Effectiveness of Neuromodulation on Abductor Muscles Electrical Activity in Subjects With Low Back Pain: A Randomized, Controlled Crossover Trial

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Abstract

Introduction

Non-specific chronic low back pain (NSCLBP) is one of the main reasons of loss of function, that can have consequences such as job absenteeism and a decrease in the quality of life. Based in clinical findings and scientific studies, different risks factors have been stated as potential implication, such as muscles weakness and muscle tightness. Electromagnetic fields positively influence human tissue and have several therapeutic effects such as: pain relief, healing bone fracture, myorelaxation, myostimulation and joint mobilization. The aim of this study was to investigate whether the effect of a magnetic particle tape applied to the lumbar area in subjects with NSCLBP influences the strength of abductor muscle contraction and whether an immediate effect is obtained on surface electromyography (sEMG) of the Gluteus Medius and the Tensor of the Fascia Lata.

Methods

It was carried out a double-blind, randomized, controlled, crossover trial and with test retest, with 41 consecutive patients younger than 65 years who previously diagnosed with NSCLBP to assess the effect of a tape with magnetic particles over hip abductor muscles strength and activity. Electromyographic (EMG) and force data were obtained during the Hip Stability Isometric Test (HipSIT). The HipSIT was used to assess the abduction strength using a hand-held dynamometer and electromyography (EMG). The HipSIT uses the maximum voluntary isometric contraction (MVIC). Four trials were recorded and the mean extracted for analysis. The tape was applied with either a magnetic particle tape or a sham magnetic particle tape bilaterally without tension on from L1 to L5 paravertebral muscles.

Results

The significant increase in the recruitment of fibers and the significant increase in the maximum voluntary contraction by applying magnetic particle tape with respect to the placebo tape, correspond to the increases in the Peak Force and the decrease in the time to reach the maximum force (peak time) of both muscles.

Conclusions

Application of a magnetic particle tape in people with low back pain suggest an increase in muscle strength of the Gluteus Medius and Tensor Fascia Lata bilaterally during the HipSIT test. Lumbar metameric neuromodulation with Magnetic Tape improves muscle activation of the hip musculature.

Impact Statement

The findings of this study will provide data on the effectiveness of a tape with magnetic particles for People with NSCLP for health care policy makers, physicians, and insurers. Data from this study will also inform future pragmatic trials for non-pharmacological interventions and chronic musculoskeletal pain conditions.

Introduction

Non-specific chronic low back pain (NSCLBP) is one of the main reasons of loss of function, that can have consequences such as job absenteeism and a decrease in the quality of life[1,2]. Based in clinical findings and scientific studies, different risks factors have been stated as potential implication, such as muscles weakness[3,4] and muscle tightness[5].

The NSCLBP conservative treatment could include medication management and physical therapy[6]. Several physical therapy interventions have been suggested, mainly exercise programs, manual therapy, education and electrotherapy[7]. There is low-quality evidence that kinesiotaping has a beneficial role in pain reduction and disability improvement for patients with NSCLBP[8]. However, elastic taping therapy in patients with lumbar radiculopathy has a positive effect on pain and functional status compared to rigid tape. Elastic taping can be recommended for clinical use because its effect is superior in some recovery parameters and its ease of use[9].

Electromagnetic fields positively influence human tissue and have a number of therapeutic effects such as: pain relief, healing bone fracture, myorelaxation, myostimulation and joint mobilization. Gossling HR et al.[10] scientifically demonstrated in 1992 that the activation of body magnetic fields in different traumatic pathologies can be as effective compared to surgical interventions. Li Y et al.[11] reached the same conclusions in 2020. Magnetotherapy could provide a non-invasive, safe and easy method to directly treat the area of pain[12].

The lumbopelvic and hip muscles dysfunction have been found in NSCLBP population[13]. Gluteus medius and hip muscles are more likely to show altered recruitment and reduced strength[14,15]. The superior gluteal nerve is found in the lower pelvis and arises from the dorsal divisions of the L4, L5, and S1 nerve roots of the sacral plexus. The superior gluteal nerve is responsible for innervation of the gluteus medius, gluteus minimus, and tensor fasciae latae muscles[16].

Although the hip joint is one of the most inherently stable joints, hip pain and injuries, caused by hip instability are problematic and common in active individuals. The gluteus medius is the largest muscle among the hip abductor muscles and is vital for hip stability[17].

Magnetic particle tape is an elastic adhesive tape that incorporates magnetic particles with the ability to create low-power magnetic fields, which in a previous study provided preliminary results of blood flow and pain modulation in subjects with low back pain. [18] It is unknown whether lumbar metameric neuromodulation would improve muscle activation of the hip musculature in patients with NSCLBP.

The aim of this study was to investigate whether the effect of a magnetic particle tape applied to the lumbar area in subjects with NSCLBP influences the strength of abductor muscle contraction and whether an immediate effect is obtained on surface electromyography (sEMG) of the Gluteus Medius and the Tensor of the Fascia Lata.

Methods

2.1. Study Design

A Randomized, Controlled Crossover Trial was conducted between October 2021 and February 2022 to assess the effect of a tape with magnetic particles over hip abductor muscles strength and activity. Forty-one consecutive patients younger than 65 years who previously diagnosed with NSCLBP by a physician were recruited to participate in the study from the following clinics from Valencia (Spain): Acuario Sports Clinic, Aston Clinic specializing in traumatology and sports physiotherapy, and Francisco Selva Physiotherapy Clinic.

2.2. Ethics Approval and Consent to Participate

All participants were informed about the study, they provided informed consent in accordance with the Helsinki Declaration and the study was approved for the Ethical Committee of University of Valencia by number 1622496 and registered on 20/05/2021 at clinicaltrials.gov (NCT04893967). The recommendations of the “Consolidated Standards of Reporting Trials” (CONSORT) were followed[19] (Figure 1).

2.3. Participants

From an initial sample of 56 subjects, 41 were finally included in the study, applying the following inclusion and exclusion criteria:

Inclusion criteria were as follow: (1) over 18 and less than 65 years of age and (2) having a medical diagnosis of NSCLBP. The exclusion criteria were as follow: (1) presence of malignant diseases such as cancer, neurological or degenerative diseases (2) pain duration less than three months (3) having conditions that would be a contraindication for the adhesive tape on the skin such as allergies (4) being pregnant (5) having a pacemaker (6) taking any medication that may interact with magnetic fields or contraindicated (7) metallic implant in lower limb (8) recent injury or trauma in spine or lower limbs.

The participants were assigned randomly into either magnetic particle tape group (MPT=21) or sham magnetic particle tape group (SMPT=21). Two conditions were applied in a crossover design for each condition with a washout period of 1 day between the trials.

2.3.1. Sample Size

The latest version of the free GRANMO program version 7.12 was used. The sample size of 41 randomly distributed patients provided at least 80% statistical power to detect a difference in a cut-off frequency at 20–450 Hz in the isometric tests. This calculation assumed a bilateral significance level of 5% using the average of the three maximum peaks of the root mean square (RMS) signal during the 5 s isometric test. In addition, a loss rate of 10% was calculated until the end of the study.

2.4. Tests and Measurements

The Hip Stability Isometric Test (HipSIT)[20] was used to assess the abduction strength. The HipSIT offers a unique assessment of the strength of the entire posterolateral hip musculature without the need to evaluate each muscle alone[21].The subject was instructed to separate the knees while maintaining contact between the heels, moving the superior hip into abduction[21]. The HipSIT uses the maximum voluntary isometric contraction (MVIC).

Participants were positioned in side-lying on the treatment plinth and the lower limbs in 45° of hip flexion and 90° of knee flexion asked to perform 4 MVIC using the dynamometer Lafayette ™ handheld dynamometer-HHD (Lafayette Instrument Company, Lafayette, IN, USA). This instrument has been widely used to measure muscle strength because of it has shown excellent intrarater and interrater reliability and validity compared with the gold standard isokinetic dynamometer[22].

The intervention was delivered by an expert physiotherapist woman in the use of electromyography (EMG) and a hand-held dynamometer (HHD). Physiotherapist received training from mDurance® system two years ago.

It was placed between the femur and the strap, over a mark located 5 cm proximal to the lateral knee joint line and the participant was instructed to push the tested leg upwards (abduction) in 20° of abduction[21]. Participants were instructed to push the dynamometer as hard as they could for 5 seconds. They performed 1 practice trial, rested for 30 seconds, and then performed the measured trials[21]. Four trials were recorded and the mean extracted for analysis[23].

A pre-defined script was used to describe the tests so as not to bias efforts exerted by participants. Peak force in kilograms (Kg), average force in kilograms (kg), and peak time in seconds (sec) over a five second maximal voluntary isometric contraction was recorded for hip abductor muscles. (Figure 2 A).

Muscles-activity data were obtained using a validated[21] surface electromyography (EMG) system (mDurance® system; mDurance Solutions SL, Granada, Spain). This novel system includes a user-friendly software, and a light hardware, which make it more affordable and accessible for clinicians and sport trainers. The skin was prepared by scrubbing the area using a cotton ball soaked with rubbing alcohol.

The surface EMG electrodes were placed over the muscle's bellies and in line with the muscle-fibbers orientation of the Tensor Fascia Latae (TFL) and gluteus medius bilaterally[24]. The amplitude during the MVIC trials were collected. Gluteus medius and TFL RMS mean (mV), RMS mean/sec (mV/sec) and MVC mean (mV). We used the equipment, prepared the exam, collected and rectified signals in accordance with the SENIAM guidelines[25] (Figure 2 B).

Each session before intervention one initial measure of the test was made recording MVIC and EMG like a control measure the baseline measures were obtained. Four tests were performed, with a 30-second rest between trials. Mean values were calculated for each participant. When compensation was identified, values were discarded and a new evaluation was done after 20 seconds[21].

Participants were also urged to abstain from high intensity exercise for the 24 hours preceding both testing sessions.

2.4.1. Data Processing

First, the isometric tests were filtered using a fourth order Butterworth bandpass filter with a cut-off frequency at 20–450 Hz. Second, the signal was smoothed using a window size of 0.025 s root mean square (RMS) and an overlapping of 0.0125 s between windows for both systems separately. And third, the MVIC value was calculated using the average of the three maximum peaks of the RMS signal during the 5 s isometric test and being the MVIC used for normalized the RMS signal of each system[24].

2.5. Intervention

The researcher who applied the tape were unknown about what were applying by using a black tape non identifiable. The therapist was given the tape to apply in each case. She did not know if it was the experimental tape or the placebo tape. The allocation of the participants for the tape application was randomized using the program Random Allocation Software[26] and then was applied with either the MPT group or SMPT group bilaterally without tension on from L1 to L5 paravertebral muscles[27] (Figure 3).

In the first session, they completed the evaluation form and the informed consent form and conducted the HipSIT using dynamometer and EMG for muscle strength assessments.

2.6. Statistical Analyses

For the statistical analysis, the R Ver. 4.1.3. program was used. (R Foundation for Statistical Computing, Institute for Statistics and Mathematics, Welthandelsplatz 1, 1020 Vienna, Austria) and the "refund"[28] package.

The level of significance was established at $p<0.05$.

The Shapiro-Wilk test was used to determine the distribution of the quantitative variables. Qualitative variables were described in absolute values and relative frequencies and quantitative variables as mean and standard deviation.

The outcome variables were analyzed using a robust model of repeated measures with two factors, between (groups) and within (measurements), due to the non-normal distribution of the variables; the omnibus test reports with its level of significance an Anova-type pseudo-statistic obtained by bootstrap (ATS_{boot}). For the post hoc tests an exact permutation test between groups and the Wilcoxon Signed Rank test within groups were applied, in both cases the Bonferroni correction was applied.

The effect size was calculated with the statistic η^2_p (partial eta squared) obtained by bootstrap due to the non-normal distribution of the variables, defined as small (0.01-0.06), moderate (0.06-0.14) and large (>0.14). In the post hoc tests, the non-parametric statistic r was used as the effect size, defined as 0.1-0.4 (small), 0.4-0.6 (moderate) and > 0.6 (large).

The raw sEMG signal was analyzed by applying a 5 Hz highpass filter and a 100 Hz lowpass filter and moving average smoothing. The first trial was selected using Bonato's double-scheme threshold-based algorithm[29].

Two variable-domain functional regression [scalar-on-function regression (SoFR)] models were applied between groups and measurement times using the processed sEMG data signal in gluteus medius and tensor fasciae latae.

A SoFR model is one in which the response variable takes scalar values, and the covariates take functional or scalar values. This type of model is an extension of the generalized additive models (GAM). In our case, since the sEMG data had a different number of data points between subjects, a VDFR model was applied that allows the functional coefficients to vary, smoothly, according to the domain width of each subject[30].

Results

The study involved 41 subjects balanced between men and women 19 males 22 females; age: 43.85 ± 12.89 years; height: 167.31 ± 27.95 cm; weight: 72.98 ± 14.92 kg, in whom the majority dominant leg was the right (90.2%) (Table 1).

Table 1: Clinical and demographic characteristics of the participants.

n		41
Gender, n(%)	Female	22 (53.7)
	Male	19 (46.3)
Weight (kg)		72.98±14.92
Height (cm)		167.31±27.95
Age		43.85±12.89
Dominant leg, n(%)	Left	4 (9.8)

Data expressed as mean±standard deviation or with absolute and relative values (%).

The existence of significant differences (p<0.05) in the main effect of time it could be verified in all the quantitative result variables, except in the variables Tensor fasciae latae RMS mean/sec (μV/sec), Dynamometry average force with small effect sizes and significant (Table 2).

Table 2: Quantitative outcome variables.

	Dominant leg			**Non dominant leg**					
	Baseline	**MPT**	**SMPT**	**Baseline**	**MPT**	**SMPT**	[a]time p value	[a]group p value	[a] p
Gluteus medius RMS mean (μV)	16.558±9.147	19.975±10.413	18.065±9.255	17.724±11.704	19.328±11.429	17.819±11.676	0.967	<0.001	0
Gluteus medius RMS mean/sec (μV/sec)	0.174±0.109	0.216±0.131	0.19±0.109	0.186±0.123	0.2±0.124	0.184±0.12	0.907	0.005	0
Gluteus medius MVC mean (μV)	86.056±49.887	100.311±59.583	91.986±50.009	88.942±66.357	96.446±61.748	90.095±66.302	0.938	<0.001	0
Tensor fasciae latae RMS mean (μV)	18.207±14.122	22.703±21.313	20.082±24.529	18.6±15.848	21.647±15.48	18.587±16.051	0.856	0.002	0
Tensor fasciae latae RMS mean/sec (μV/sec)	0.187±0.163	0.244±0.256	0.219±0.339	0.2±0.183	0.226±0.182	0.199±0.197	0.859	0.079	0
Tensor fasciae latae MVC mean (μV)	103.292±120.238	112.525±108.843	99.949±104.51	94.057±80.125	115.083±93.685	91.372±79.367	0.833	<0.001	0
Dynamometry peak force	21.355±8.387	23.834±9.128	20.915±8.763	20.996±7.691	23.454±8.825	20.792±7.971	0.876	<0.001	0
Dynamometry average force	1.74±0.98	1.891±0.931	1.609±0.973	1.615±0.857	1.664±0.804	1.671±0.952	0.594	0.292	0
Dynamometry peak time	18.327±7.473	20.704±8.103	17.987±7.909	18.054±6.985	20.484±7.871	17.934±7.132	0.904	<0.001	0

Data expressed with mean±standard deviation; 95%CI: 95% confidence interval. η^2_p: bootstrapped partial eta squared effect size.

[a]significant if p<0.05 (shown in red). RMS, root mean square; MVC, maximal voluntary contraction; MPT, magnetic particle tape; SMPT, sham magnetic particle tape.

In the post hoc tests between groups, no significant differences between the dominant and non-dominant leg were evident (Supplementary File 1. Table 1). However, in the intra-group pairwise comparisons, significant differences were evident in both the dominant and non-dominant legs in most of the outcome variables in the MPT - Baseline, SMPT - MPT comparisons, except for the variable Dynamometry peak force, with moderate to large significant effect sizes (Supplementary File. Table 2).

The trend graphs showed how the dynamometry and sEMG activation values were greater in the dominant leg compared to the non-dominant one, although these differences were not significant. These values increased with the application of the MPT in both groups, with significant differences compared to baseline values, and drastically decreased with the application of the SMPT with significant differences between both types of tape, with a return to values similar to those obtained baseline, which explained the absence of significant differences in the SMPT - Baseline comparison (Figure 4).

The sEMG recording of the gluteus medius and tensor fasciae latae raw and processed is shown in Figure 5.

The SoFR regression model showed no significant difference between the dominant and non-dominant leg (Supplementary File. Table 3). EMG recording in gluteus medius was found to significantly predict (F=13.71, p=0.013) the type of tape (MPT or SMPT) applied (Table 3).

Table 3: sEMG raw smoothed models between measurement times.

	EDF (df_{ref})	F	^{a}p value
Baseline vs MPT			
Gluteus medius	3.879 (4.074)	8.331	0.076
Tensor fasciae latae	3 (3)	4.325	0.228
MPT vs SMPT			
Gluteus medius	4.048 (4.216)	13.710	0.013
Tensor fasciae latae	3 (3)	0.444	0.931
Baseline vs SMPT			
Gluteus medius	3.685 (3.925)	5.406	0.273
Tensor fasciae latae	3 (3)	5.267	0.153

EDF: Effective degrees of freedom. df_{ref}: Reference degrees of freedom. ^{a}significant if p<0.05 (shown in red). MPT, magnetic particle tape; SMPT, sham magnetic particle tape.

The contour graph showed how a greater activation of the gluteus medius was associated with the application of the MPT (Figure 6).

Discussion

The primary aim of this study was to investigate whether the effect of a tape with magnetic particles applied to the lumbar area in subjects with NSCLBP has an effect on MVIC of the hip abduction by the Hip Stability Isometric Test (HipSIT). The secondary aim was to determine if there were differences on the gluteus and tensor fascia latae activation.

Our data agree with prior studies showing the effects of tape with magnetic particles in the population with NSCLBP results with immediate effects of pain relief and an increase in the parameters of blood flow analyzed, postulating it to be a plausible therapy for pain and systemic neuromodulation[18]. In our case, it was in the muscle force production and muscle electrophysiology.

Our findings are in line with the results of previous studies in the biomedical magnetizing effects[10,11,28–37]. Our hypothesis and interpretation about the action of the tape with magnetic particles would be oriented to the development of similar properties used in the biomedical magnetic field, so they do not show any magnetization unless they encounter magnetic fields like those of the epidermis, presenting a rapid change of magnetic state.

Perhaps, if pain is reduced, the pain-producing mechanisms may no longer negatively influence the electrical signals of the lumbar nerves, especially the superior gluteal nerve that innervates the tested musculature[18].

We found higher activation in gluteus medius and TFL in MPT group in dominant and in non-dominant leg compared against SMPT group and baseline.

Just recently was assumed that sensory neurons were the main and, in some cases, the only transducers of innocuous and noxious stimuli in the skin[38]. However, this dogma has been essentially denied by recent work demonstrating how non-neuronal cells, including keratinocytes, are required for normal detection and encoding of somatosensory stimuli in the peripheral nervous system[38].

The epidermis is the most superficial layer of the skin and is part of the Central Nervous System. The epidermis contains intraepidermal free nerve endings (FNE) corresponding to Aδ and C fibers as well as Aβ fibers associated with Merkel cells[39.] Two distinct groups of nerve fibers are found in the epidermis, the cutaneous sensory nerve fibers and the autonomic nerve fibers. The epidermis contains a variety of different cells[40]. The most relevant cells of the epidermis are keratinocytes and Merkel cells, which together with the dendrites of Aβ-type afferent sensory neurons, whose cell bodies are located in the dorsal root ganglia, form the “Tactile Dome”. Together, these structures can be considered the mechanosensory organs of the epidermis[40].

Keratinocytes are activated by electromagnetic wave radiation such as UVB. In a mouse model of sunburn pain, exposure to UVB light resulted in profound mechanical and thermal allodynia, effects that were entirely dependent on UVB-induced activation and sensitization of TRPV4-expressing keratinocytes[41]. Once the epidermal ion flow has been created, the mechanism of electrical and magnetic stimulation at the neural level could be the same, which are the depolarization of the axon and the initiation of the action potential[39]. The identification of keratinocytes as the primary transducers of damaging stimuli is a paradigm shift in the field of cutaneous sensory transduction[39].

The low electromagnetic intensity that can be generated with MPT as it does not adhere or repel like magnets, suggests that it acts superficially. Activation of keratinocytes, which make up more than 95% of epidermal cells, could be releases a wide range of neuroactive factors in addition to forming tight "synapse-like" connections with intraepidermal nerve fibers[38], inducing action potential activation in sensory neurons[38].

In the present study, the value of peak force in dynamometry was statistically significant when control and experimental group were compared in dominant and non-dominant leg. The effect of the MPT on peak force (see Table 2) is comparable with Chilibeck et al., (2011)[42] when application of spinal manipulation reported an increase (104 ± 43 to 116 ± 43 Nm) compared to placebo (84 ± 24 to 85 ± 31 Nm) (p = 0.03).-

The increase in the recruitment of fibers obtained with the EMG and the increase in maximum voluntary contraction by applying MPT, correspond to the increases in Peak force and the decrease in the time to reach maximum force (peak time) of both muscles. Therefore, MPT looks to be helpful to recruit more fibers and increase voluntary force, reaching it in less time in patients with NSCLBP.

This translates into better muscle tone and, when doing sports, less risk of injury by activating the muscles earlier and with more force. In people with NSCLBP, dysfunction of muscles such as the gluteus medius have been demonstrated to increase spinal loading and reduce spinal stability[43.]

This finding is complementary to the one made by Selva et al[18] for being able to reduce the perceived low back pain when applying MPT. Therefore, when the pain decreases, nerve activity could be activated, modulating the nervous information that reaches the musculature, influencing the tone.

Gluteus medius muscle weakness is a common presentation in people with NSCLBP[44.] The musculature of the hip and ankle are coactivated, so surely in people with NSCLBP there will be neural dysfunction in both joints[45]. The assessment of ankle dorsiflexion is used to prevent and treat injuries in the lower extremities, so it would be interesting to assess the influence of NSCLBP on ankle joint mobility. Cooper at al., (2016)[44] concluded that focusing on assessment and treatment of gluteus medius muscle dysfunction may allow for better clinical decision-making and better treatment outcomes for people with LBP, then the application of MPT could help this kind of patient groups. If the metameric application of Magnetic Tape achieves a significant and immediate increase in muscle strength, perhaps it means that the dysfunction or lack of strength is not due to the musculature itself, but to incorrect nerve activation.

We believe that patients with NSCLBP presenting with gluteus medius weakness and associated tenderness may represent a treatment subgroup that could benefit from first achieving correct muscle activation of the TFL and gluteus medius, followed by appropriate therapeutic exercise.

To the best our knowledge, this is the first study to observe the effects of magnetic particles in a tape on an epidermis and the effect in the force and activation of hip abduction muscles. On the other hand, only the acute effects of the MPT on force and activation was studied. Then, we must be careful to generalize the results and middle and long-term effect in greater sample should be studied. As well as the implication of the effects of magnetic tape on the autonomic nervous system. Further research should answer these questions.

The results of application of MPT in people with NSCLBP suggested an increase in muscle strength of the Gluteus Medius and Tensor Fascia Lata bilaterally during the HipSIT test. MPT could be involved in recruitment of more fibers and increase voluntary force, reaching it in less time in patients with NSCLBP.

The application of MPT reported an immediate improvement in NSCLBP, so the improvement in strength observed in this study may have helped to decrease or eliminate inhibitory reflexes, allowing neuromodulation of muscle electrical activity.

By placing MPT bilaterally, no differences were found between the dominant and non-dominant side, although fiber recruitment, maximum voluntary contraction, Peak force were significantly increased on both sides, and the time to reach peak time of recovery was decreased in both muscles compared to SMPT tape and basal state.

Limitations and Future Directions

As limitations, pain in the paravertebral back muscles could have been recorded in addition to the irritated bone element. Also, the referred pain to lower limbs or loose of function. This may be the cause of the contradictory results in activation and differences between dominant and non-dominant in some cases. Finally, the visceral or abdominal and pelvic viscero-somatic relations neither were considered.

The results demonstrate physiological baselines states changes. Future research is needed to explore the possible mechanisms of action and the possible benefits for other conditions and locations using MPT, given that to date, we can only establish hypotheses, in the light of the results obtained, and based on neuroscience.

Finally, it is possible to study the influence of patients' expectations regarding the treatment they are going to receive, since it has been shown that certain patient expectations, such as the expectation of tailored treatment with frequent follow-ups, the hope for the best possible outcomes, realism or resignation regarding pain relief, good dialogue and communication, the need to be seen and confirmed as an individual, and the desire to receive an explanation of the pain could be related to better recovery outcomes for patients with low back pain[46].

Conclusions

Magnetic particle tape applied to the lumbar area in subjects with NSCLBP was effective in increasing abductor muscle contraction strength compared to the sham magnetic particle tape group.

Greater activation of the gluteus medius and TFL was found in the magnetic particle tape group in the dominant and non-dominant leg compared to the sham magnetic particle tape group.

Declarations

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Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki and approved for the Ethical Committee of University of Valencia by number 1622496 and registered on 20/ 05/2021 at clinicaltrials.gov (NCT04893967). Informed consent was obtained from all subjects involved in the study.

Consent for publication

Patients gave their consent to publish the results of the study, and their anonymity was always respected.

Availability of Data and Materials

The data presented in this study are available on request from the corresponding authors.

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Competing Interests

SFS is the creator of the magnetic particle tape used in the study. The rest of the authors do not present any relationship of any kind with the brand.

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Authors' Contributions

Conceptualization: BGH, SFC, FSS, JNCZ; Data curation: SFC, JNCZ; Formal analysis: JNCZ; Funding acquisition: NA; Investigation: JCBM, BGH; Methodology: JCBM, BGH, SFC, DPM, FSS, JNCZ; EASR Project administration: JCBM, BGH, SFC, DPM, FSS, JNCZ; Resources: BGH, FSS; Software: JNCZ; Supervision: SFC, FSS; EASR Validation: JCBM, BGH, SFC, DPM; EASR; Visualization: JCBM, BGH, SFC, DPM, FSS, JNCZ; EASR Writing-original draft: BGH, SFC, FSS, JNCZ; Writing-review and editing: JCBM, BGH, SFC, DPM, FSS, JNCZ, EASR

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Figures

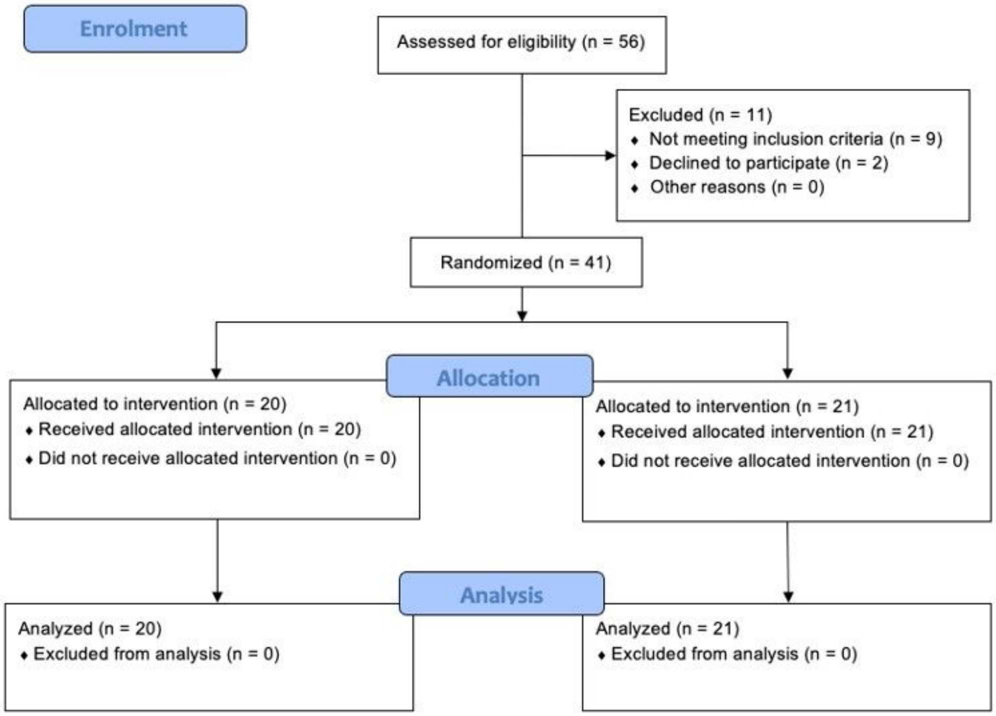

Figure 1

CONSORT Flow-diagram

Figure 2

Electrode positioning for EMG evaluation (A). Dynamometry during hip abduction (B).

Figure 3

Magnetic particle tape or sham magnetic particle tape application.

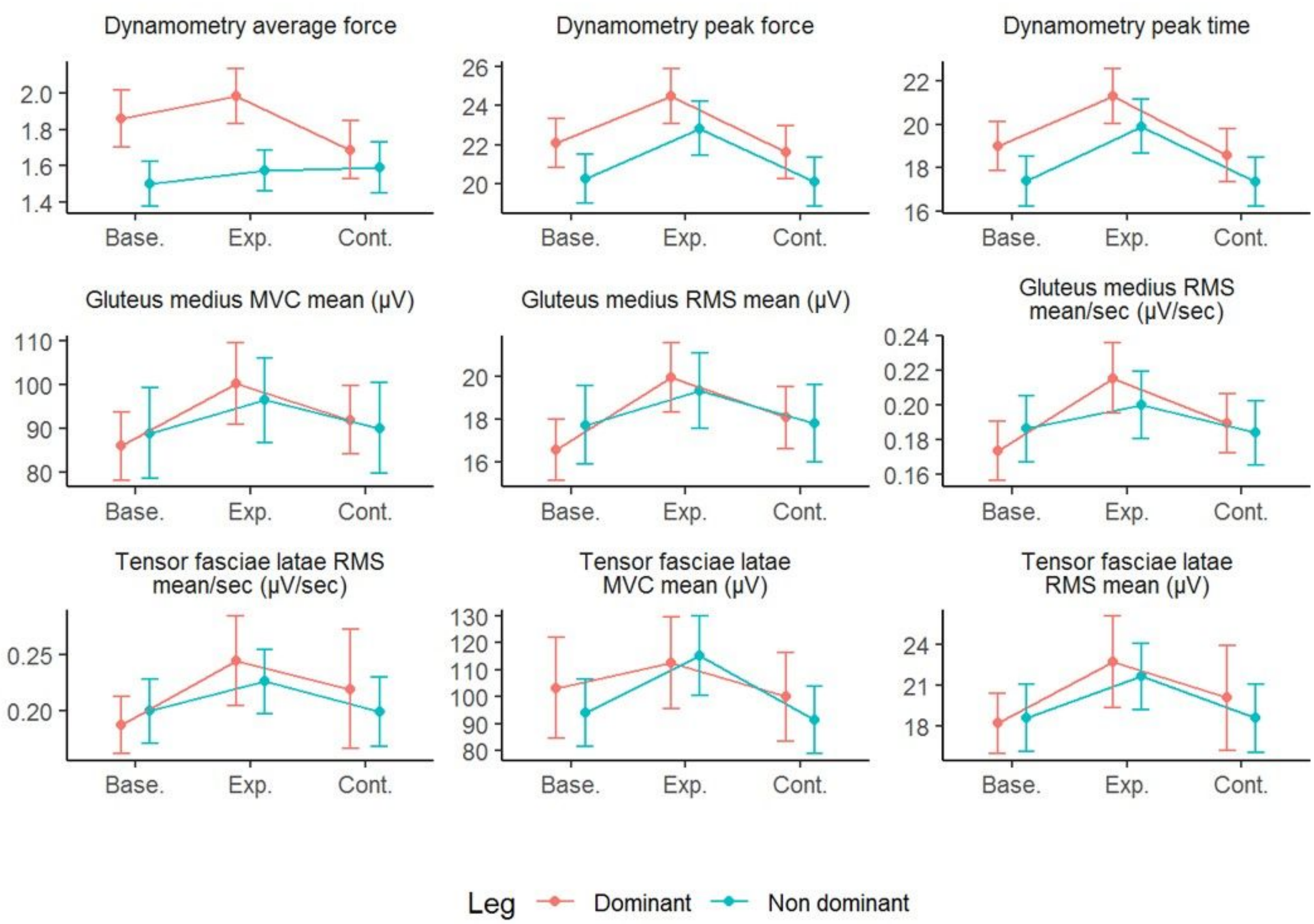

Figure 4

Outcome variables trend graphs. Base: baseline; Exp.: magnetic particle tape; Cont.: sham magnetic particle tape.

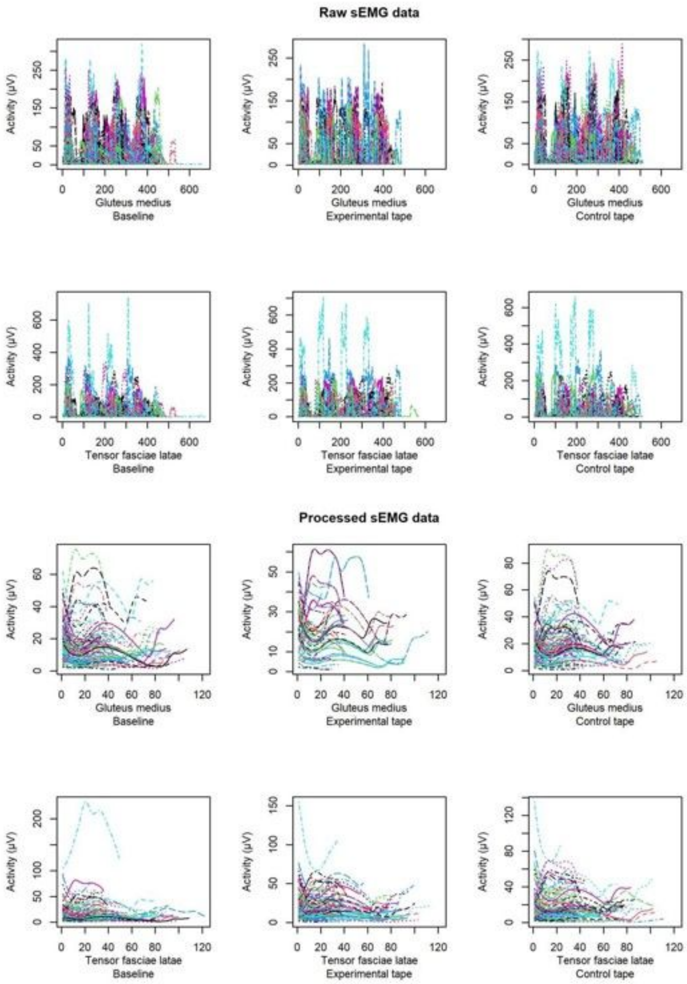

Figure 5

sEMG recording of the gluteus medius and tensor fasciae latae raw and processed.

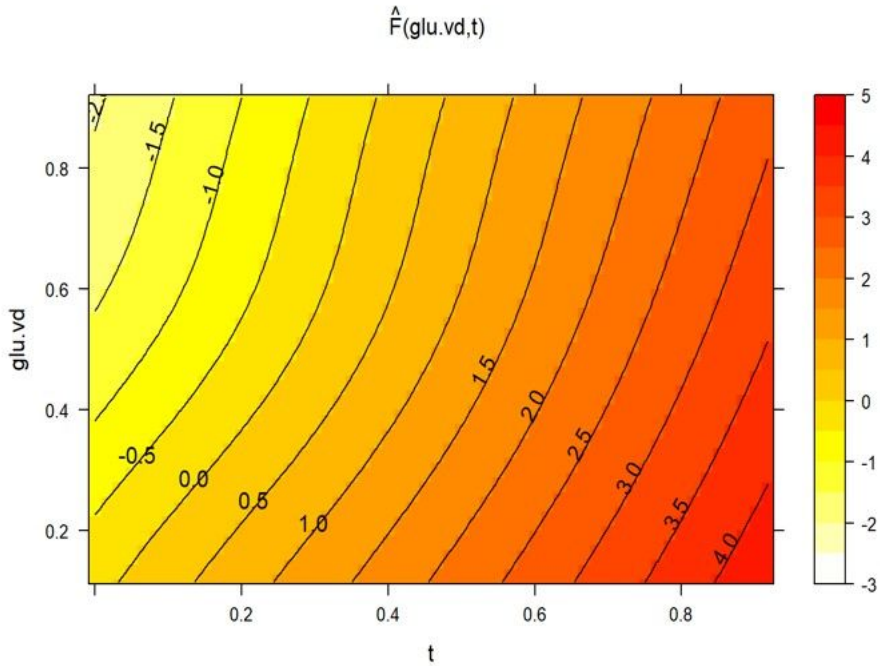

Figure 6

Contour plot of pseudo t-statistic.

Supplementary Files

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- Supplementarytables13.docx