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Non-randomized Interventional Study

The Effects of Dry Needling on Gait and Balance in patients with Multiple Sclerosis: A Quasi-experimental Study

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ABSTRACT

Introduction: Spasticity is one of the most disabling symptoms affecting patients with multiple sclerosis and may lead to gait and balance problems. Although dry needling (DN) effectively decreases spasticity and improves gait in patients with different neurological conditions, the effect of DN on the static and dynamic balance hasn't been researched yet. This study aimed to assess the effects of DN on gait and balance in patients with multiple sclerosis.

Material and methods: A quasi-experimental before-after survey was designed. Patients received three monthly DN sessions for 2 months in the gastrocnemius and hamstring muscles. Participants were assessed at baseline and after the 6 DN sessions (month 2).

Results: Twenty patients with multiple sclerosis participated in the study. DN had a positive impact on balance, measured with the Tinetti test just after the treatment completion (6 sessions) ($p=0.004$).

Conclusion: A protocol of 6 DN sessions in the knee and ankle flexor spastic muscles in patients with MS seems to have a positive effect on balance.

Keywords: multiple sclerosis; spasticity; dry needling; gait; balance, physiotherapy.

1. Introduction

Multiple Sclerosis (MS) is the most common inflammatory neurological disease in young adults. It can include various neurological manifestations such as optic neuritis, diplopia, sensory loss, spasticity, limb weakness, gait ataxia, loss of bladder control, and cognitive dysfunction^(1,2). The etiology of the condition is complex and multifactorial, involving both genetic and environmental factors. It predominantly affects women, with a female-to-male ratio of approximately 3:1, and is considered the second leading cause of disability among young adults aged 25 to 30 years. The estimated prevalence in Europe is 83 cases per 100,000 inhabitants in the last three decades, with an incidence of 4.3 cases per 100,000 inhabitants^(3,4).

The treatment of MS requires multidisciplinary therapeutic measures and specialized services for comprehensive management. Spasticity is one of the most relevant targets in the treatment, although the evidence is still limited⁽⁵⁾. Spasticity is one of the most frequent signs of MS (85%), leading to gait problems^(6,7), affecting the patient's quality of life, and having an essential socio-economic impact⁽⁸⁾.

Among the physical impairments caused by spasticity, gait dysfunction is one of the most disabling for patients with MS, as it directly affects autonomy, participation in daily life activities, and fall risk. Gait assessment, therefore, becomes a key outcome for evaluating the effectiveness of interventions aimed at improving mobility and functional independence in this population. In addition to gait disturbances, balance impairments are highly prevalent in individuals with MS and are a major contributor to falls. Balance dysfunction can result from a combination of sensory deficits, motor weakness, cerebellar involvement, and impaired postural responses, all common in MS. Evaluating balance is crucial for understanding functional limitations and guiding targeted interventions to improve safety and mobility in this population.

Physiotherapy interventions are safe and effective for spasticity management in patients with MS⁽⁹⁾. Specifically, invasive physiotherapy such as acupuncture, electro-acupuncture, and dry needling (DN) has been shown to have good results in reducing spasticity⁽¹⁰⁾, as well as being safe⁽¹¹⁾. The proposed mechanisms by which DN may reduce spasticity include the modulation of spinal reflex excitability⁽¹²⁾, the disruption of dysfunctional motor endplates⁽¹³⁾, and the restoration of normal afferent input through mechanical stimulation of muscle fibers⁽¹⁴⁾. These effects may reduce hypertonia and improve motor control in neurologically impaired patients⁽¹⁵⁾.

DN has been shown to be effective in patients with stroke to improve gait^(16,17), whereas in other populations such as Parkinson's Disease⁽¹⁸⁾ or Spinal Cord Injury⁽¹⁹⁾, its effect is unclear. Moreover, DN is a cost-effective treatment for spasticity in patients with chronic⁽²⁰⁾ and subacute⁽²¹⁾ stroke. It could be an alternative to other pharmacological treatments, although further studies are necessary to compare effectiveness and cost-effectiveness⁽²²⁾. A recent study in which patients with MS received 12 DN sessions over a period of 4 months suggests that DN may improve mobility⁽²³⁾ and gait speed⁽²⁴⁾. However, the effects of DN on static and dynamic balance, which can be related to an increased risk of falls, have not been researched. The objective of this study is to evaluate the effect of dry needling on gait and balance in patients with multiple sclerosis.

2. Description of the clinical case/case series

2.1 Patient information

The study was approved by the Clinical Research Ethics Committee of Hospital Universitario de Canarias, Canary Islands, Spain (dated 22 February 2018) with act number 2017_100. All procedures were applied following the Declaration of Helsinki. All patients signed an informed consent document before participating. Informed consent was obtained from all subjects involved in the study. To carry out this study, the instructions of the CONSORT guide were followed. The patient(s) have obtained written informed consent to publish this paper.

2.2 Clinical Findings

The study was carried out in the neurology service of Hospital Universitario de Canarias between 2019 and 2020. A convenience sample of patients were recruited for the study with the following inclusion criteria (1) having been diagnosed with multiple sclerosis by a neurologist, (2) being over 18 years of age and less than or equal to 60 years of age, (3) having a score equal to or greater than 2 in the Expanded Disability Status Score (EDSS), 4) having a score >2 in the pyramidal, brainstem, gait and sphincter domains (5) having hypertonia, clinically assessed as an increase in the resistance to passive stretch and (6) having hourly availability to receive therapies. The exclusion criteria were: (1) having a disease associated with multiple sclerosis where dry needling is contraindicated, (2) being in relapse or having suffered it in the thirty days prior to starting the treatment program and (3) taking medications that are contraindicated with DN.

2.3 Diagnostic assessment

Participants were assessed by an independent assessor at the start of the study (baseline, T0), just after 6 DN sessions (T1). The primary outcome was the Timed 25-Foot Walk (T25FW), a quantitative mobility and leg function performance test based on a timed 25-foot walk⁽²⁵⁾. This is considered the "gold standard" for assessing gait speed in MS patients. Gait impairments are among the most disabling symptoms in multiple sclerosis, often appearing early in the disease course and worsening with progression⁽²⁶⁾. Therefore, gait speed and mobility are key functional parameters to evaluate the clinical effectiveness of rehabilitation interventions in this population⁽²⁷⁾. The test measures the time in seconds the patient needs to walk 25 feet (7,5 meters). The test was done twice, and the mean value was calculated⁽²⁸⁾. The T25FW has been used to assess interventions in drug and rehabilitation trials and is useful to evaluate ambulation changes in the clinical setting⁽²⁹⁾. Apart from this primary outcome, the following secondary outcomes were also assessed:

Multiple Sclerosis Walking Scale (MSWS-12) is a self-report measure of the impact of MS on the individual's walking ability⁽³⁰⁾. Each item is scored from 1 (no limitation) to 5 (extreme limitation), with a total score ranging from 12 to 60, where higher values show higher impairment⁽³¹⁾. The MSWS-12 scale shows properties that make it suitable for use in clinical practice, specifically for patients with medium-to-high levels of walking disability⁽³²⁾.

The Multiple Sclerosis Quality of Life-54 questionnaire (MSQol 54). This is a specific quality of life questionnaire for MS. This self-assessment questionnaire comprises 54 items, divided into a physical and mental domain. The range goes from 0 to 100, where 100 is the highest quality of life. The Spanish version of the MSQoL 54 instrument is a valid and reliable for measuring quality of life in patients with MS [33, 34].

The Time up and Go test (TUG) was designed initially to measure the probability for falls among older adults, but has been validated also for other populations such as MS. For this test, the participants sit in a chair with their backs supported by the back of the chair and their arms resting on the armrests. The participants were asked to get up from the chair and walk 3 meters, turn around (360°), walk back to the chair, and sit down again. The participants perform the test twice, and the mean value is chosen. The TUG test has been demonstrated to be highly reliable and responsive in the assessment of the walking capacity and general mobility of patients with MS with mild disability⁽³⁵⁾. Test-retest reliability and reproducibility have been confirmed⁽³⁶⁾.

The Tinetti balance test (TBT) is a widely used clinical tool for assessing balance and gait in older adults and individuals with neurological conditions. It consists of two subscales: balance (maximum 16 points) and gait (maximum 12 points), with a total maximum score of 28 points⁽³⁷⁾. The TBT has demonstrated good reliability and validity in various neurological populations, including stroke and Parkinson's disease^(38,39), and has also been used in patients with multiple sclerosis (MS) to identify mobility impairments and fall risk. Its simplicity, minimal equipment requirements, and sensitivity to change make it a suitable tool for clinical and research settings focused on balance-related outcomes in MS. The test evaluates functional tasks such as sitting balance, rising from a chair, turning, and step symmetry. Lower scores indicate a higher risk of falls.

Expanded Disability Status Score (EDSS). This scale is used to measure eight different domains from 0 to 10: 1) visual (eye fundus, scotoma, diopters, etc.); 2) Brainstem (nystagmus, dysphagia, dysarthria, etc.); 3) Pyramidal (extremity strength, reflexes, etc.); 4) Cerebellum (ataxias, dysmetria); 5) Sensitive (cutaneous, vibratory, deep sensitivity); 6) Vesical/intestinal (micturition dysfunction, intestinal, urgency, incontinence, catheterization, etc.); 7) Mental (depression, fatigue, sexual dysfunction, etc.) and 8) Ambulation. Since its introduction, EDSS has been a standard instrument for assessing patients with MS and for follow-up changes. It is widely used in clinical trials to evaluate the effectiveness of clinical interventions and in the routine clinical assessment of disease progression in MS⁽⁴⁰⁾.

2.4 Therapeutic intervention

Two physiotherapists (AO and PP) working at Hospital Universitario de Canarias, with 5 years of experience performing DN treatments, were involved. Patients received three DN monthly sessions for 2 months (6 sessions) in the Myofascial Trigger Points of the gastrocnemius and the hamstring muscles, leaving at least five days between treatments to respect tissue repair⁽³⁴⁾. The patient was placed in a prone position with a pillow under the ankles (Figure 2). Muscles were placed in submaximal stretch position, following the criteria for DN in neurological patients⁽³⁷⁾. Repeated needle insertions were performed in the muscles at approximately 1 Hz for one minute. The materials used for the study were: dry needling needles (0.25 x 40 and 0.25 x 25 mm, Agupunt®, Barcelona, Spain), a stretcher, gauze, alcohol, and gloves.

2.5 Statistical analysis

Statistical analysis was performed with SPSS v. 25.0 (Chicago, IL, USA). P values less than 0.05 are considered statistically significant. Categorical variables are expressed as frequencies and percentages. Continuous variables are expressed as means, standard deviations, medians, and ranges (min–max). Since the outcome variables did not follow a normal distribution, the Wilcoxon signed-rank test was used to compare pre-treatment and post-treatment scores.

3. Results

Twenty patients with MS ($44,42 \pm 8,43$ years) participated in this study. All participants were diagnosed with Relapsing Remitting Multiple Sclerosis type. Sixteen women and four men participated in the study. There was a positive impact of DN on balance, measured with the Tinetti test just after the treatment completion (6 sessions) ($p=0,004$) (See Table 1). When this improvement was analyzed separately for dynamic and static balance, only the static balance had significant improvements ($p=0,023$). There was also a significant improvement immediately after the 6 treatment sessions in quality of life in both the physical ($p=0,003$) and mental ($p=0,014$) domains measured with the MSQol 54 and in the Expanded Disability Status Score ($p=0,057$). There was not a significant improvement immediately after 6 treatment sessions in the Time Up and Go test ($p=0,542$), the T25FW test ($p=0,275$), and the Multiple Sclerosis Walking test ($p=0,075$).

Table 1. Measures at T0 (Baseline), T1 (immediately after the 6 treatment sessions)

	T0 (baseline)	T1 (immediately after 6 treatment sessions)	Treatment effect. Mean $\pm$ SD (p-value)
EDSS	4,5 $\pm$ 1,27	4,3 $\pm$ 1,46	0,21 $\pm$ 0,45 (0,057)
MSQol54-Physical	54,83 $\pm$ 13,34	62,35 $\pm$ 14,55	-7,52 $\pm$ 9,43 (0,003*)
MSQol54-Mental	62,78 $\pm$ 15,94	70,78 $\pm$ 19,18	-7,99 $\pm$ 12,77 (0,014*)
TUG	18,45 $\pm$ 14,29	18,05 $\pm$ 14,62	0,39 $\pm$ 2,74 (0,542)
T25FW	15,08 $\pm$ 16,21	14 $\pm$ 13,30	1,07 $\pm$ 4,17 (0,275)
MSWS-12	39,78 $\pm$ 14,38	34,68 $\pm$ 13,66	5,10 $\pm$ 11,78 (0,075)
TINETTI	19,63 $\pm$ 5,68	21,42 $\pm$ 4,37	-1,78 $\pm$ 2,32 (0,004*)
TINETTI GAIT	8,48 $\pm$ 2,96	9,26 $\pm$ 2,07	-0,68 $\pm$ 1,66 (0,91)
TINETTI BALANCE	10,63 $\pm$ 3,57	12,16 $\pm$ 2,63	-1,52 $\pm$ 2,67 (0,023*)

Data are mean $\pm$ SD. $P \leq 0,05$.

QOL54: Quality of Life 54; TUG: Time up and go; T25FW: Time-25- Foot Walk test; MSWS-12: Twelve MS Walking Scale.

EDSS: Expanded Scale of Disability Status; Tinetti: gait and balance scale

4. Discussion

The main objective of this study was to analyze whether DN may improve gait and balance in patients with MS, as well as whether any specific aspects of gait may improve, whereas others don't. Because of it, different clinical scales measuring different gait aspects were used. On the one hand, no changes were found in the walking ability measured qualitatively with the MSWS-12 or quantitatively with the TUG test. Moreover, no changes were found in gait speed measured with the T25FW. The result from our study differs from a previous one carried out in patients with MS by Del Pilar Pérez-Trujillo⁽²⁴⁾, who found significant changes in the T25FW and TUG, which could be because patients received double the number of sessions than in our study. In our study, patients received six DN sessions, three per month, over two months. This dosage was selected to ensure sufficient time for tissue recovery⁽⁴¹⁾. However, other studies have employed more intensive protocols, such as three sessions per week, and still reported positive spasticity reduction outcomes. Further studies comparing different treatment dosages and session frequencies could help establish optimal protocols for clinical use⁽⁴²⁾. Another study, carried out by Miller⁽⁴³⁾, found improvements in the distance walked during the six-minute walk test (6MWT) and the walking speed with the T25FW. However, this study combined intermuscular electrical stimulation with functional electrical stimulation and treadmill training, which doesn't allow us to compare the specific effects of the DN interventions and how much this could have contributed to the overall improvement.

On the other hand, there was a significant improvement in the Tinetti Scale, specifically in the sub-scale where balance is measured. Regarding balance, our results differ from the study by Miller⁽⁴³⁾, who didn't find significant improvements in balance measured with the Berg test after applying a protocol including intermuscular electrical stimulation. Although our study found significant balance changes, the MCID for patients with multiple sclerosis measured with the Tinetti Scale hasn't been determined yet, so it is possible that the difference found was not a real or clinically significant change, considering that the mean change was only 1,52 points. Future studies should research how DN interventions, isolated or combined with other interventions, may improve balance. One possible explanation for the observed improvement in balance but not in gait speed or functional walking tests is that DN may exert a more significant effect on postural control mechanisms, such as proprioceptive feedback, reflex modulation, and neuromuscular coordination, rather than directly enhancing muscle strength or endurance. These effects could lead to improved static and dynamic balance without necessarily translating into measurable changes in gait performance, especially over short intervention periods.

Our study showed significant improvements in the mental and physical domains regarding quality of life. These improvements are similar to what was found in patients with MS⁽²⁴⁾ and in other populations such as stroke⁽¹⁵⁾. After analyzing the questionnaires used and knowing the relationship that quality of life has with disability and self-efficacy and that fatigue plays a significant role, an association⁽⁴⁴⁾ could be determined between this significant improvement in quality of life and a possible improvement in fatigue in patients with MS because it was noticed that the main changes occurred in questions from 4 to 12 in MSQOL-54, which were related to muscle fatigue. In addition, it should be noted that with the application of only six DN sessions, patients with MS significantly improved their quality of life, similar to receiving twice the num-

ber of sessions⁽²⁴⁾, which is something important to consider when performing future studies of cost-effectiveness due to the shorter duration of the protocol. Although the improvement in quality of life was statistically significant, further studies are needed to determine whether these changes exceed the minimal clinically important difference (MCID) for the MSQOL-54. Nevertheless, given the observed changes in the mental and physical domains, particularly in items related to fatigue and physical function, it is plausible that reductions in spasticity or improved confidence in movement contributed to the perceived improvements.

Future research should explore the long-term effects of DN in MS, as well as identify the optimal number and frequency of sessions needed to achieve clinically meaningful improvements in gait, balance, and quality of life, as well as analyzing the cost-effectiveness of DN in patients with MS as it has been done in other pathologies such as stroke^(16,17), plantar pain⁽⁴⁵⁾ or patellar tendinopathy⁽⁴⁶⁾, or the effect of DN as part of a multi-modal treatment to understand which is the value of adding DN to a rehabilitation program. This study has some limitations, including a small sample size, the absence of a control group, and the use of a quasi-experimental design. Nevertheless, the objective was to evaluate the potential effects of dry needling in a real-world clinical setting. Preliminary studies like this are essential to justify and inform the design of future randomized controlled trials, including sample size estimation. Additionally, hypertonia was assessed clinically without the use of a standardized scale such as the Modified Ashworth Scale. While this reflects routine clinical practice and was performed by experienced neurologists, it may reduce reproducibility and introduce variability in patient selection.

5. Conclusion

A protocol of 6 DN sessions in the knee and ankle flexor spastic muscles of the lower extremities in patients with MS seems to have a positive effect on balance and quality of life. However, further research is necessary to determine the optimal number of DN sessions necessary to achieve changes in gait and to analyze the effects that DN may have in the long term. While the findings of this study are promising, they should be interpreted with caution due to limitations such as the small sample size, absence of a control group, and short duration of follow-up. These results should be preliminary and warrant confirmation through larger, controlled trials.

6. Patient's informed consent

All patients signed an informed consent document before participating. Informed consent was obtained from all subjects involved in the study. To carry out this study, the instructions of the CONSORT guide were followed. Written informed consent has been obtained from the patient(s) to publish this paper.

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