	3.65	2.74	1.14	3.05	1.63	3.78
Resting EMG Peak - Pre	14.80	19.80	6.00	5.45	17.80	5.92	2.84	5.35	4.18	6.88
Resting EMG Peak - Post 1 min	5.96	2.24	5.85	3.78	8.33	10.10	5.37	9.25	5.98	14.30
Resting EMG Peak - Post 10 min	7.31	3.11	6.85	4.73	10.30	7.01	3.62	5.85	3.95	10.50
Isometric EMG Peak - Pre	49.20	18.30	41.90	33.60	66.10	89.30	73.80	59.70	38.90	112.00
Isometric EMG Peak - Post 1 min	67.10	27.30	57.00	43.50	96.20	83.00	56.50	67.50	39.40	144.00
Isometric EMG Peak - Post 10 min	62.50	22.00	57.40	42.40	78.20	81.20	76.80	57.10	43.70	93.60
Resting EMG RMS - Pre	3.31	1.37	3.30	1.95	4.30	3.61	1.57	3.35	2.29	4.55
Resting EMG RMS - Post 1 min	2.49	1.11	2.10	1.73	2.95	3.46	1.51	3.20	2.14	4.45
Resting EMG RMS - Post 10 min	3.45	1.44	3.35	2.15	4.88	4.14	2.49	3.45	2.15	5.75
Isometric EMG RMS - Pre	31.90	15.80	28.40	19.20	44.50	36.40	26.40	30.60	17.50	44.00
Isometric EMG RMS - Post 1 min	31.20	8.11	32.10	25.70	39.10	40.30	21.20	30.50	26.40	55.80
Isometric EMG RMS - Post 10 min	31.40	8.57	31.90	25.10	36.90	37.50	24.10	28.20	24.50	45.00

SD: Standard Deviation; 1st Qt: 1st Quartile; 3rd Qt: 3rd Quartile; PPT: Pressure Pain Threshold; RMS: Root Mean Square.

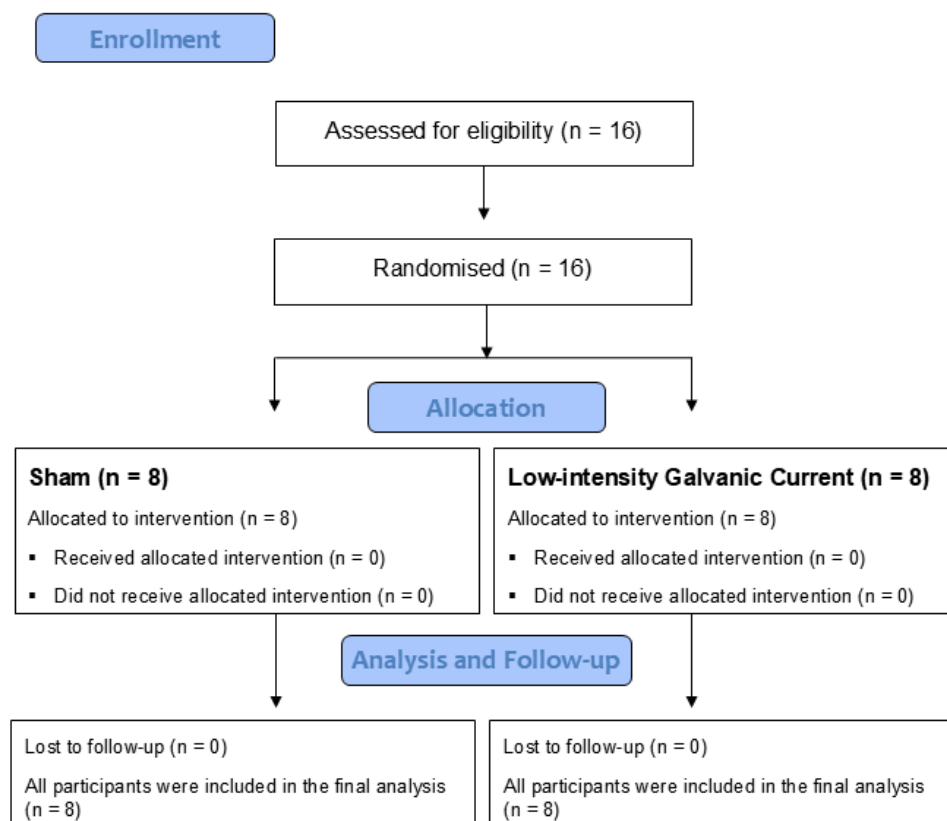


Figure 1. Participants flow diagram.

3.2 Result for each outcome

As a result, although no statistically significant differences were observed between groups for the variables studied, change score analysis ($\Delta 1$ min–baseline; $\Delta 10$ min–baseline), presented in Table 3, enabled examination of within-group variations over time. Some results indicated moderate to strong effects, as interpreted according to Cohen's d criteria^[28].

Table 3. Baseline values and change scores ($\Delta 1$ min–baseline; $\Delta 10$ min–baseline) for pressure pain threshold and electromyographic variables in both groups.

Outcome	Baseline	$\Delta 1$ min–baseline	$\Delta 10$ min–baseline
PPT (Sham)	1.84	0.49	0.79
PPT (Percutaneous Microelectrolysis)	2.06	0.39	0.68
Resting EMG Peak (Sham)	14.80	-8.80	-7.45
Resting EMG Peak (Percutaneous Microelectrolysis)	5.92	4.22	1.09
Isometric EMG Peak (Sham)	49.20	17.93	13.30
Isometric EMG Peak (Percutaneous Microelectrolysis)	89.30	-6.30	-8.06
Resting EMG RMS (Sham)	3.31	-0.83	0.14
Resting EMG RMS (Percutaneous Microelectrolysis)	3.61	-0.15	0.53
Isometric EMG RMS (Sham)	31.90	-0.78	-0.50
Isometric EMG RMS (Percutaneous Microelectrolysis)	36.40	3.96	1.13

3.2.1 Surface Electromyography

For Baseline Electrical Activity and Isometric Electrical Activity, the analysis revealed average effect sizes for the variables associated with the root mean square (RMS), both evaluated one minute post-intervention. For resting peak EMG activity measured one minute after the intervention, a large effect size was observed, suggesting that this specific variable may have been more responsive to the intervention in terms of changes in electrical activity.

3.2.2 Pressure Pain Threshold

No significant differences were detected in PPT values over time between groups. While the mean and standard deviation fluctuated, these variations did not translate into statistically significant differences or large effects. All descriptive characteristic data are shown in Table 2, and the results of the Independent-sample t-tests, with their respective effect sizes, are shown in Table 4.

Table 4. Outcomes of the interactions between time and group variables for Pressure Pain Threshold and Surface Electromyography for baseline peak electrical and isometric electrical activity.

	<i>p</i>	Mean Diff.	95% CI (Bootstrap)		Cohen's <i>d</i>
			Lower	Upper	
PPT - Pre	0.52	-0.22	-0.85	0.40	0.32
PPT - Post 1 min	0.74	-0.12	-0.85	0.57	0.17
PPT - Post 10 min	0.85	-0.10	-1.01	0.91	0.08
Resting EMG Peak - Pre	0.24	8.84	-0.32	21.01	-0.62
Resting EMG Peak - Post 1 min	0.06	-4.17	-8.71	0.40	1.00
Resting EMG Peak - Post 10 min	0.86	0.30	-3.25	4.08	-0.08
Isometric EMG Peak - Pre	0.17	-40.07	-98.92	2.71	0.74
Isometric EMG Peak - Post 1 min	0.48	-15.85	-59.17	20.20	0.35
Isometric EMG Peak - Post 10 min	0.52	-18.71	-86.26	25.62	0.33
Resting EMG RMS - Pre	0.69	-0.29	-1.80	1.11	0.20
Resting EMG RMS - Post 1 min	0.16	-0.96	-2.26	0.36	0.73
Resting EMG RMS - Post 10 min	0.51	-0.68	-2.70	1.04	0.33
Isometric EMG RMS - Pre	0.69	-4.42	-26.22	15.03	0.20
Isometric EMG RMS - Post 1 min	0.27	-9.16	-25.96	4.62	0.56
Isometric EMG RMS - Post 10 min	0.52	-6.05	-24.01	7.33	0.33

PPT: *Pressure Pain Threshold*; RMS: *Root Mean Square*.

4. Discussion

The aim of this study was to analyze the effect of percutaneous microelectrolysis on MTrP activity and pain pressure threshold in the upper trapezius muscle. No statistically significant differences were observed between groups. Moderate-to-large effect sizes were identified for some EMG variables. However, these findings should be interpreted cautiously due to the pilot design and limited sample size. Change score analysis revealed temporal variations in peak EMG activity within groups, particularly at 1-minute post-intervention. The study may have been underpowered to detect between-group differences. Given the multifactorial nature of pain, further investigation using diverse assessment tools and adequately powered designs is warranted. Although the current literature on MEP remains limited, emerging evidence has explored its potential applications^(26,29).

Rehabilitation interventions, including physical therapy modalities such as therapeutic exercise, manual techniques, and physical agents, have been shown to significantly reduce musculoskeletal pain^(26,30). However, musculoskeletal pain itself is a multifaceted condition that may affect various structures and tissues, presenting as either localized or widespread, acute or chronic⁽³¹⁾. Such pain often leads to functional impairment, directly impacting patients' overall health^(31,32).

Percutaneous Microelectrolysis has been proposed as a promising approach for pain management and the resolution of tissue dysfunction due to its unique mechanisms. Unlike thermal interventions, MEP induces a controlled local inflammatory response, promoting soft tissue regeneration⁽²⁶⁾. Additionally, it activates numerous inflammatory mediators, facilitating proper phagocytosis⁽²⁹⁾. Another possible mechanism involves neurophysiological modulation. Ronzio et al.⁽³³⁾ suggest that PME may directly influence pain regulation, a finding supported by different groups^(29,34), who observed activation of the parasympathetic nervous system during MEP application.

Regarding clinical management, recent studies indicate that MEP may be slightly more effective than dry needling in reducing pain in the short, medium, and long term⁽³⁵⁾. Similarly, a systematic review and meta-analysis⁽³⁶⁾ found that percutaneous microelectrolysis, particularly when combined with other interventions, may improve pain and disability in the short- to medium-term. Given the substantial economic, social, and psychological burdens associated with musculoskeletal pain^(37–39), MEP presents a compelling option for clinical intervention. Therefore, percutaneous microelectrolysis may be considered as a complementary intervention within multimodal treatment approaches for myofascial trigger points.

In a multimodal therapeutic approach, MEP may be further enhanced by integration with diagnostic imaging, such as ultrasound guidance. Recent findings suggest that ultrasound-guided percutaneous needle electrolysis can effectively reduce pain in tendinopathy, though optimal dosimetry, target populations, and potential adverse effects require further investigation⁽⁴⁰⁾. Conversely, some studies argue that Percutaneous Microelectrolysis, even when combined with therapeutic exercise, does not provide additional benefits for pain intensity or disability in conditions such as chronic rotator cuff tendinopathy⁽⁴¹⁾. The key consideration, therefore, is es-

establishing an algorithmic clinical decision-making framework, as proposed by Girasol et al.⁽⁴²⁾, that emphasizes intervention strategies based on clinical signs and symptomatic progression.

Considering directional factors such as clinical algorithms and scenarios of specificity and scientific robustness, the therapeutic window approach stands out. In this context, advancements such as the review by Ortiz et al.⁽²⁶⁾ are necessary, as they highlight optimal amplitude ranges and sufficient energy levels to promote therapeutic responses. Supporting this line of investigation, the group of Sánchez-González et al.⁽⁴³⁾ also emphasizes research on different current intensities.

In the present study, the electrolysis protocol was selected based on previously described clinical applications of percutaneous microelectrolysis, in which short stimulation periods are commonly used due to the localized delivery of galvanic current through an acupuncture needle directly into the trigger point. Unlike conventional electrotherapy modalities, which typically require longer application times to modulate peripheral or central pain pathways via transcutaneous stimulation, percutaneous electrolysis targets the affected tissue more directly. By combining needle insertion with electrical current, this approach may induce localized electrochemical reactions and mechanical stimulation, resulting in controlled microtrauma that may contribute to tissue repair and symptom modulation. Nevertheless, further studies are warranted to determine optimal stimulation parameters and to better understand the neurophysiological mechanisms underlying the potential analgesic effects of this intervention, as well as its role in improving functional outcomes⁽⁴⁴⁾.

Although no statistically significant between-group differences were identified, change score analysis revealed temporal variations in some EMG peak variables. As this pilot trial was not powered to detect group $\times$ time interactions, the possibility of type II error cannot be excluded. These findings should be interpreted cautiously due to the small sample size and short follow-up period. A baseline imbalance in resting peak EMG values was observed, which may have influenced change estimates due to regression to the mean; baseline-adjusted models were not applied given the limited sample size. Larger adequately powered trials using adjusted analytical approaches are warranted to confirm these findings and better define clinically meaningful effects.

5. Conclusions

In this pilot trial, adding low-intensity galvanic current to needling did not result in statistically significant between-group differences in pressure pain threshold or electromyographic activity compared with the sham condition. Although moderate-to-large effect sizes were observed in some EMG variables immediately post-intervention, these findings should be interpreted cautiously given the small sample size and short follow-up period. Further adequately powered studies are warranted.

References

1. David G. Simons, Janet G. Travell, Lois S. Simons. Myofascial Pain and Dysfunction: The Trigger Point Manual. Baltimore MD, editor. Lippincott Williams & Wilkins; 1998.
2. Zhai T, Jiang F, Chen Y, Wang J, Feng W. Advancing musculoskeletal diagnosis and therapy: a comprehensive review of trigger point theory and muscle pain patterns. *Front Med (Lausanne)*. 2024;11. <https://doi.org/10.3389/fmed.2024.1433070>
3. Cao Q-W, Peng B-G, Wang L, Huang Y-Q, Jia D-L, Jiang H, et al. Expert consensus on the diagnosis and treatment of myofascial pain syndrome. *World J Clin Cases*. 2021;9:2077–89. <https://doi.org/10.12998/wjcc.v9.i9.2077>
4. Li L, Stoop R, Clijsen R, Hohenauer E, Fernández-de-las-Peñas C, Huang Q, et al. Criteria Used for the Diagnosis of Myofascial Trigger Points in Clinical Trials on Physical Therapy. *Clin J Pain*. 2020;36:955–67. <https://doi.org/10.1097/AJP.0000000000000875>
5. Cojocaru MC, Cojocaru IM, Voiculescu VM, Cojan-Carlea NA, Dumitru VL, Berteanu M. Trigger points--ultrasound and thermal findings. *J Med Life*. 2015;8:315–8. PMID: 26351532.
6. Quintner JL, Bove GM, Cohen ML. A critical evaluation of the trigger point phenomenon. *Rheumatology*. 2015;54:392–9. <https://doi.org/10.1093/rheumatology/keu471>
7. Shah JP, Thaker N, Heimur J, Aredo J V., Sikdar S, Gerber L. Myofascial Trigger Points Then and Now: A Historical and Scientific Perspective. *PM&R*. 2015;7:746–61. <https://doi.org/10.1016/j.pmrj.2015.01.024>
8. Fernández-de-las-Peñas C, Dommerholt J. International Consensus on Diagnostic Criteria and Clinical Considerations of Myofascial Trigger Points: A Delphi Study. *Pain Medicine*. 2018;19:142–50. <https://doi.org/10.1093/pm/pnx207>
9. Geri T, Botticchio A, Rossetini G, Pournajaf S, Pellicciari L, Di Antonio S, et al. Pressure Pain Threshold of the Upper Trapezius Trigger Point: A Systematic Review with Meta-Analysis of Baseline Values and Their Modification after Physical Therapy. *J Clin Med*. 2022;11:7243. <https://doi.org/10.3390/jcm11237243>
10. Castaldo M, Catena A, Fernández-de-las-Peñas C, Arendt-Nielsen L. Widespread Pressure Pain Hypersensitivity, Health History, and Trigger Points in Patients with Chronic Neck Pain: A Preliminary Study. *Pain Medicine*. 2019;20:2516–27. <https://doi.org/10.1093/pm/pnz035>
11. Fernández-de-las-Peñas C, Dommerholt J. International Consensus on Diagnostic Criteria and Clinical Considerations of Myofascial Trigger Points: A Delphi Study. *Pain Medicine*. 2018;19:142–50. <https://doi.org/10.1093/pm/pnx207>
12. Park G, Kim CW, Park SB, Kim MJ, Jang SH. Reliability and Usefulness of the Pressure Pain Threshold Measurement in Patients with Myofascial Pain. *Ann Rehabil Med*. 2011;35:412. <https://doi.org/10.5535/arm.2011.35.3.412>
13. Perreault T, Ball A, Dommerholt J, Theiss R, Fernández-de-las-Peñas C, Butts R. Intramuscular Electrical Stimulation to Trigger Points: Insights into Mechanisms and Clinical Applications—A Scoping Review. *J Clin Med*. 2022;11:6039. <https://doi.org/10.3390/jcm11206039>
14. Lara-Palomo IC, Antequera-Soler E, Fernández-Sánchez M, Castro-Sánchez AM, García-López H. Electrical dry needling versus a non-invasive multicomponent intervention in the treatment of myofascial trigger points in patients with chronic low back pain: A randomised clinical trial. *Clin Rehabil*. 2024;38:347–60. <https://doi.org/10.1177/02692155231201589>

- 15.** Dommerholt J, Mayoral O, Thorp JN. A critical overview of the current myofascial pain literature – January 2021. *J Bodyw Mov Ther.* 2021;25:261–71. <https://doi.org/10.1016/j.jbmt.2020.12.044>
- 16.** Alayat MSM, Battecha KH, Elsodany AM, Alzahrani OA, Alqurashi AKA, Jawa AT, et al. Effectiveness of Photobiomodulation Therapy in the Treatment of Myofascial Pain Syndrome of the Upper Trapezius Muscle: A Systematic Review and Meta-Analysis. *Photobiomodul Photomed Laser Surg.* 2022;40:661–74. <https://doi.org/10.1089/photob.2022.0056>
- 17.** Johnson MI, Paley CA, Jones G, Mulvey MR, Wittkopf PG. Efficacy and safety of transcutaneous electrical nerve stimulation (TENS) for acute and chronic pain in adults: a systematic review and meta-analysis of 381 studies (the meta-TENS study). *BMJ Open.* 2022;12:e051073. <https://doi.org/10.1136/bmjopen-2021-051073>
- 18.** Ortiz H, Cancino J, Peña FS, León FS, Donoso EM, Gaete VT. Effectiveness of percutaneous microelectrolysis and ultrasound in the decrease of pain in myofascial trigger points: evaluation through algometry and visual analog scale. *Physiotherapy Quarterly.* 2020;28:1–8. <https://doi.org/10.5114/pq.2020.95768>
- 19.** De-la-Cruz-Torres B, Romero-Rodríguez B, Romero-Morales C. Ultrasound-Guided Percutaneous Needle Electrolysis Combined With Therapeutic Exercise May Add Benefit in the Management of Soleus Injury in Female Soccer Players: A Pilot Study. *J Sport Rehabil.* 2022;1–7. <https://doi.org/10.1123/jsr.2022-0021>
- 20.** Ronzio OA, da Silva Coldibeli E, Soares Fernandes MDR, Froes Meyer P, da Silva RM V. Effects of percutaneous microelectrolysis (MEP®) on pain, rom and morning stiffness in patients with achilles tendinopathy. *Eur J Physiother.* 2017;19:62–3. <https://doi.org/10.1080/21679169.2017.1381321>
- 21.** d’Almeida SM, Silva RMV da, Ronzio OA. Nivel de satisfacción sobre la seguridad y complicaciones a cuatro años de la introducción de la técnica Microelectrólisis Percutánea (MEP®) Sport como práctica fisioterapéutica. *Fisioterapia e Pesquisa.* 2019;26:190–5. <https://doi.org/10.1590/1809-2950/18038726022019>
- 22.** Lluch E, Nijs J, De Koning M, Van Dyck D, Vanderstraeten R, Struyf F, et al. Prevalence, Incidence, Localization, and Pathophysiology of Myofascial Trigger Points in Patients With Spinal Pain: A Systematic Literature Review. *J Manipulative Physiol Ther.* 2015;38:587–600. <https://doi.org/10.1016/j.jmpt.2015.08.004>
- 23.** Hopewell S, Chan A-W, Collins GS, Hróbjartsson A, Moher D, Schulz KF, et al. CONSORT 2025 explanation and elaboration: updated guideline for reporting randomised trials. *BMJ.* 2025;e081124. <https://doi.org/10.1136/bmj-2024-081124>
- 24.** Costa LOP, Christine Lin C-W, Grossi DB, Mancini MC, Swisher AK, Cook C, et al. Clinical trial registration in physiotherapy journals: Recommendations from the International Society of Physiotherapy Journal Editors. *Man Ther.* 2013;18:1–3. <https://doi.org/10.1016/j.math.2012.10.009>
- 25.** Gerwin RD, Shannon S, Hong C-Z, Hubbard D, Gevirtz R. Interrater reliability in myofascial trigger point examination. *Pain.* 1997;69:65–73. [https://doi.org/10.1016/S0304-3959\(96\)03248-4](https://doi.org/10.1016/S0304-3959(96)03248-4)
- 26.** de la Barra Ortiz HA, Chamorro C, Ronzio Ó. Percutaneous electrolysis and microelectrolysis for musculoskeletal pain management: milliamps or microamps? An evidence-based comparison through systematic review and meta-analysis. *Advances in Rehabilitation.* 2024;38:36–60. <https://doi.org/10.5114/areh.2024.141103>
- 27.** Lenhard, W. & Lenhard, A. (2022). Computation of effect sizes. Retrieved from: https://www.psychometrica.de/effect_size.html. *Psychometrica.* <https://doi.org/10.13140/RG.2.2.17823.92329>

28. Cohen J. A power primer. *Psychol Bull.* 1992;112:155–9. <https://doi.org/10.1037/0033-2909.112.1.155>
29. Rodríguez-Sanz J, Rodríguez-Rodríguez S, López-de-Celis C, Malo-Urriés M, Pérez-Amodio S, Pérez-Antoñanzas R, et al. Biological and Cellular Effects of Percutaneous Electrolysis: A Systematic Review. *Biomedicines.* 2024;12:2818. <https://doi.org/10.3390/biomedicines12122818>
30. Sluka KA, Frey-Law L, Hoeger Bement M. Exercise-induced pain and analgesia? Underlying mechanisms and clinical translation. *Pain.* 2018;159:S91–7. <https://doi.org/10.1097/j.pain.0000000000001235>
31. Raja SN, Carr DB, Cohen M, Finnerup NB, Flor H, Gibson S, et al. The revised International Association for the Study of Pain definition of pain: concepts, challenges, and compromises. *Pain.* 2020;161:1976–82. <https://doi.org/10.1097/j.pain.0000000000001939>
32. Turner JA, Arendt-Nielsen L. Four decades later: what's new, what's not in our understanding of pain. *Pain.* 2020;161:1943–4. <https://doi.org/10.1097/j.pain.0000000000001991>
33. Ronzio OA, Villa CA, Gómez D, Valentim da Silva RM, Gill JP, d'Almeida S, et al. Effects in pressure-pain threshold of percutaneous galvanic microcurrent in the trapezius trigger points. *Physiotherapy.* 2015;101:e1297–8. <https://doi.org/10.1016/j.physio.2015.03.1214>
34. García Bermejo P, de la Cruz Torres B, Naranjo Orellana J, Albornoz Cabello M. Autonomic activity in women during percutaneous needle electrolysis. *Eur J Integr Med.* 2017;11:53–8. <https://doi.org/10.1016/j.eujim.2017.02.002>
35. Fakontis C, Iakovidis P, Lytras D, Kasimis K, Koutras G, Ntinou SR, et al. Efficacy of percutaneous needle electrolysis versus dry needling in musculoskeletal pain: A systematic review and meta-analysis. *J Back Musculoskelet Rehabil.* 2023;36:1033–46. <https://doi.org/10.3233/BMR-220408>
36. Silva ACT da, Kamonseki DH, Azevedo LMV de, Araújo JN de, Magalhães GC, Oliveira VMA de. Effect of percutaneous electrolysis on pain and disability in individuals with tendinopathy: Systematic review and meta-analysis. *J Bodyw Mov Ther.* 2024;40:640–9. <https://doi.org/10.1016/j.jbmt.2024.05.030>
37. Faria BSF, Gonçalves JS, Sato T de O. Association between psychosocial factors in workers and multisite pain: cross-sectional study. *Brazilian Journal Of Pain.* 2022;5. <https://doi.org/10.5935/2595-0118.20220002>
38. Roomes D, Abraham L, Russell R, Beck C, Halsby K, Wood R, et al. Quantifying the Employer Burden of Persistent Musculoskeletal Pain at a Large Employer in the United Kingdom. *J Occup Environ Med.* 2022;64:e145–54. <https://doi.org/10.1097/JOM.0000000000002468>
39. Blyth FM, Briggs AM, Schneider CH, Hoy DG, March LM. The Global Burden of Musculoskeletal Pain—Where to From Here? *Am J Public Health.* 2019;109:35–40. <https://doi.org/10.2105/AJPH.2018.304747>
40. Ferreira MHL, Araujo GAS, De-La-Cruz-Torres B. Effectiveness of Percutaneous Needle Electrolysis to Reduce Pain in Tendinopathies: A Systematic Review With Meta-Analysis. *J Sport Rehabil.* 2024;33:307–16. <https://doi.org/10.1123/jsr.2024-0009>
41. Magalhães GC, Kamonseki DH, da Silva ACT, Nunes JA, de Sousa AIAF, Ribeiro DC, et al. Effectiveness of Microelectrolysis Associated With Exercises Versus Exercises Alone on Pain Intensity and Disability in Individuals With Chronic Rotator Cuff Tendinopathy: A Randomized Controlled Trial. *Arch Phys Med Rehabil.* 2024; <https://doi.org/10.1016/j.apmr.2024.10.016>
42. Girasol CE, Durán NE, D'Almeida SM, Ronzio OA. Toward an algorithm of percutaneous microelectrolysis: a randomized clinical trial on invasive techniques. *Sao Paulo Medical Journal.* 2025;143. <https://doi.org/10.1590/1516-3180.2024.0164.r1.07032025>

43. Sánchez-González JL, Navarro-López V, Cañada-Sánchez P, Juárez-Vela R, Viñaspre-Hernández RR de, Varela-Rodríguez S. Efficacy of different intensities of percutaneous electrolysis for musculoskeletal pain: A systematic review and meta-analysis. *Front Med (Lausanne)*. 2023;10. <https://doi.org/10.3389/fmed.2023.1101447>

44. Yildizgoren MT, Bagcier F. A modern interpretation of traditional galvanic current: percutaneous needle electrolysis therapy. *Acupuncture in Medicine*. 2024;42:56–7. <https://doi.org/10.1177/09645284231210569>

Editorial information

✉ Correspondence

carlos.egirasol@gmail.com

Dates

Received: 02.02.2026

Accepted: 11.03.2026

Published: 23.03.2026

Author Contributions

Conceptualization, C.E.G. and O.A.R.; methodology, C.E.G. and O.A.R.; formal analysis, C.E.G. and S.M.D.; investigation, S.D.M. and N.E.D.; resources, O.A.R.; data curation, C.E.G., N.E.D. and S.M.D.; writing—original draft preparation, C.E.G., N.E.D. and S.M.D.; writing—review and editing, C.E.G. and O.A.R.; visualization, C.E.G. and N.E.D.; supervision, O.A.R.; project administration, C.E.G. and O.A.R.; funding acquisition, O.A.R. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Universidad Maimónides (protocol code A-01-CEBBAD-20, approved on October 6, 2020).

Clinical trial registration

Trial registration number: NCT05478928.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Funding

This research received no external funding.

Acknowledgments

The authors would like to express their sincere gratitude to all participants who generously contributed their time and effort to this study. Their involvement was essential to the successful completion of this research.

Data Availability Statement

The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest

The authors declare no conflicts of interest.

Suggested citation

Girasol CE, Escobar Durán N, D'Almeida SM, Ronzio OA. Influence of Percutaneous Microelectrolysis in the Upper Trapezius on Pressure Pain Threshold and Surface Electromyography: A Randomized Sham-Controlled Pilot Trial. *Invasive Physiother Musculoskelet Med*. 2026;2:e23. doi: 10.63360/ipmm.v2.e23

Disclaimer/Publisher's Note

The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of IPMM and/or the editor(s). IPMM and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

Copyright

© 2026 by the authors.

Publication under the terms and conditions of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA) license (<https://creativecommons.org/licenses/by-nc-sa/4.0>)