

Research Article

Impact Of Percutaneous Electrolysis Vs. Ultrasound-Guided Percutaneous Neuromodulation In Plantar Fasciitis. In A Randomized Clinical Trial In Military Subjects.

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Abstract

Plantar fasciitis is a common condition that causes severe pain and biomechanical changes in the plantar fascia, resulting in disability. Despite conservative treatments, many cases do not improve and require surgery, being a leading cause of disability and military casualties.

Proposal: This study evaluated the impact of percutaneous electrolysis (PE) technique versus ultrasound-guided percutaneous neuromodulation (EPN) on pain intensity and satisfaction in the treatment of plantar fasciitis in military subjects.

Methodology: A clinical trial was conducted with two groups: group 1 (EP, n=34) and group 2 (EPN, n=33), at the "Central Military Hospital of Peru".

Results: The intensity of pain due to plantar fasciitis, measured with the VAS test, decreased in both groups ($p < 0.001$), and in comparison between groups, EP achieved a greater reduction in pain than the EPN technique ($p = 0.023$); in the variable satisfaction, with respect to the treatment, both groups presented better satisfaction (z 's < 1.96); in comparison between groups, EP presented better satisfaction than EPN ($p = 0.030$).

Conclusion: The study shows that both EP and EPN are effective in reducing pain and increasing satisfaction in military subjects with plantar fasciitis. Although EP causes greater pain during treatment, the results indicate that it offers greater satisfaction and overall efficacy compared to EPN.

Keywords : Percutaneous electrolysis, ultrasound guidance, percutaneous neuromodulation and plantar fasciitis.

INTRODUCTION

The plantar fascia or plantar aponeurosis is an anatomical structure composed of collagen and quasi-elastic fibers, whose main function is to stabilize the longitudinal arch of the foot and distribute forces during walking. It is divided into three bundles of longitudinal fibers: medial, central and lateral (1), which have a heterogeneous thickness. Due to biomechanical changes, these fibers can undergo degeneration, resulting in plantar fasciitis. This condition is one of the most common musculoskeletal disorders, affecting 15% of medical visits; particularly frequent in people of working age and runners, as well as in individuals in the military, who perform activities

that subject the plantar aponeurosis to prolonged loads and repetitive movements (2).

Percutaneous Electrolysis (PE) is a minimally invasive technique (3), that is expanding in Europe, using galvanic current through acupuncture-like needles and under ultrasound guidance (4). This technique has proven to be effective in the treatment of tendinopathies and muscle injuries (5), showing in preclinical studies an increase in the expression of anti-inflammatory and angiogenic genes (6), as well as improvements in collagen remodeling (7) (8). EP acts through double stimulation (9) (10): mechanical, by insertion of the needle, and biochemical, by direct electric current, which promotes the regeneration of tendons

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without damaging surrounding healthy tissues. (11) (12). The stimulation Mechanical is interpreted as non-thermal electrochemical ablation of the lesion by using a cathodic fluid (13). It generates mechanotransduction, activating fibrocytes that induce remodeling of the extracellular matrix (14). Electrical stimulation induces an electrolysis process at the negative cathode, promoting ablation of inflamed tissue. Although EP can cause discomfort in the treatment, modified needles and advanced devices minimize pain, and the technique has some contraindications that must be evaluated clinically.

Percutaneous ultrasound-guided neuromodulation (PEN) is an innovative therapeutic technique that uses alternating current TENS to modulate pain and improve neuromuscular function. Applied using modified needles guided by ultrasound. PEN stimulates peripheral nerves or motor points (15), favoring the regulation of neuronal responses and reducing sensitivity to pain. Its mechanism of action is based on the theory of "gate control", which inhibits pain signals at the spinal level (16). In addition, this technique has applications in the treatment of musculoskeletal and myofascial disorders, contributing to normalize the musculoskeletal system. PEN has also shown potential in the management of conditions such as urinary incontinence by modifying the behavior of the urinary tract. However, its application in plantar fasciitis still requires more scientific evidence.

Electrolysis and neuromodulation require ultrasound guidance which allows for greater precision in needle insertion, improving the safety and efficacy of the treatment.

MATERIALS AND METHODS

Design and sample

A randomized, prospective, longitudinal clinical trial was conducted in the physical medicine area of the Central Military Hospital of Peru with military subjects aged 18 to 65 years, following the Consolidated Standards of Reporting Trials criteria. CONSORT (17).

Following approval by the Clinical Research Ethics Committee at the Central Military Hospital of Peru and after verifying compliance with the Declaration of Helsinki, the Biomedical Law, the Law on Patient Autonomy in the Processing of their Data, and the Organic Law on Data Protection (WM Association, 2013), and approval of the project by the Research Ethics Committee of the European University of Madrid, with the entry registration code CIPI/19/171, The study was carried out during 4 weeks of intervention and 4 weeks of follow-up, in the Department of Physical Medicine, specifically in an office with access to the gym and the rehabilitation traumatology area.

The subjects of the study were those who belonged to the Peruvian Army and had the right to be treated only at the

Central Military Hospital of Peru and its polyclinics. The study was open to officers, technicians and civilians (non-assimilated health professionals), and of all types of professional rank, who were referred to the research clinic by psychiatrists and physiotherapists from the Physical Medicine area and its polyclinics.

For the study, a total of 72 military subjects of both sexes diagnosed with plantar fasciitis were collected. However, after the information was provided orally and with the freedom to make their own decisions, and those who decided to sign the informed consent, at the time of the evaluation, the selection criteria were considered; 5 of them were excluded for presenting pathologies unrelated to plantar fasciitis (2 with tarsal tunnel syndrome, 1 with valgus foot and Hallux, and 2 with Morton's neuron syndrome) and in the same way the other interferences were respected. The final sample was 67 military subjects; of which, 64 men and 3 women. Then, through simple randomization, two groups were obtained: a group of 33 men and 1 woman and another group of 31 men and 2 women.

To determine the assignment of techniques to each group, as well as the assignment of subjects, a "coin toss" was performed by a professional not involved in the research. Of these, a first group was obtained: "Sello", which corresponded to the EP technique and to the first subject; the second group: "Cara", which corresponded to the EPN technique and to the second subject.

Materials

The ultrasound machine used was a portable model, Chison Eco2 brand with linear probe, with frequency between 5.3 and 10MHz, assessment of plantar fascia thickness in longitudinal section and millimeters.

It was used according to the protocol indicated by the "Ecographer", the legal framework of ultrasound in physiotherapy is: ORDER CIN2135/2008 and the law of organization of health professions: LAW 44/2003, percutaneous electrolysis equipment, continuous low-frequency galvanic current (18) and an AWQ-104L Digital equipment, which has 4 outputs for stimulation and a fifth APD / EE output.

Assessment

The pain variable was the Visual Analogue Scale (VAS) test, which measures the intensity of pain subjectively, allowing the patient to indicate on a 10 cm line the intensity of their pain, from 0 (no pain) to 10 (maximum pain). In addition, ultrasound was used following the protocol indicated by the "Echograph" manual. (19) (20), an objective technique that allows observing the musculoskeletal structures and detecting possible alterations that may cause pain. The combination of both tools, subjective and objective, facilitated a more precise

evaluation of pain and allowed for an appropriate therapeutic intervention based on specific data. It also consisted of three evaluations of both groups (before treatment, after treatment and follow-up).

Regarding the variable satisfaction, at the end of the research, each subject proceeded to complete the survey formulated as a Likert scale. With 4 options from “bad” to “very good”. The following characteristics were taken into account : Evaluation of the environment (accessibility and possibility, size and comfort, and hygiene of the facilities), evaluation and treatment (duration of the evaluation, satisfaction with the equipment, duration of treatments, total duration of the study and evaluation of the research), and technological means (methodology, improvements in their pathology, improvements in their quality of life, perceived improvements in pain and satisfaction of having participated in the study.

Treatment

For the treatment of EP, the subject's position was prone with the foot to be treated uncovered and resting on a roller placed on the anterior and distal surface of the spinal tibial. Procedure: after the necessary information, to the subject about the importance of EP, a cleaning with alcohol was carried out, leaving the area clean, then a layer of cold conductive gel was placed and then the transducer in a longitudinal position on the plantar area of the calcaneus (21). The electrode (anode) was placed in the course and middle area of the Achilles tendon, then below the transducer the puncture was made in the affected fascia longitudinally with an inclination of 45° on average with the modified acupuncture needle that was connected to the pulser of the device at the negative pole (cathode). Once the needle was placed at the point of injury, the galvanic current was transmitted at an intensity of 300µA / 40 seconds (22) (18) and small movements were made. For treatment with EPN, the subject's position was supine on the table, with the foot to be treated relatively in hip external rotation and knee flexion, while the contralateral side was

in full extension. Next, the posterior tibial nerve was located with the transducer. Once the tibial nerve was located, the first puncture was carried out with the modified needle (23) and connected to the anode electrode. In the most distal part of the lateral nerve, the second puncture was made and connecting the needle to the electrode (cathode). Then, after removing the transducer, the TENS current was transmitted for 25 min per session and with an intensity according to the subject's tolerance, twice a week for 1 month.

Data analysis

IBM SPSS V.245 (Armonk, NY, USA) and jamovi V.2.3 (www.jamovi.org) programs were used for data analysis and production of figures. The level of significance was set at $\alpha = 0.05$ (or 95% confidence level) for all analyzes and a power $(1-\alpha\beta) = 0.95$ (see participants section).

RESULTS

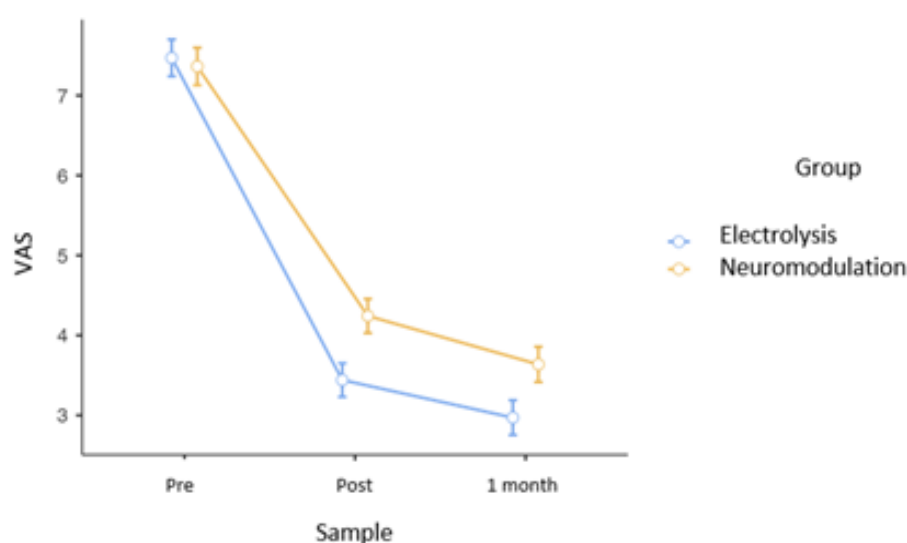
Pain intensity

Pain scores, as measured by the VAS test, varied considerably throughout the treatment (**Table 1**). The MR ANOVA with sphericity adjustment $\epsilon = 0.84$, confirmed this large effect of intake $F(1.68, 109.12) = 301.00$, $p < 0.001$, $\eta^2 = 0.82$. The post hoc analysis confirmed that both groups reduced their scores from pre to post ($p's < 0.05$) and from post to 1 month ($p's < 0.05$). Furthermore, simple interaction effects showed that the EP group achieved a greater reduction in pain than the EPN group between pre and post, $F(1,65) = 5.39$, $p = 0.023$, $\eta^2 = 0.08$, but with no differences in the evolution between pre and 1 month, $F(1,65) = 3.44$, $p = 0.068$, $\eta^2 = 0.05$, or between post and 1 month, $F(1,65) = 0.25$, $p = 0.615$, $\eta^2 < 0.01$. That is, both groups reduced pain, but the EP group did so to a greater extent in the post and to a lesser extent from post to 1 month (**Figure 1**). At 1 month, both groups reduced their pain similarly compared to pre. No main effect of group was found $F(1,65) = 3.80$, $p = 0.056$, $\eta^2 = 0.06$.

Table 1. Number of participants (N), Mean (M), Lower (I) and Upper (S) Limit of the Confidence Interval of the Mean at 95% and Standard Deviation (SD) of the plantar fascia thickness by group and sample.

Sample	Group	N	M	IC 95%		DT
				I	S	
Pre	Electrolysis	34	7.47	6.95	7.99	1.48
	Neuromodulation	33	7.36	6.94	7.79	1.19
Post	Electrolysis	34	3.44	3.01	3.87	1.24
	Neuromodulation	33	4.24	3.81	4.68	1.23
1 month	Electrolysis	34	2.97	2.56	3.38	1.17
	Neuromodulation	33	3.64	3.15	4.12	1.37

Nota. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 1. EVA test scores by group and sample. Error bars represent standard error of the mean.

Satisfaction questionnaire

According to the scores obtained in the questionnaire, it could be said that satisfaction was very positive. In most of the items, only good and very good frequencies were found (**Figure 2**). For example, in the evaluation and treatment sections, all the evaluations were good or very good. As shown in **Table 2**, both groups showed a similar satisfaction in all sections (z 's < 1.96). Only one significant difference was found according to Fisher's exact test ($p = 0.030$). The EP group showed greater satisfaction for having participated, since all their scores were distributed between good and very good. The EPN group, on the other hand, more frequently evaluated a regular satisfaction compared to the EP group, $z = 2.6$, $p < 0.01$.

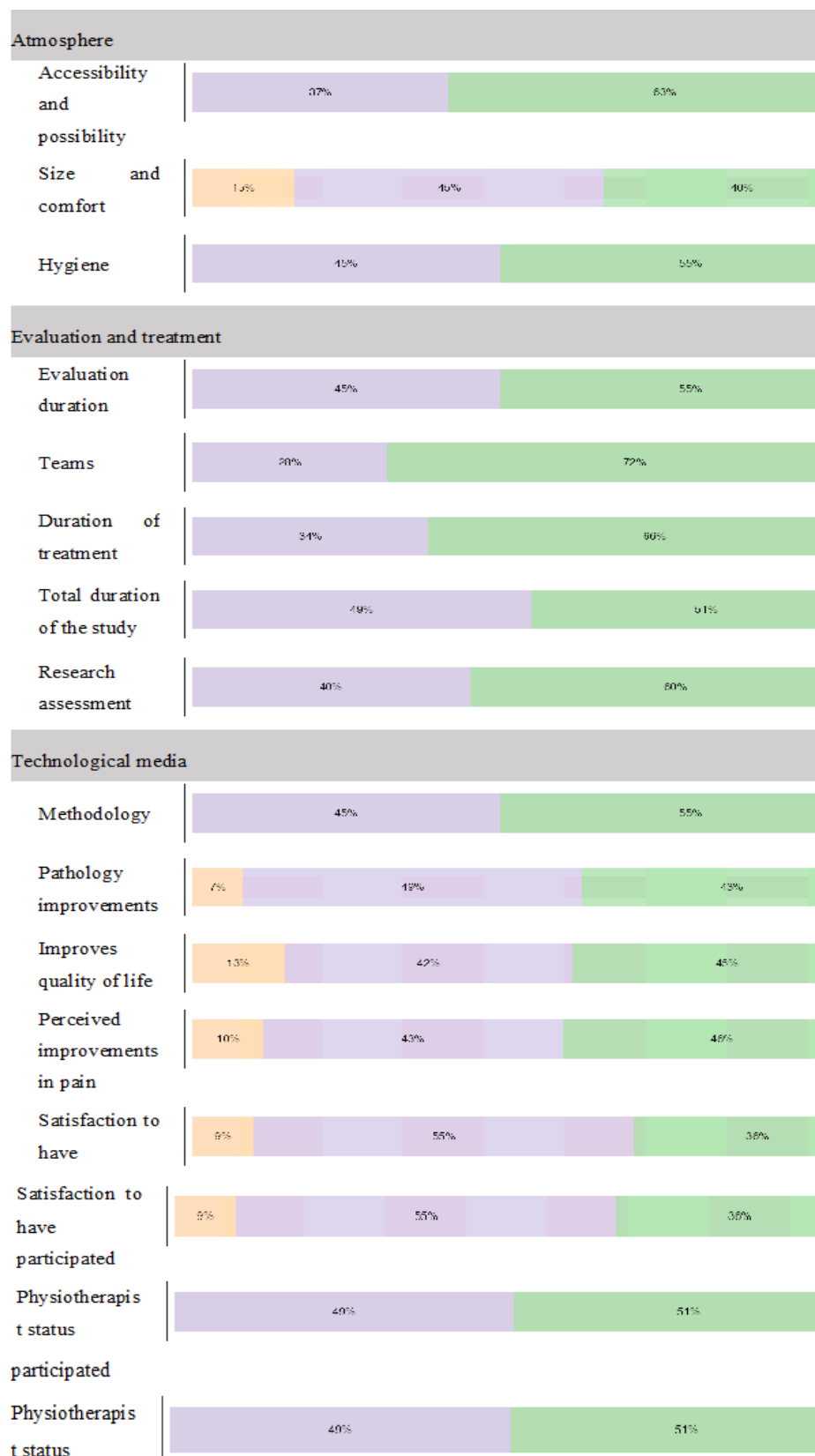
Table 2. Frequency distribution of the items in the satisfaction questionnaire by group.

Frequency					
Item	Group	Regular		Well	Very good
Hygiene	Electrolysis			14	20
	Neuromodulation			16	17
Evaluation and treatment					
Duration of the evaluation	Electrolysis			16	18
	Neuromodulation			14	19
Satisfaction with the equipment	Electrolysis			7	27
	Neuromodulation			12	21
Duration of treatment	Electrolysis			13	21
	Neuromodulation			10	23
Total duration of the study	Electrolysis			42	44
	Neuromodulation			36	46
Research assessment	Electrolysis			14	20
	Neuromodulation			13	20
Technological media					
Methodology	Electrolysis			15	19
	Neuromodulation			15	18
Improvements in your pathology	Electrolysis			15	18
	Neuromodulation			18	11
Improvements in your quality of life	Electrolysis	3		14	17
	Neuromodulation	6		14	13
Perceived improvements in pain	Electrolysis	3		14	17
	Neuromodulation	4		15	14
Satisfaction of having participated	Electrolysis	0	**	20	14

	Neuromodulation	6		17	10
Status of the physiotherapist	Electrolysis			17	17
	Neuromodulation			16	17

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 2. Percentage of responses by items of the satisfaction questionnaire.



DISCUSSION

Two treatment techniques for plantar fasciitis, EP and EPN, were compared in terms of pain intensity and patient satisfaction. A significant decrease in pain intensity was observed in both groups according to the VAS scale, suggesting that both techniques are effective for managing pain associated with this pathology. However, when comparing the two techniques, EP showed superior results in terms of pain reduction and satisfaction, which aligns with a previous and similar study, such as that of Iborra-Marcos Á., et al., 2018 (24): Furthermore, Fernández-Rodríguez T., et al., 2018, who used the EP technique, concluded that it was effective in the short term (0-3 months) and medium term (3-6 months), providing better pain relief and improvement in functional disability in the management of chronic pain (25). Regarding the dose of EP current for pain management in plantar fasciitis, Fernández RT., et al., 2018, conducted a study using an intensity of 28 mC and found an effect in reducing chronic heel pain (25). However, although the effect of the study is similar, the amount of current used is ambiguous, since it would have been ideal to consider the application time.

Pain management with other techniques in plantar fasciitis has been a goal of study, considering that the majority of the sample was in the chronic stage. Trojian, T., & Tucker AK., 2019, concluded that the dexamethasone group had better pain relief at four weeks (number needed to treat = 3) and decreased plantar fascia inflammation at three months compared to the saline injection group (26). Furthermore, Hsiao MY., et al., 2015, in a 2014 meta-analysis showed that ultrasound-guided injections are superior to palpation-guided injections in relieving pain and reducing plantar fascia thickness (27). Donley BG., et al., 2007, provided some evidence that the use of an NSAID may increase pain relief and decrease disability in patients with plantar fasciitis when used with a conservative treatment regimen (28). But Krogh TP., et al., 2013, question the long-term benefits of corticosteroids (usually >6 months), as most randomized trials show no benefit of steroid treatment over placebo injection, physical therapy, or rest alone (29). Furthermore, Kim C., et al., 2010, felt that beyond three weeks of symptoms, inflammatory activity is absent, therefore, corticosteroid injections for chronic plantar fasciitis do not have much relevance from a basic science perspective and should be done with caution due to potential complications (30). Also Lemont H., et al., 2003, disagreed on the potential complications of corticosteroid injections, which include fascial tear and fat pad atrophy. Rupture is estimated to occur in approximately 2.4% of patients receiving multiple injections, and injections into the calcaneal side of the plantar fascia are thought to be less likely to cause fat pad atrophy (31). On the other hand, Johannsen FE., et al., 2019,

conducted a combined study with corticosteroid injections and training (strength training and stretching), demonstrating a superior short- and long-term effect on plantar fasciitis, with suggestions on limiting loading, running and jumping, and recommendations for the use of cushioned shoes and insoles (32). This research creates discrepancies in oral lifestyle changes, apart from the management of tissue damage. In addition, the suggestions made could have modified the effects of the study, thus reducing the value of the evidence. No studies were found on the reduction of pain in plantar fasciitis by stimulating the posterior tibial nerve with the EPN technique, nor was there evidence of a comparison between the EP technique and the EPN technique in the treatment of plantar fasciitis or other pathologies. However, Erken HY., et al., 2014, demonstrated a reduction in chronic pain by stimulating the inferior calcaneal nerve using the ANRF technique (33).

Patient satisfaction is a crucial aspect to consider when evaluating the effectiveness of any medical treatment. In the case of treatment of plantar fasciitis using EP and EPN, high patient satisfaction has been observed. Compared between techniques, EP had better acceptance due to the efficacy of the treatment. Studies have shown that a significant percentage of patients report favorable satisfaction with both techniques treated individually and in different structures. For example, one study found that 97.5% of patients treated with EP experienced improvements in symptoms and showed high satisfaction with the treatment. Abat F, et al., 2014, patient satisfaction at the end of treatment at 3 months after treatment with percutaneous electrolysis was excellent in 26 cases (78.8%) (34). Satisfaction of patients undergoing EPN, 75% of participants, reported improvements in pain and overall satisfaction with the treatment. Valeria Calero J., et al., 2022, surprisingly both EP procedures were perceived as "less painful" compared to dry (35) needling. However, these investigations were carried out in different pathologies and individually by technique, and no comparative studies were found between the two techniques in the specific treatment of plantar fasciitis.

CONCLUSION

Both the EP technique applied to the plantar fascia and EPN applied to the tibial nerve were shown to be effective in reducing pain intensity in military subjects with plantar fasciitis. However, the EP technique had a greater impact on pain reduction compared to EPN. In addition, both treatments were well accepted, with subjects showing greater satisfaction after receiving EP treatment than EPN. These results suggest that EP may be a more effective and satisfactory therapeutic option for the management of pain associated with plantar fasciitis in military subjects.

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