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Percutaneous Electrical Nerve Stimulation Versus Dry Needling: Effectiveness in the Treatment of Chronic Low Back Pain

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ABSTRACT. **Objective:** The aim of this study was to evaluate the effectiveness of treating myofascial trigger points [TrPs] with dry needling [DN] compared to percutaneous electrical nerve stimulation [PENS].

Method: In this clinical trial, 122 subjects suffering from non-specific chronic low back pain [CLBP] were treated. They were randomly distributed into two treatment groups: one taking PENS and the other taking DN of TrPs on the deep lumbar paraspinal muscles [lumbar multifidi], quadratus lumborum, and gluteus medius. Four variables were measured: perceived pain and sleep quality using a visual analog scale [VAS], pressure-pain tolerance threshold on TrPs with an algometer, and quality of life assessed with the Oswestry Disability Index.

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Results: At least one TrP was found in all patients, most commonly situated in the quadratus lumborum muscle [97.6 percent]. The improvement achieved for both treatment groups was similar in all the measured variables, although the DN group carried out fewer sessions than the PENS group.

Conclusions: It could be concluded that the effectiveness of DN is comparable to that of PENS and, therefore, it may be considered as another useful tool with limited adverse effects within the multidisciplinary approach required in the management of non-specific CLBP.

KEYWORDS. Chronic low back pain, Trigger points, PENS, Dry-needling, Myofascial pain syndrome

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INTRODUCTION

The incidence of chronic low backpain [CLBP] is reported to be very high. Between 60 and 80 percent of the population have lumbar pain in the course of their lives (1, 2). Treatment for CLBP is mainly pharmacological, given that it provides a temporary relief. However, it is associated with side effects, thus the current trend is to seek alternative, non-pharmacological treatments (3, 4). For this reason, clinical practice guidelines recommend using a multidisciplinary approach (2, 5), through applying different techniques to CLBP, in which percutaneous electrical nerve stimulation [PENS] is included and considered as a highly effective analgesic technique (3, 6).

Another effective treatment for muscular pain, and the object of the ongoing study, is dry needling [DN] of myofascial trigger points [TrPs] which gets performed on selected muscles of the lower spine and pelvis (7–9). The comparison of the effectiveness of DN to that of PENS is of interest due to the lower costs that its use and practice entail.

Percutaneous electrical nerve stimulation is an analgesic treatment in which low frequency electrical currents are applied through needles inserted into the affected areas. It consists in nerve stimulation at the level of the dermatomes corresponding to the area affected by pain. The analgesic effect is based on Melzack and Wall's Gate Control theory (10). The effectiveness of PENS in the treatment of CLBP has been demonstrated in comparison with other commonly used therapies (3, 4).

At present, a consistent theory attributes the cause of musculoskeletal pain to the existence of an active TrP, the myofascial pain syndrome theory (9, 11, 12). A TrP is a hyperirritable nodule found in a taut, palpable band of skeletal muscle, producing focal pain on compression. Seen from a microscopic perspective, it is made up of multiple contraction knots, representing a severe, localized shortening of select sarcomeres. The most accepted and developed hypothesis explaining the etiology of TrP, suggests that TrPs are the result of dysfunctional motor endplates of extrafusal skeletal muscle fiber, characterized by an excessive release of acetylcholine. Therefore this could be conceived as a neuromuscular dysfunction. Besides pain, TrPs are the cause of functional limitation, weakness, and motor ataxia (12).

There are many techniques for TrP treatment, but DN has shown to be effective in inactivating them (13). The injection onto the TrP of substances such as local anaesthetics, nonsteroidal antinflamatory drugs [NSAID], or botulinum toxin has not shown greater effectiveness than DN, which does not add any substance and uses only the mechanical effects as a therapy, with the condition of obtaining the local twitch response (14, 15).

Previous comparative studies on these two techniques have never been carried out. Both of them have been separately tested and proved highly effective, PENS as a treatment for CLBP (3, 4, 6), and DN as a technique of choice in the treatment of myofascial pain (14). Given the similarities between chronic muscular pain and myofascial pain and the involvement of TrPs in the circuits of hyperalgesia and chronic pain [peripheral sensitization, spinal segmental sensitization with involvement in myotome, sclerotome and dermatome, central sensitization, and dysfunctional inhibition], we propose a comparison of the two techniques, one of them with the treatment focused on the "target organ" [the DN], and the other with the stimulation of

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peripheral sensory nerves at the level of the dermatomes involved in low back pain, also known as PENS.

Therefore, the main objective of this study is to assess the effectiveness of DN therapy for CLBP by comparing it to PENS. Furthermore, we aim to establish a link between non-specific CLBP and the presence of TrPs in order to explain its clinical background and justify its treatment.

MATERIALS AND METHODS

A pragmatic clinical trial was carried out by randomizing two parallel groups in order to compare the effectiveness of DN to that of PENS in the non-pharmacological treatment of non-specific CLBP. The trial was based on previous studies (3, 16, 17) in which patients were recruited from four primary health care centers belonging to the Health Service in the city of Zaragoza between July 2004 and 2005. These patients were randomly allocated into two groups and each one was given a treatment, either PENS or DN. Both methods were applied in all health centers participating in the study.

A third-party investigator carried out the randomized distribution of both the sequence and the assignment, by using a random numbers table applied in order of inclusion of each patient into the study.

The study was done on patients over 18 years of age who had been referred to the physiotherapy consultation by their primary physician, and whose CLBP had been evolving for four months or more, or fewer duration if it has had been a recidivate. All of them expressed their consent to participate in this research after being informed. All the subjects had previously received pharmacological treatment [NSAIDs and/or analgesics] and had reported little or modest improvement, to the extent that at the time of inclusion in the study, 65.3 percent of the subjects, equally distributed into both treatment groups, were taking medication, either when needed or on a regular basis. Exclusion criteria were suspected or diagnosed fibromyalgia syndrome and suspected or diagnosed structural lesions in the lumbar column, either at the disc level or on any other structure. Concomitant non-pharmacological treatments [acupuncture, homeopathy] were also excluded, as well as any medical conditions or circumstances that, in the researcher's judgment, might have interfered in the results.

Neither advanced age, nor the possible existence of facetary and/or ligament problems with normal radiology that might be modifier factors of the effect, were considered as exclusion criteria. It is also possible that degenerative problems of different ranges may coexist, or any other alterations of the statics with overload of capsuloligamentary structures that may also participate in the pain and play an important role in the perpetuation of the active TrPs.

In brief, the patients diagnosed with non-specific CLBP were included according to an exclusively medical criterion, without regarding alterations in any other complementary test, but without discriminating the origin of the low back pain.

The independent variable was the therapeutic method assigned: PENS or DN. The dependent variables were: 1. Perceived pain measured using a visual analog scale [VAS: 0 as absence of pain and 10 as maximum pain in a total of 10 cm, 1 cm per level]; 2. Pain tolerance measured by algometer on selected TrPs [pain-pressure tolerance threshold, PPT]; the more active the TrP is, the less pressure it can tolerate (18); 3. Sleep quality [also measured using VAS], and 4. Quality of life measured in terms of ability to function using the Oswestry Disability Index.

Other variables were registered including sex, age, pain background, medication, previous therapies [pharmacological treatment, type of medication, duration of treatment, and development], trauma or surgical events, and other concurrent conditions. At the time of the study, 65.3 percent of the subjects in the study were taking some kind of medication for CLBP, either on a regular basis [40 percent] or as required depending on the occurrence of pain [60 percent]. The duration of medication ranged from three weeks [for cases of exacerbated occurrence of CLBP] to several years. The limited improvement of non-specific CLBP symptoms with pharmacological treatment is the reason that led us to seek an alternative, non-pharmacological therapy (9).

Once the patients were included in the study, an initial measurement of the dependent variables was made and a diagnosis of active TrPs present in the previously selected muscles was carried out, no matter what the therapy they were to receive. Those muscles were: deep lumbar paraspinal muscles, right and left quadratus

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IMAGE 1.

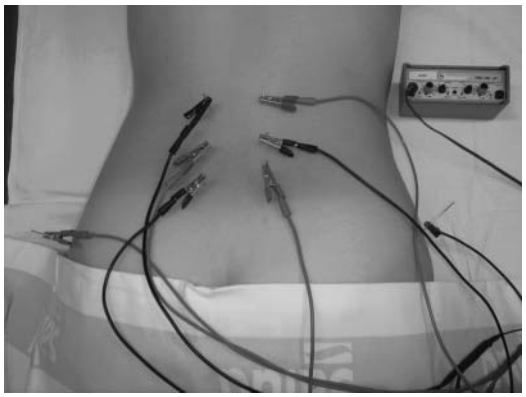
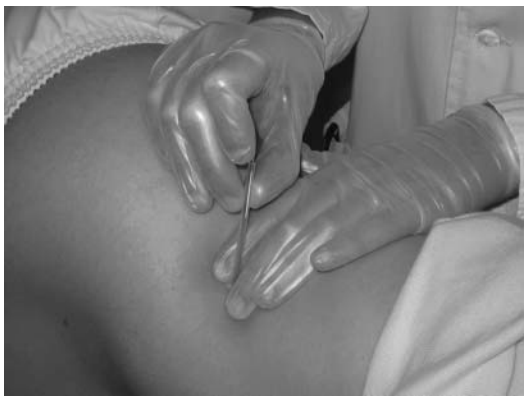


IMAGE 2.



lumborum [superficial TrPs] (19, 20), and right and left gluteus medius [TrP 3] according to Travell and Simons' nomenclature (12). The criteria for diagnosis of the active TrPs were the existence of a painful nodule in taut band and the pain recognized by the patient when pressure is exerted on it (12).

Percutaneous electrical nerve stimulation therapy consisted of the application of a low-frequency [4 Hz] electric current through eight 0.3 × 25 mm acupuncture needles, which were introduced at a depth of 2 to 2.5 cms. They were positioned at the level of dermatomes from L2 to L5, as shown in Image 1. The duration of the impulse was 0.3 milliseconds and it was applied with a portable device normally used in primary care facilities [Carin TNS 190 portable]. Each patient was subjected to a total of nine PENS sessions spread over three weeks, three sessions per week on alternate days. Every session lasted for 30 minutes.

Dry needling therapy consisted of three sessions during three weeks, once per week, leaving at least an eight-day latent period between sessions (12). The treatment was registered and consisted of the DN technique performed using needles with plastic guide tubes, measuring 0.30 × 40 mm. It was applied according to the fast-in and fast-out Hong's technique [Image 2], which is based on the search for local twitch response (15), followed by the spray and stretch technique for each treated muscle. Each muscle was passively stretched in three sequences and vapocoolant spray was applied to the pain reference zone in three sweeps for each sequence. In the first session, treatment was carried out on the TrPs diagnosed during the initial assessment. In successive sessions, only those TrPs that remained active were treated.

In order to minimize variability from having to involve professionals from different fields for each therapy, researchers were previously trained to perform both therapies (19, 20). Variable measurement criteria were also unified. In our study we have tried to minimize these shortcomings through consensus in TrP diagnosis criteria and training for all study physiotherapists, regardless of the fact whether they have an expertise in TrP management or lack thereof. Permanent telephone contact was maintained with the coordinating researcher in order to solve any kind of doubts or problems that might have risen.

Additionally, peripheral noxious stimulation would be produced by the actual insertion of the needle, whether superficial or deep, which would activate pain control mechanisms at the level of the posterior horn of the spinal cord (21, 22). For this reason no placebo group was used for either of the compared therapies [in their study on PENS, Ghoname et al. (3) did use one].

With regard to the dependent variables, VAS pain and quality of sleep were measured on three occasions: at the beginning, at an intermediate point [before the second DN session and the sixth PENS session], and at the end of the therapy. The algometry on TrPs was performed at the beginning and at the end, and likewise for quality of life/functioning with the Oswestry Disability Index.

All dependent variable measurements were made by a blinded evaluator. The variables that showed a normal distribution were contrasted

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using Student's *t*-test. These were VAS pain and algometry on the deep paraspinal muscles. A Mann–Whitney U test was used for the variables that did not follow a normal distribution: These were sleep quality, algometry on the quadratus lumborum and gluteus medius, and the Oswestry Disability Index.

RESULTS

There was a recruitment of 91 women and 31 men, for a total of 122 patients. The average age was 45.85 years, with a standard deviation of 14.4. PENS therapy was given to 67 patients and DN therapy to 68. The study was abandoned by 10 patients, 3 from PENS and 7 from DN therapy.

Being a pragmatic clinical trial, the statistical analysis of this study was based on the actual data. At the end of the study, the data analyzed were those from the patients who had completed the treatment. The confidence interval used was of about 95 percent.

As shown in Table 1, both groups gave similar measurements at the start of the study. All patients [100 percent] presented at least one TrP, the most common location being the quadratus lumborum muscle [97.6 percent].

Table 2 shows results for the variables VAS pain and sleep quality. The difference between initial and final measurements for each treatment was calculated to obtain the degree of improvement. As observed, there were no significant differences in the results of both therapies [$P = 0.94$ for VAS pain, $P = 0.68$ for quality of sleep].

Table 3 gives the results of algometry on deep paraspinal muscles, quadratus lumborum, and gluteus medius muscles. If less pain is found at the TrP, the values measured by the algometer become higher. The improvement was calculated from the difference between initial and final measurements. As we could see, there were no significant differences in the results of both therapies [$P = 0.93$ for right deep paraspinal, $P = 0.83$ for left deep paraspinal, $P = 0.33$ for right quadratus lumborum, $P = 0.12$ for left quadratus lumborun, $P = 0.32$ for right gluteus medius, and $P = 0.14$ for left gluteus medius].

Regarding the quality of life in terms of ability to function measured using the Oswestry Disability Index, improvement was considered as the difference between initial and final measurements. The following sections were studied: personal care, lifting weight, walking, sitting, standing, and social life. As can be seen in Table 4, there were no significant differences in the results of both therapies with regard to quality of life in any sections [personal care P = 0,94, walking P = 0,86, sitting P = 0, 51, standing P = 0, 26, social life P = 0, 18], except in "lifting weight" [P = 0.03], where the improvement was greater for the DN technique.

In terms of clinical relevance, a lessening of VAS pain of 40 percent or more was considered as an improvement. In Table 5 the improvement results for both groups are shown.

DISCUSSION

Similar levels of effectiveness for the treatment of non-specific CLBP in both the techniques were compared. Differences in the results of both interventions were not relevant. We obtained changes in all the variables of measurement for both treatment groups. However, the most relevant result was the drop of local sensitivity to compression on existing TrPs [measured with algometry] for both PENS treated group and DN treated group.

The clinical recovery obtained along with the changes in local sensitivity to compression obtained in TrPs confirmed previous studies, from those of Dr. Travell in the second half of the 20th century to the most recent publications (23), which back up a close relationship between CLBP and the TrPs. Although the pathophysiology of the TrPs is not completely known, it has been demonstrated the high concentration of nociceptive substances inside active TrPs and its link with central sensitiveness circuits in the present concept of chronic pain (24). The drop in the concentration of nociceptive substances after the local twitch response elicited would explain the inactivation of the active TrP with DN, through a specific local technique on the sensitized tissue which is the active TrP (25).

We have also found certain significant differences in the PPT algometric measurements of the active TrPs in the subjects treated with PENS, who were not given any local treatment on the TrPs. At this point, analgesia in the mechanism of myofascial pain could be explained in terms of central desensitization. The involvement

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TABLE 1. Initial Values for Both Groups

Variables	PENS	DN	*P*-value
GENDER:			
Male	18.8%	32.8%	0.08
Female	81.3%	67.2%	
AGE:			
<40 years old	34.4%	50.0%	0.18
40–60 years old	45.3%	31.0%	
>60 years old	20.3%	19.0%	
OCCUPATION:			
Sedentary	23.4%	20.0%	0.89
Standing position	25.0%	25.9%	
Physical activity	48.5%	53.5%	
DEVELOPMENT PERIOD:			
0–3 months	15.6%	25.8%	0.52
3–6 months	25%	25.8%	
6–12 months	15.6%	10.3%	
Over one year	43.7%	36.2%	
PREVIOUS OCCURRENCES:			
Yes	87.5%	89.7%	0.71
No	12.5%	10.3%	
MEDICATION:			
Yes	60.32%	70.69%	0.23
No	39.68%	29.31%	
INITIAL VAS PAIN	6.27[±1.68] point	6.04[±1.68] point	0.45
INITIAL QUALITY OF SLEEP [median VAS values]	3.75[±2.95] point	3.89[±3.04] point	0.81
PAIN MEASURED BY ALGOMETRY [median initial values]			
Right deep paraspinal	6.38[±2.17] g/cm^2	6.83[±3.10] g/cm^2	0.59
Left deep paraspinal	5.97[±2.37] g/cm^2	6.33[±2.64] g/cm^2	0.68
Right quadratus lumbor	5.26[±2.39] g/cm^2	5.28[±2.64] g/cm^2	0.96
Left quadratus lumbor	5.54[2.60]± g/cm^2	5.19[±2.71] g/cm^2	0.55
Right gluteus medius	5.71[±2.79] g/cm^2	5.48[±2.65] g/cm^2	0.69
Left gluteus medius	5.63[±2.97] g/cm^2	5.50[±2.55] g/cm^2	0.84

TABLE 2. Median Difference Values in VAS Measurements of Pain and Sleep Quality at the Beginning and the End of the Treatment According to Therapy

	PENS	DN	*P*-value
Initial–final VAS difference in pain	2.38[±2.27]	2.35[±2.58]	0.94
Initial–final VAS difference in sleep quality	1.72[±2.67]	1.85[±2.66]	0.68

Statistical analyses used: Student's *t*-test for pain perception and Mann–Whitney U test for sleep quality.

TABLE 3 Median Difference Values for Initial and Final Algometry Readings According to Therapy

	PENS	DN	*P*-value
Right deep paraspinal	0.91[±4.39]	1.04[±4.45]	0.93
Left deep paraspinal	1.75[±4.6]	2.06[±3.35]	0.83
Right quadratus lumborum	0.89[±3.10]	1.73[±3.47]	0.33
Left quadratus lumborun	0.76[±2.77]	1.64[±2.91]	0.12
Right gluteus medius	0.77[±3.27]	0.87[±2.76]	0.32
Left gluteus medius	0.58[±2.46]	1.77[±3.44]	0.14

Statistical analyses used: Student's *t*-test for deep paraspinal muscles and Mann–Whitney U test for quadratus lumborum and gluteus medius muscles.

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TABLE 4. Median Difference Values between Initial and Final Measurements of Oswestry Disability Index Variables

	PENS	DN	*P*-value
Personal care	0.38[±0.97]	0.34[±0.82]	0.94
Lifting weight	0.59[±1.42]	0.06[±0.96]	0.03
Walking	0.17[±0.98]	0.15[±0.57]	0.86
Sitting	0.21[±0.89]	0.33[±1.05]	0.51
Standing	0.25[±0.84]	0.41[±0.82]	0.26
Social life	0.72[±1.10]	0.72[±3.03]	0.178

Statistical analysis used: Mann–Whitney U test.

TABLE 5. Clinical Relevance

	No of patients with more than 40% reduction in VAS pain	Percentage of patients with more than 40% reduction in VAS pain
PENS	28	53.85%
DN	24	46.15%

of central desensitization in TrPs related pain syndromes can be discussed in terms of bilateral decrease in PPT, central changes following dermatomal electrical stimulation, and temporal summation of pain in the myofascial pain syndromes (18, 24, 25).

Percutaneous electrical nerve stimulation proved to be a simpler technique to apply than DN because it raised less problems or doubts among professionals in the field. DN needs a previous process of standardization before it can be applied. However, as we required a larger number of PENS sessions in order to obtain the same results, we can state that DN is more cost-effective.

Postreatment soreness could justify the higher rates of abandonment in the DN treatment (15). Moreover, in cases in which the level of initial pain was very high on the VAS, an important lessening of pain was observed in more than half of the subjects [intermediate measurement] with higher levels of tolerance to the treatment. The less the initial pain was, the lesser the tolerance was. This finding could suggest that DN might be an advisable technique for severe back pain, as it starts with higher levels of pain and might compensate for the pain caused by the treatment.

In brief, we can state that both techniques are equally effective for short-term treatment of non-specific CLBP. DN proved to be more cost-effective, but postreatment soreness associated to it can cause a higher rate of abandonment with regard to PENS. Therefore, we have two useful tools to deal with chronic muscular pain the action of which have been confirmed in different ways in the context of neuromuscular chronic pain matrix.

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