Degenerative Neurological and Neuromuscular Disease

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CASE REPORT

Ultrasound-Guided Percutaneous Neuromodulation in Multiple Sclerosis: A Case Report

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Abstract: Multiple sclerosis is a degenerative inflammatory disease that causes different musculoskeletal problems. Its impact has led to the study of treatment alternatives such as the use of invasive physiotherapy. In this study, we analyze the effects of ultrasound-guided percutaneous neuromodulation to a 51-year-old man suffering from multiple sclerosis and an associated hemiparesis in the left upper limb. A dry needling needle was placed in contact with the median nerve under ultrasound guidance and 10 trains of 10 seconds of electrostimulation with a frequency of 10 Hz and an impulse width of 240 μs were applied, with 10 seconds of pause between them. There was a significant improvement in the grip strength immediately after the treatment which increased progressively at 24 hours and at 4 days follow-up. There was also an improvement in the hand function, with a decrease in the time necessary to perform the 9 Hole Peg Test immediately after the treatment, which was maintained at 24 hours and at 4 days follow-up. Future studies with larger samples are needed to further test the effects of this invasive physiotherapy technique as well as its possible applications to other neurological conditions.

Keywords: physiotherapy, multiple sclerosis, dry needling, percutaneous neuromodulation

Introduction

Multiple sclerosis (MS) is the most common inflammatory neurological disease in young adults. The mean age of diagnosis is about 30 years, with most patients having recurrent neurological relapses. After typically 10–20 years, many of those affected develop a "progressive" clinical course.[1] The estimated prevalence in Europe is 83 cases per 100,000 population, with an average incidence of 4.3 cases per 100,000.[2]

Symptoms of MS include fatigue, poor balance, pain, muscle weakness, and spasticity, amongst others. There is not much evidence about hand dysfunction in people with MS and how it may impact the individual's quality of life, especially in those with more advanced disease. Hand dysfunction, which includes both strength and coordination as functional dimensions, has been associated with increased unemployment and therefore it becomes a main challenge in rehabilitation.[3]

In the case of rehabilitation treatments, on the one hand, different types of neuromodulation treatments such as intrathecal baclofen pump, functional electrical stimulation, deep brain stimulation, transcranial magnetic stimulation, bladder stimulation, spinal cord stimulation and brain–computer interface have been applied to treat MS-related symptoms.[4] On the other hand, minimally invasive techniques such as dry needling (DN) have shown to have neuromodulating effects at different levels in the CNS[5,6] and achieve positive changes in patients with MS, concretely in spasticity, quality of life, walking capacity and manual dexterity.[7]

In the case of functional electrical stimulation, this is applied transcutaneously to restore function and prevent muscle atrophy (e.g stimulation of the common peroneal nerve in patients with foot drop). Although the use of transcutaneous electrical stimulation has been widely used in MS patients, the effects of this stimulation performed percutaneously has

Received: 27 October 2022
Accepted: 18 January 2023
Published: 27 January 2023

been only researched in musculoskeletal conditions,[6] showing to be effective to treat chronic lateral epicondylalgia,[7] chronic low back pain[8] and to decrease postoperative pain following ambulatory rotator cuff repair.[9]

Percutaneous Neuromodulation (PN), which is recommended to be applied ultrasound-guided, consists of the application of low or medium frequency percutaneous electrical stimulation seeking a sensory and/or motor response with an acupuncture-like needle, with an electrode placed near the nerve or muscle motor point.[10] Considering the evidence supporting the use of ultrasound guided PN in different musculoskeletal conditions and the effectiveness of transcutaneous electrical stimulation in neurological patients, we aimed to analyze if PN may be effective to treat MS-related symptoms and become a potential treatment for this type of patients. Therefore, the objective of this case report was to analyze if a single session of ultrasound-guided PN may have any effects on grip force and hand function and how long these effects last.

Case Report

Case description: The patient is a 51-year-old Caucasian man diagnosed with herpetic encephalitis at 10 years of age and a left cerebellar stroke in 2006, with demyelinating disease type submissive-recurrent MS since 2007. His last outbreak occurred in November 2020 after receiving seven months of outpatient rehabilitation. Patients with multiple sclerosis who were previously treated in the rehabilitation service in the past years were invited to participate in a clinical trial to research the effectiveness of ultrasound-guided percutaneous neuromodulation. This patient was recruited in January 2022 and he didn´t receive any other treatments since November 2020. He had a left hemiparesis, with a muscular strength of 3 points in the Daniels-5-point scale in the left finger flexor muscles, with hypoesthesia in the 4th and 5th left hand finger, as well as dystonia in some postures.

Intervention: A single application of ultrasound-guided PN was performed. DN needles (APS, 0.30×40 with guide), an electro stimulator (Globus Génesy SII) and an imaging ultrasound device (Logiq e, GE) were used (Figure 1). The median nerve was stimulated between the two fascicles of the pronator teres muscle (Figure 2), using 10 trains of 10 seconds of electrostimulation and 10 seconds of pause between them, with a frequency of 10 Hz and an impulse width of 240 μs, as established by the protocol of Valera-Garrido et al[11] The procedure was performed at the University Hospital of the Canary Islands after being approved by the Ethical Committee (code NEUROECO-2020) and after having signed the informed consent. This clinical trial was registered with reference NCT05053984 at www.clinicaltrials.gov. Informed consent was obtained from the patient to publish the case report.

Assessment: The grip strength was measured with a dynamometer (KERN MAP 130K1, Figure 3) whereas the hand function was measured with the nine hold peg test (9HPT) (Figure 4). Three measurements were taken, choosing the highest value in the case of the grip force and the lowest one for hand function. Measurements were taken at baseline, immediately after, 24 hours and four days after the intervention.

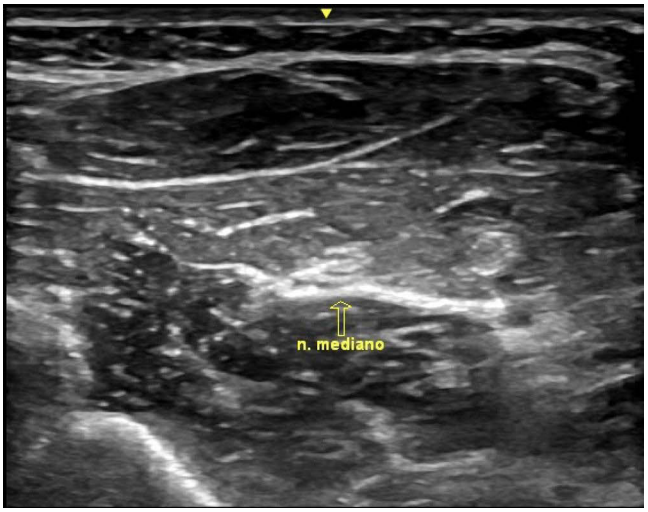

Figure 1 Use of ultrasound to locate the median nerve for the application of the percutaneous neuromodulation intervention.

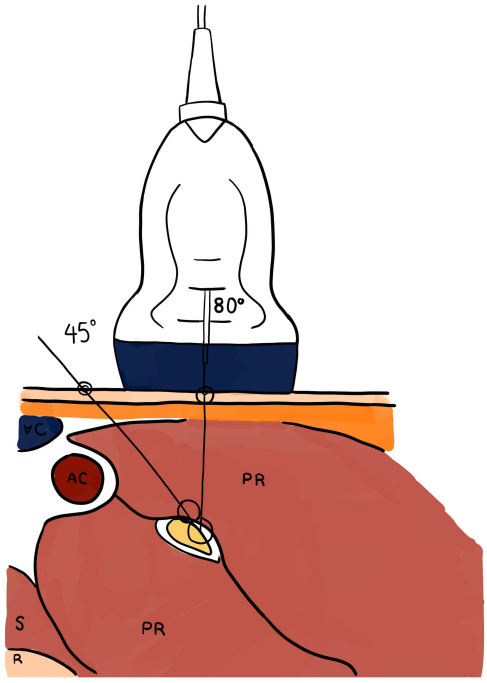

Figure 2 Needle approach to contact the median nerve.

Figure 3 Dynamometry test.

Results

There was a significant improvement in the grip strength immediately after the treatment from baseline (5.5 Kg), which increased progressively at 24 hours (12.4 kg) and 4 days follow-up (14.1 Kg) (Table 1). There was also an improvement in hand function, with a decrease in the time necessary to perform the 9HPT of 10.61 seconds immediately after the treatment, which was maintained at 24 hours (11.87 seconds) and at 4 days follow-up (9.77 seconds) (Table 1).

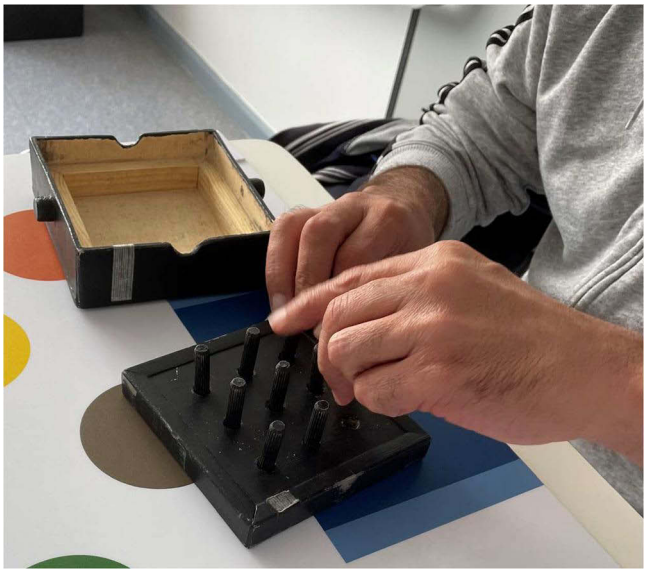

Figure 4 9 Hole Peg test.

Discussion

The study results show that a single session of ultrasound-guided PN may be effective to improve hand function and grip strength in a patient with MS. Although no cause-effects can be established as this was only a case report, this study is the first one researching the effects of percutaneous needle stimulation on a peripheral nerve in a neurological patient. Grip strength followed improving at 24h and 4 days after the intervention whereas hand function improvements remained stable over time. These results are similar to the results reported by Álvarez-Prats et al in 13 patients with knee pathology, where an increase of maximal isometric strength was observed after the application of ultrasound-guided percutaneous neuromodulation of the femoral nerve.[12]

However, our results were not in line with a study carried out in a patient with post-stroke tremor[13] and post-stroke spasticity,[14] where the peak effects were achieved immediately after the DN intervention but did not maintain over time. This could be because the DN treatment performed in the aforementioned cases has demonstrated to have a mechanical effect, working through the mechanical disruption of dysfunctional endplates, which are reinnervated after 3 days,[15] whereas PN acts at a central level, without mechanical effects. However, DN performed at Myofascial Trigger Points is also known to have indirect effects in the central nervous system,[5,6] which makes it difficult to formulate any hypothesis that may explain the differences found. Because of this, future studies should compare different invasive techniques such as DN and PN to better understand both the effects they have and how long they last. Neuromodulation is a quality of the nervous system that regulates or modifies electrical impulses, by enhancing or inhibiting them. Even though its mechanism of action is yet to be fully determined, it is known that it lies on the ascending and descending pathways and the supraspinal regions of the central nervous system. The chronic effect of said neurophysiological process may cause central nervous system plasticity.[16]

Table 1 Measures of Grip Force and Hand Function

Variable	Pre-Treatment (T0)	Post-Treatment (T1)	Treatment Effect (T1-T0)	24-Hours Post-Treatment (T2)	Treatment Effect (T2-T0)	4 Days Post-Treatment (T3)	Treatment Effect (T3-T0)
9HPT (seconds)	44.21	33.59	−10.62	32.34	−11.87	34.44	−9.77
Grip strength (kg)	15.7	21.2	5.5	28.1	12.4	29.8	14.1

Abbreviation: 9HPT, 9 Hole Peg Test.

Although minimally invasive techniques such as acupuncture or dry needling may have minor adverse effects such as mild bleeding, bruising, and pain,[17] in this patient there were no adverse effects when performing this treatment. This was possibly due to the ultrasound-guided procedure, which decreases the risk of needling a blood vessel as well as needling the nerve. The specificity of this technique depends on placing the needle close to the nerve that is going to be stimulated without needling it, as this may provoke pain, tingling and have the risk of damaging the nerve.

This study has some strengths, such as being the first study researching the effect of PN in a patient with MS. However, it also has some limitations, which impede the generalization of results, as this is a case report and does not have a control. In this study, it was only analyzed the effects of a single session of PN, and therefore it is necessary that future studies analyze the effects of different number of PN sessions and the cost-effectiveness of them, similarly to what has been performed in other studies related to tendinous injuries,[18] myofascial pain[19] and spasticity,[20,21] or compared to pharmacological alternatives such as BTX A.[22] Moreover, future studies should be developed with larger samples and with other neurological populations, analyzing also the effect of PN as part of a multimodal treatment, in order to understand which is the additional improvement that PN may achieve in patients with neurological impairments.

Data Sharing Statement

The data that support the findings of this study are available from the first author [AJO], upon reasonable request by email to albert.jaor@gmail.com. Clinical deidentified participant data will be made available after the manuscript publication.

Ethical Approval and Informed Consent

This study was approved by the Committee of Ethics of Hospital Universitario de Canarias, Canary Islands, Spain with code NEUROECO-2020 and is compliance with the declaration of Helsinki. The participant signed informed consent.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This research received no external funding.

Disclosure

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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