acupuncture IN MEDICINE

Original paper

Acupuncture in Medicine
1–10
DOI:10.1177/09645284211039232

Effects of dry needling on gait and muscle tone in Parkinson's disease: a randomized clinical trial

Natalia Brandín-de la Cruz[1], Sandra Calvo[1], Cleofás Rodríguez-Blanco[2], Pablo Herrero[3] and Elisabeth Bravo-Esteban[4]

Abstract

Background: Alterations in gait and muscular rigidity are common and disabling in persons with Parkinson's disease (PD).

Objective: The aim of this study was to determine whether a single dry needling (DN) session can promote changes in gait and muscle tone in the lower extremities as well as in the evolution of the disease in persons with PD.

Methods: A randomized double-blind clinical trial was designed. Participants were randomly assigned to an intervention group (IG) that received a session of DN over the semitendinosus, medial gastrocnemius, soleus and rectus femoris muscles, or to a control group (CG) that received a session of sham DN in the same muscles. The effects of DN were assessed using the timed up and go test (TUG), 10 meter walk test (10MWT), 6 minute walk test (6MWT) and myotonometry before, immediately after, and 7 days after the intervention.

Results: Thirty-three participants were analyzed aged 69.9 ± 7.2 years (mean ± SD; 39% female). There were no significant differences between the IG and CG for any outcomes. Significant differences were observed when comparing the Pre and Follow-up values in the IG for functional mobility of gait in the TUG ($p = 0.049$), gait speed in the 10MWT ($p = 0.041$) and muscle tone in the lower extremities by myotonometry (frequency ($p = 0.027$) and stiffness ($p = 0.013$)). By comparison, there were no significant within-group differences in the CG.

Conclusion: A single session of DN had no measurable benefit compared to a single session of sham DN. Within-group changes in the IG suggested improvements in functional mobility of gait and gait speed, as well as changes in the muscle tone in the lower extremities of PD patients, which could be worthy of further exploration by future research.

Keywords

dry needling, gait, muscle tonus, Parkinson's disease

Accepted: 21 July 2021

Introduction

Parkinson's disease (PD) is a degenerative disorder of the central nervous system (CNS) that mainly affects people in the later years of life. It is the second most common neurodegenerative disease worldwide.[1] Its prevalence in industrialized countries is estimated between 0.3% and 1% in persons older than 60 years, and 3% in people over 80 years of age, with incidence rates between 0.08 and 0.18 per 1000 people/year.[2] The symptomatology varies between individuals, although the most common clinical characteristics are resting

[1]Universidad San Jorge, Zaragoza, Spain
[2]Department of Physical Therapy, Faculty of Nursing, Physiotherapy and Podiatry, University of Seville, Seville, Spain
[3]Departamento de Fisiatría y Enfermería, Universidad de Zaragoza, Zaragoza, Spain
[4]Department of Nursing, Physical Therapy, and Occupational Therapy, Toledo Physiotherapy Research Group (GIFTO), University of Castilla-La Mancha, Toledo, Spain

Corresponding author:
Pablo Herrero, Departamento de Fisiatría y Enfermería, Universidad de Zaragoza, C/ Domingo Miral s/n. CP 50009 Zaragoza, Spain.
Email: pherrero@unizar.es

tremor, muscular rigidity, dystonia, bradykinesia, postural instability and gait impairments.[1]

PD is usually managed through a combination of medical therapies, surgical interventions and physiotherapy, with the aim of slowing down the loss of function.[3,4] Non-pharmacological minimally invasive treatments have also been used, such as acupuncture, based on inconclusive evidence,[5] and dry needling (DN), based on no evidence (to our knowledge) in PD populations. However, DN of myofascial trigger points (MTrPs) has been demonstrated to improve gait and muscle tone in persons with stroke,[6,7] although the exact mechanism of action of DN in neurological patients remains unclear.[8–12]

DN has been demonstrated to be a safe treatment, the most common adverse effects of which are bruising, bleeding and pain during and after treatment.[13] Besides, DN is associated with lower costs than pharmacological treatments in patients with musculoskeletal[14] and neurological[15] disorders. Despite this, the effect of DN in persons with PD has not been researched and constitutes the novelty of this randomized clinical trial (RCT), the aim of which was to determine the effects of a single session of DN on gait, muscle tone of the lower extremities and the evolution of disease in persons with PD.

Methods

Design

A double-blind RCT was designed. It was approved by the Ethics Committee of Aragon (CEICA; registration no. PI16/0226) and followed the clinical practice principles of the Declaration of Helsinki. The trial was prospectively registered at ClinicalTrials.gov (registration no. NCT04101214) on 24 September 2019. All participants provided signed informed consent before participation in the study. This manuscript follows the CONSORT 2010 recommendation guidelines.[16]

Participants

Participants were recruited from the Aragon Association of Parkinson (Zaragoza, Spain). Inclusion criteria were as follows: (1) diagnosis of PD by a neurological doctor; (2) age $>$ 55 years; and (3) presence of resistance to passive movement $\geqslant$ 1 in at least one of the two lower extremities evaluated, according to the rigidity item of the unified Parkinson's disease rating scale (UPDRS). Exclusion criteria consisted of: (1) severe cognitive impairments or inability to communicate; (2) infiltration of botulinum toxin (BTX) in the last 6 months; (3) fear of needles; (4) progressive or severe neurological diseases; (5) presence of fixed contractures; and (6) any absolute contraindication to DN. Resignation criteria were: (1) lack of tolerance to pain caused by DN; and (2) refusal to continue.

Participants were informed about the nature of the study, objectives, and voluntary participation, as well as the possible adverse effects of DN, such as slight post-DN pain.

Treatment allocation

Participants were randomly allocated into two groups: the intervention group (IG) and the control group (CG). Simple randomization was performed with a 1:1 allocation ratio, using an online research randomizer sequence generator by a physiotherapist who was independent of the study, administered the list, and prepared sequentially numbered index cards containing the random assignments. The index cards were folded and placed into sealed envelopes. The allocation was concealed until interventions were assigned. Another physiotherapist (SC) opened each envelope and performed the interventions according to group assignment. Participants were evaluated by another physiotherapist that was blinded (NBC).

Interventions

The IG received a session of DN in the semitendinosus, medial gastrocnemius, soleus and rectus femoris muscles in both lower extremities. The CG received a session of sham DN in the same muscles. Both interventions and evaluations were performed in the same place to maximally standardize participant conditions. Participants were treated by a physiotherapist trained in DN.

In the IG, DN was performed with DN needles (APS®, Agu-punt, Spain). These were filiform, solid, with a tapered tip, non-beveled, and included a guide tube. The caliber of the needles was 0.25 mm and the length was either 25 mm or 40 mm, depending on participant and muscle characteristics. There was only one insertion point per muscle. MTrPs were diagnosed following the Dry Needling Hypertonia and Spasticity (DNHS®) technique with specific diagnostic criteria for DN in persons with CNS impairments:[8,17] within the ensemble of taut bands, the one that displays the highest degree of tension; the nodular zone within the band or the more sensitive area, if this exists; assessment of the movement and function of the patient. Application criteria were based on the DNHS® technique;[8,17] the muscle to be treated was placed in a position of submaximal stretch, and MTrPs were explored using the needle, while controlling the stability of the segment. Local twitch response (LTR) achievement was key to confirm that MTrPs had been treated. LTRs were obtained in all the muscles of the participants of the IG. The application of the DN was performed with repeated needle insertions in the selected MTrPs at a

frequency of approximately 1 Hz over 1 min per MTrP, during which the direction of needling was varied until LTRs disappeared or substantially decreased. Treatment was discontinued if the participant complained of intolerable pain.

The CG received the same intervention with sham DN (considered a non-active treatment for MTrPs, as they were not needled).[18] Participants were blinded to the intervention using sham needles which were only placed superficially at the level of the skin, enough for participants to perceive a needle prick but without going beyond the skin layer. The same protocol and temporality were followed as per the IG.

Outcome measures

Participants who confirmed their willingness to participate, and fulfilled the inclusion criteria, were enrolled in the study and assessed for all outcome measures at baseline (Pre), immediately after the intervention (Post) and after 7 days (Follow-up), except for the UPDRS, which was only measured at Pre and Follow-up. Baseline data included sociodemographic and clinical data: gender, age, height, weight, and the Hoehn and Yahr scale.[19] All evaluations were performed when participants were in the "on" medication state and at the same time of day for each patient, to control for this potential confounding factor. Furthermore, other factors like changes in medication were also controlled for, with no patients reporting any changes in the medication regimen during the study. Primary outcomes were changes in gait, evaluated using the timed up and go test (TUG), the 10 meter walk test (10MWT) and the 6 minute walk test (6MWT). Secondary outcomes included myotonometry and the UPDRS.

TUG. This test assesses the patient's functional mobility with respect to gait. The patient gets up from a chair, walks 3 m, turns, and sits back down. The TUG has been shown to be reliable in PD.[20]

10MWT. This test consists of asking the subject to walk a distance of 10 m on a flat area at a comfortable speed and measuring the time spent from meter 2 to meter 8. The comfortable speed 10MWT has been proven to be reliable in PD.[21]

6MWT. This test consists of measuring the maximum distance in meters that the subject can walk during 6 min on a flat surface.[22] There is evidence that the 6MWT is reliable in PD.[21]

Myotonometry. The myotonometer can quantify differences in the mechanical properties of myofascial tissues. It is measured with the MyotonPro® device (Müomeetria AS, Estonia). The parameters measured were: stiffness (N/m), which reflects tissue resistance; oscillation frequency (Hz), as an indicator of muscle tone; and logarithmic decrement, which is considered to reflect the ability of the muscle to restore its initial shape after being deformed. The myotonometer was located perpendicular to the skin surface and stable during the measurement position. An automatically controlled preload (0.18 N) was applied with an automatic mechanical impulse to the contact area, with a duration of 15 ms and a constant force of 0.4 N. One measurement set of 10 consecutive impulses was completed at the MTrPs that were treated, with a time interval of 1 s between each impulse.[23] The myotonometer has shown to be reliable in PD.[24,25]

UPDRS. This is a specific scale for PD that measures its degree of evolution. The scale is divided into four subscales: I (mental state, conduct and mood); II (activities of daily living); III (motor evaluation); and IV (complications). The scale score ranges from 0 to 199, where 199 represents the highest evolution and 0 the lowest evolution of the disease.[26] The UPDRS has shown to be reliable in PD.[27]

Sample size calculation

The sample size calculation was performed with G*Power 3.1 (Heinrich-Heine University Düsseldorf, Germany). The calculations were based on a standard deviation (SD) of 2.9 s, a between-group difference of 3.5 s (the minimal detectable change (MDC) of the TUG),[28] an alpha level of 0.05, a beta level of 10% and a desired power of 90%. These parameters generated a necessary sample size of at least 16 participants in each group. The total number of participants recruited was 15% higher than that calculated considering possible dropouts. Therefore, the sample required was estimated to be 37 participants.

Statistical analysis

Data were analyzed with the Statistical Package for the Social Sciences (SPSS) version 25 (IBM Corporation, Armonk, NY, USA). The Kolmogorov–Smirnov test was performed to check for normal distribution of all variables. Baseline sociodemographic and clinical variables were compared between groups using independent Student's t-tests for parametric data, and chi-square tests of independence for categorical data. Descriptive statistics were calculated, including mean and SD for parametric data. An intention-to-treat analysis was carried out. Statistical significance was defined as $p < 0.05$.

A 2 × 2 mixed model repeated-measures analysis of covariance (ANCOVA) with time (Post, Follow-up) as the within-subjects factor, group (IG, CG) as the

between-subjects factor, and baseline scores (Pre) as the covariate was used to determine the effects of the treatment on the TUG, 10MWT and 6MWT. One-factor ANCOVA (IG, CG) with baseline scores (Pre) as the covariate was used to determine the effects of the treatment on the UPDRS. A 2 × 2 × 2 mixed model repeated-measures ANCOVA with time (Post, Follow-up) and extremity (right, left) as the within-subjects factors, group (IG, CG) as the between-subjects factor, and baseline scores (Pre) as the covariate was used to determine the effects on myotonometry. Separate repeated-measures analyses of variance (ANOVAs) were conducted for each dependent variable within each group in order to evaluate changes over time for TUG, 10MWT, 6MWT and UPDRS. Separate 2 × 2 mixed model repeated-measures ANOVAs with extremity (right, left) as the within-subjects factor and group (IG, CG) as the between-subjects factor were conducted for myotonometry. If statistical significance was obtained ($p < 0.05$) in the ANOVA, we used paired samples t-tests with Bonferroni post hoc corrections for pairwise comparisons.

Results

Thirty-seven participants with PD were screened for eligibility between October and December 2019. Thirty-three aged 69.9 ± 7.2 years (mean ± SD; 39% female) fulfilled the eligibility criteria and agreed to participate. Baseline characteristics of both groups were similar (Table 1). There were no changes in the medication regimen of participants during the study. In total, 31 participants (94%) completed the treatment intervention (Figure 1). No participants reported any adverse effects during or after the interventions.

Regarding gait, the 2 × 2 mixed model repeated-measures ANCOVA revealed non-significant group × time interactions for TUG, 10MWT and 6MWT (Table 2). Separate repeated-measures ANOVAs showed significant effects of time for the IG in TUG ($F = 3.30$; $p = 0.049$) and 10MWT ($F = 3.50$; $p = 0.041$), while the CG exhibited no changes in any outcome. Paired samples t-tests with Bonferroni post hoc correction showed significant improvements over time in 10MWT between Pre and Follow-up for the IG ($p < 0.05$; Table 3).

Regarding muscle tone, the 2 × 2 × 2 mixed model ANCOVA did not reveal any significant group × time × extremity interaction for myotonometric measurements, and there was no significant group × time interaction (Table 2). Separate 2 × 2 mixed model repeated-measures ANOVAs showed significant effects of time for the IG in frequency ($F = 4.00$; $p = 0.027$) and stiffness ($F = 4.92$; $p = 0.013$) myotonometric measurements, while the CG remained invariable. Paired samples t-test with Bonferroni post hoc correction showed significant improvements over time in frequency and stiffness between Pre and Follow-up for the IG ($p < 0.05$; Table 3).

There were no other significant changes in any of the other variables included in the study (Table 3).

Discussion

To our knowledge, this study is the first to evaluate the effects of DN on gait, muscle tone of the lower extremities and evolution of the disease in persons with PD. The main findings showed that a single session of DN was not associated with any statistically significant improvements relative to an untreated control group, although within-group analysis showed increased functional mobility of gait and gait speed, and changes in frequency and stiffness (evaluated by myotonometry) in PD patients. Our results are in line with another published RCT of stroke patients,[7] which showed improvements in the IG over time in gait, measured with the TUG and 10MWT, but not with in the CG or between groups. An apparently controversial finding is that there were significant changes at 7 days follow-up but not immediately after DN in the IG. This is something described in the literature, mainly when applying DN in the lower extremities, with different muscles potentially responding in different ways just after being needled.[29]

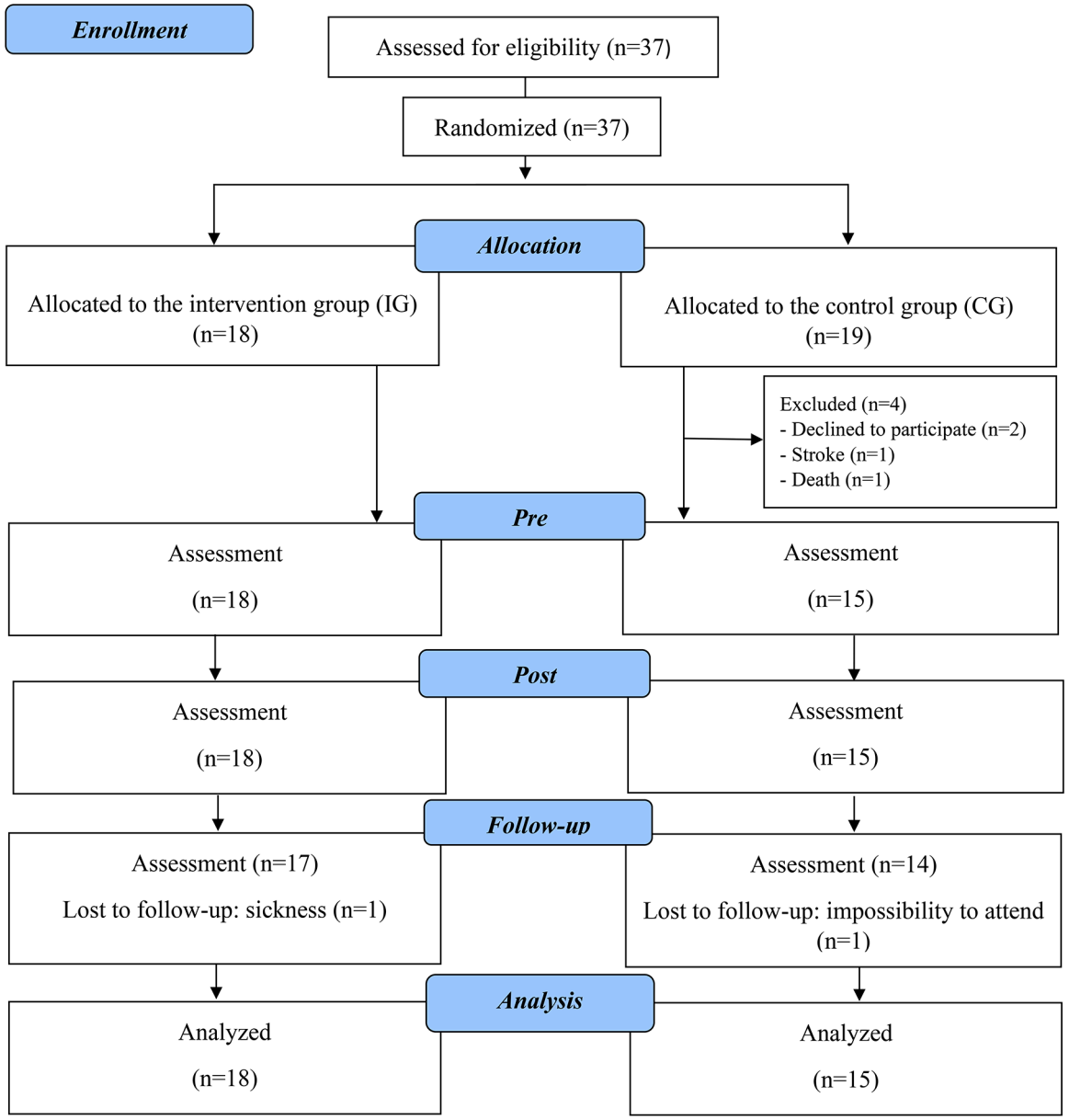
Regarding gait, our study showed results similar to another study carried out in post-stroke patients,[6] who improved after the application of a single session of DN, as well as other studies in which a single session of BTX was administered in PD and similar improvements in the TUG were demonstrated.[30,31] Our participants improved by 1.7 s at a follow-up time of 1 week, similar to the results of Gupta et al., who reported improvements of 1.6 s[30] and 1.5 s[31] after 3 weeks. However, these changes are below the MDC for persons with PD, which is considered to be 3.5 s.[28] Regarding gait speed, measured with the 10MWT, there were also within-group improvements after DN. Our participants improved by 0.7 s after 1 week, similar to another study that found an improvement of 0.7 s at 3 weeks after a single session of BTX in persons with PD.[31] However, persons with PD in another study improved by 1.3 s at 3 weeks after a single session of BTX,[30] which may have been influenced by the fact that the participants in that study started with lower baseline rates than in ours. Despite this statistically significant change in the IG, the mean change we obtained (0.12 m/s) was also less than the MDC, which is considered to be 0.18 m/s for comfortable speed.[21] Although there were no significant results in walking distance measured with the 6MWT, our results showed an improvement of 22.6 m, similar to other studies that found an improvement of 22.7 m at 3 weeks after a single session of BTX in persons with PD.[30] This change was also under the MDC, considered to be 82 m.[21]

Table 1. Clinical and sociodemographic characteristics of Parkinson's disease (PD) patients in the intervention group (IG, n = 18) and control group (CG, n = 15).

PD patient no.	Age (years)	Sex (F/M)	Body mass (kg)	Height (cm)	Diagnosis (years)	Hoehn and Yahr scale
IG869	72	M	80	170	4	II
IG071	65	M	108	165	10	IV
IG324	80	M	67	164	7	II
IG555	66	F	50	157	6	II
IG876	53	M	110	184	7	II
IG893	79	F	61	160	8	II
IG851	75	M	91	180	6	II
IG349	75	M	74	160	15	II
IG391	72	M	72	173	14	IV
IG120	61	F	69	160	3	II
IG111	75	F	50	152	14	III
IG044	78	M	80	178	23	III
IG346	66	M	68	168	9	III
IG128	69	M	94	170	15	III
IG230	71	M	101	166	3	I
IG414	73	M	88	165	2	III
IG084	75	M	70	162	10	II
IG010	57	F	78	158	6	III
Mean ± SD	70 ± 7.5	(5/13)	78 ± 17.6	166 ± 8.5	9 ± 5.4	–
CG029	70	F	88	160	36	IV
CG351	60	M	62	160	23	III
CG205	74	M	70	170	7	II
CG584	75	F	77	150	10	III
CG370	59	F	74	151	7	II
CG267	65	F	63	154	10	III
CG137	79	F	68	145	11	II
CG573	73	F	92	159	6	II
CG415	75	F	64	160	4	IV
CG863	79	M	65	175	3	I
CG078	71	M	65	163	4	II
CG330	62	M	95	168	3	I
CG036	76	M	89	179	5	I
CG320	64	F	62	170	18	IV
CG981	61	M	82	179	4	III
Mean ± SD	70 ± 7.1	(8/7)	74 ± 11.9	163 ± 10.5	10 ± 9.2	–

No.: number; F: female; M: male; SD: standard deviation.

Figure 1. Flow chart of study participants.



Regarding muscle tone, Rätsep and Asser found that, after performing deep brain stimulation, there were changes in the stiffness of resting muscles as measured by myotonometry in persons with PD.[24] These results are similar to ours, showing possible changes in both stiffness and frequency parameters via myotonometry. Similarly, Marusiak et al.[32] concluded that dopaminergic medication induced changes in mechanical properties of the muscle measured by myotonometry in persons with PD. A case report published by Calvo et al.[29] in a patient with chronic stroke found similar changes in muscle tone after DN application, although the technique used to measure muscle tone was tensiomyography, which uses different parameters. Moreover, a recent study found that DN was better than simple stretching therapy at relieving MTrP activity in rats,[33] which may help us understand how DN may work for tone management in PD patients.

In relation to the evolution of the disease measured using the total scores of the UPDRS, we did not find

Table 2. Treatment effects between groups immediately post-intervention and at 7-day follow-up (mean difference and 95% CI).

Assessment	Effect pre–post	Effect pre–follow-up	ANCOVA		
	Adjusted mean difference [95% CI]	Adjusted mean difference [95% CI]	F	p[a]	Effect size
TUG (s)	−0.57 [−2.11 to 0.97]	−0.72 [−2.08 to 0.63]	0.04	0.842	0.001
10MWT (s)	0.03 [−0.83 to 0.89]	−0.15 [−0.95 to 0.66]	0.29	0.593	0.010
6MWT (m)	4.7 [−22.4 to 31.9]	−3.6 [−36.7 to 29.5]	0.28	0.601	0.009
UPDRS	–	1.0 [−2.9 to 4.9]	0.27	0.610[b]	0.009
ΣF-LE					
R	−1.5 [−3.5 to 0.6]	−0.3 [−2.8 to 2.3]	0.01	0.979	0.001
L	0.9 [−0.9 to 2.7]	−0.4 [−2.6 to 1.9]			
ΣD-LE					
R	−0.20 [−0.53 to 0.12]	−0.17 [−0.57 to 0.23]	3.30	0.080	0.102
L	0.01 [−0.30 to 0.32]	0.24 [−0.19 to 0.67]			
ΣS-LE					
R	−21 [−59 to 16]	9 [−35 to 54]	0.10	0.757	0.003
L	2 [−26 to 30]	14 [−46 to 73]			

CI: confidence interval; ANCOVA: analysis of covariance; F: frequency; TUG: timed up and go test; 10MWT: 10 meter walk test; 6MWT: 6 minute walk test; UPDRS: unified Parkinson's disease rating scale; LE: lower extremity; D: decrement; S: stiffness; R: right; L left; Σ: summation; IG: intervention group; CG: control group.
Positive between-group differences represent greater change [improvement] in the IG compared to the CG.
[a]ANCOVA (group × time interaction) p value.
[b]One-factor ANCOVA p value.

statistically significant changes following a single session of DN. Our results are similar to another study[34] that found no significant changes in the total score of the UPDRS after 20 sessions of acupuncture.

Treatments carried out to date in PD patients are highly variable and are mainly based on the reeducation of balance and gait through different methods like resistance training, treadmill, cycling, dual task, complementary therapy, or external cuing, among others. This leads to the notion that improvements in mobility or gait are mainly due to improvements in motor learning and muscle strength in the lower extremities.[35] However, DN may also achieve improvements in gait, which cannot be explained through the aforementioned mechanisms, and whose effects must rely on a combination of local changes in the muscle[9,10,12,29] and increased activation of the sensory and motor areas.[8,11] Because of these different and complementary mechanisms of action, future studies should evaluate if DN can achieve any additional effects when it is combined with contemporary treatments carried out for PD. In addition, considering other studies in PD carried out with needling procedures such as acupuncture or BTX, it is necessary that future studies analyze if more than one DN session can lead to cumulative effects in PD patients.

Although this study has some strengths, like being a double-blind RCT and, to our knowledge, the first study to analyze the effects of DN in persons with PD, a few limitations should also be considered. First, this study only evaluated the short-term effects of DN (7 days) with just a single session. Future research should evaluate over longer follow-up periods and following a greater number of sessions. Second, due to ethical reasons, we could not analyze the isolated effects of DN since it was applied in combination with the standard treatment received by persons with PD in this study.

In summary, the results of this RCT did not show any benefit of a single session of DN compared to a single session of sham DN. However, within-group changes in the IG suggested there may be increased functional mobility of gait and gait speed in persons with PD, as well as changes in muscle tone in the lower extremities. Similar intra-group effects were not seen following sham DN, suggesting these potential effects are worthy of further investigation, ideally in a larger sample of PD patients. Ultimately, the within-group changes observed were not clinically meaningful, so future studies should evaluate if more DN sessions can achieve clinically relevant effect sizes and if DN can achieve any additional effects when it is combined with contemporary treatments carried out in persons with PD.

Table 3. Unadjusted outcomes (mean and SD) for each treatment group at baseline, immediately post-intervention and at 7-day follow-up.

Assessment	Group	Pre	Post	Within-group score change (pre–post)	Follow-up	Within-group score change (pre–follow-up)	ANOVA		
		Mean ± SD	Mean ± SD	Mean [95% CI]	Mean ± SD	Mean [95% CI]	F	p[a]	Effect size
TUG (s)	IG	13.42 ± 6.20	12.57 ± 4.90	−0.85 [−2.52 to 0.82]	11.74 ± 3.52	−1.68 [−3.58 to 0.21]	3.30	**0.049**	0.163
	CG	12.14 ± 3.29	12.14 ± 3.94	0.00 [−1.03 to 1.03]	11.71 ± 3.50	−0.42[−1.81 to 0.96]	0.40	0.679	0.027
10MWT (s)	IG	6.13 ± 1,80	5.88 ± 1.62	−0.25 [−0.98 to 0.48]	5.47 ± 1.39	**−0.67 [−1.3 to −0.03]***	3.50	**0.041**	0.171
	CG	6.69 ± 2.05	6.29 ± 2.19	−0.40[−1.19 to 0.39]	5.96 ± 1.86	−0.73[−1.73 to 0.26]	2.50	0.100	0.152
6MWT (m)	IG	323.0 ± 127.9	330.9 ± 123.7	7.9 [−9.7 to 25.6]	345.6 ± 125.4	22.6 [−5.2 to 50.4]	3.10	0.058	0.154
	CG	312.2 ± 89.1	315.7 ± 104.7	3.5 [−25.4 to 32.3]	338.6 ± 111.9	26.4 [−1.2 to 54.0]	2.83	0.076	0.168
UPDRS	IG	31.8 ± 15.4	–	–	30.2 ± 14.2	−1.6 [−4.8 to 1.5]	1.58	0.226	0.085
	CG	35.1 ± 20.4	–	–	31.9 ± 17.6	−3.1 [−7.6 to 1.3]	3.12	0.099	0.182
ΣF-LE									
R	IG	57.4 ± 6.1	57.5 ± 6.1	0.1 [−1.3 to 1.6]	59.0 ± 7.4	**1.7 [0.2 to 3.1]***	4.00	**0.027**	0.191
L		57.8 ± 5.8	58.8 ± 5.6	1.0 [−0.4 to 2.5]	59.4 ± 5.8	1.6 [−0.1 to 3.3]			
R	CG	57.4 ± 4.9	58.8 ± 4.5	1.4 [−0.8 to 3.6]	59.1 ± 4.5	1.7 [−1.1 to 4.6]	2.18	0.132	0.135
L		57.0 ± 4.0	57.1 ± 4.2	0.1 [−1.9 to 2]	58.8 ± 5.3	1.8 [−0.5 to 4.1]			
ΣD-LE									
R	IG	6.73 ± 1.39	6.67 ± 1.31	−0.06 [−0.25 to 0.12]	6.62 ± 1.25	−0.11 [−0.41 to 0.19]	0.66	0.525	0.037
L		6.82 ± 1.45	6.65 ± 1.35	−0.17 [−0.48 to 0.13]	6.78 ± 1.39	−0.04 [−0.43 to 0.35]			
R	CG	6.78 ± 0.94	6.91 ± 1.02	0.13 [−0.24 to 0.50]	6.48 ± 1.01	−0.30 [−0.71 to 0.11]	3.31	0.051	0.191
L		6.72 ± 1.01	6.58 ± 0.87	−0.14 [−0.40 to 0.12]	6.48 ± 0.89	−0.23 [−0.60 to 0.13]			
ΣS-LE									
R	IG	1082 ± 98	1085 ± 104	3 [−27 to 33]	1115 ± 109	**33 [10 to 55]***	4.92	**0.013**	0.225
L		1086 ± 91	1107 ± 99	20 [0 to 41]	1116 ± 97	**30 [2 to 58]***			
R	CG	1100 ± 73	1122 ± 82	22 [−12 to 56]	1124 ± 107	24 [−27 to 75]	1.61	0.218	0.103
L		1096 ± 96	1113 ± 92	17 [−10 to 44]	1135 ± 153	39 [−34 to 113]			

SD: standard deviation; CI: confidence interval; ANOVA: analysis of variance; TUG: timed up and go test; IG: intervention group; CG: control group; 10MWT: 10 meter walk test; 6MWT: 6 minute walk test; UPDRS: unified Parkinson's disease rating scale; Σ: summation; F: frequency; LE: lower extremity; R: right; L: left; D: decrement; S: stiffness.

[a]ANOVA (time effect) p value.

*Significant differences ($p < 0.05$) after paired samples t-tests with Bonferroni correction.

Bold denotes statistically significant.

Contributors

NBC, EBE, PH and SC conceived and designed the study. NBC, SC and EBE were involved in data collection. NBC, PH and CRB were involved in data analysis. All authors were involved in drafting the article and approved the final version of the manuscript accepted for publication.

Acknowledgements

We would like to acknowledge the participation from the members and staff from the Aragon Association of Parkinson in Zaragoza, especially Alicia.

Declaration of conflicting interests

The authors declared the following potential conflicts of interest with respect to the research, authorship and/or publication of this article: PH owns the registration of the DNHS® trademark. The remaining authors have no conflicts of interest to declare.

Funding

The authors received no financial support for the research, authorship and/or publication of this article.

ORCID iDs

Natalia Brandín-de la Cruz https://orcid.org/0000-0002-9426-1257

Sandra Calvo https://orcid.org/0000-0002-1674-7788

Pablo Herrero https://orcid.org/0000-0002-9201-0120

Trial registration

Trial registration number: NCT04101214 (ClinicalTrials.gov).

References

1. Sveinbjornsdottir S. The clinical symptoms of Parkinson's disease. *J Neurochem* 2016; 139(Suppl. 1): 318–324.
2. Benito-Leon J. [Epidemiology of Parkinson's disease in Spain and its contextualisation in the world]. *Rev Neurol* 2018; 66(4): 125–134.
3. Witt K, Kalbe E, Erasmi R, et al. [Nonpharmacological treatment procedures for Parkinson's disease]. *Nervenarzt* 2017; 88(4): 383–390.
4. Tomlinson CL, Patel S, Meek C, et al. Physiotherapy versus placebo or no intervention in Parkinson's disease. *Cochrane Database Syst Rev* 2013; 9: CD002817.
5. Noh H, Kwon S, Cho SY, et al. Effectiveness and safety of acupuncture in the treatment of Parkinson's disease: a systematic review and meta-analysis of randomized controlled trials. *Complement Ther Med* 2017; 34: 86–103.
6. Hadi S, Khadijeh O, Hadian M, et al. The effect of dry needling on spasticity, gait and muscle architecture in patients with chronic stroke: a case series study. *Top Stroke Rehabil* 2018; 25(5): 326–332.
7. Ghannadi S, Shariat A, Ansari NN, et al. The effect of dry needling on lower limb dysfunction in poststroke survivors. *J Stroke Cerebrovasc Dis* 2020; 29(6): 104814.
8. Calvo S, Navarro J, Herrero P, et al. Electroencephalographic changes after application of dry needling [DNHS© Technique] in two patients with chronic stroke. *Myopain* 2015; 23(3–4): 112–117.
9. Domingo A, Mayoral O, Monterde S, et al. Neuromuscular damage and repair after dry needling in mice. *Evid Based Complement Alternat Med* 2013; 2013: 260806.
10. Margalef R, Sisquella M, Bosque M, et al. Experimental myofascial trigger point creation in rodents. *J Appl Physiol* 2019; 126(1): 160–169.
11. Mohammadpour F, Ali Oghabian M, Nakhostin Ansari N, et al. Effects of dry needling on post-stroke brain activity and muscle spasticity of the upper limb: a case report. *Acupunct Med* 2020.
12. Lu Z, Briley A, Zhou P, et al. Are there Trigger Points in the spastic muscles? electromyographical evidence of dry needling effects on spastic finger flexors in chronic stroke. *Front Neurol* 2020; 11: 78.
13. Brady S, McEvoy J, Dommerholt J, et al. Adverse events following trigger point dry needling: a prospective survey of chartered physiotherapists. *J Man Manip Ther* 2014; 22(3): 134–140.
14. Vázquez-Justes D, Yarzábal-Rodríguez R, Doménech-García V, et al. Effectiveness of dry needling for headache: a systematic review. *Neurologia*. Epub ahead of print 13 January 2020. DOI: 10.1016/j.nrl.2019.09.010.
15. Fernández Sanchis D and Cuenca Zaldívar JN. Estudio de coste-efectividad de la punción seca en brazo en paciente con ictus. In: *Jornadas de Innovación en Fisioterapia* Editorial Universidad San Jorge, Zaragoza, Spain, 19 Mayo 2017, pp. 28–29.
16. Schulz KF, Altman DG and Moher D. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *BMJ* 2010; 340: c332.
17. Herrero P, Calvo S and Ortiz M. Dry needling for hypertonia an spasticity (DNHS). In: Valera F and Minaya F (eds) *Advanced techniques in musculoskeletal medicine & physiotherapy using minimally invasive therapies*. London: Churchill Livingstone, Elsevier, 2015, pp. 221–238.
18. Mitchell UH, Stoneman P, Larson RE, et al. The construction of sham dry needles and their validity. *Evid Based Complement Alternat Med* 2018; 2018: 9567061.
19. Goetz CG, Poewe W, Rascol O, et al. Movement Disorder Society Task Force report on the Hoehn and Yahr staging scale: status and recommendations. *Mov Disord* 2004; 19(9): 1020–1028.
20. Bennie S, Kathryn B, Dizon A, et al. Measurements of balance: comparison of the Timed "Up and Go" Test and Functional Reach Test with the Berg Balance Scale. *J Phys Ther Sci* 2003; 15: 93–97.
21. Steffen T and Seney M. Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the unified Parkinson disease rating scale in people with parkinsonism. *Phys Ther* 2008; 88(6): 733–746.
22. Opara J, Malecki A, Malecka E, et al. Motor assessment in Parkinson's disease. *Ann Agric Environ Med* 2017; 24(3): 411–415.
23. Jimenez-Sanchez C, Ortiz-Lucas M, Bravo-Esteban E, et al. Myotonometry as a measure to detect myofascial trigger points: an inter-rater reliability study. *Physiol Meas* 2018; 39(11): 115004.
24. Ratsep T and Asser T. The effect of subthalamic stimulation on viscoelastic stiffness of skeletal muscles in patients with Parkinson's disease. *Clin Biomech* 2017; 44: 94–98.
25. Marusiak J, Kisiel-Sajewicz K, Jaskolska A, et al. Higher muscle passive stiffness in Parkinson's disease patients than in controls measured by myotonometry. *Arch Phys Med Rehabil* 2010; 91(5): 800–802.
26. Fahn S and Elton R, Members of UPDRS Development Committee. Unified Parkinson's disease rating scale. In: Fahn S, Marsden C, Calne D, et al. (eds) *Recent developments in Parkinson's disease*. Florham Park, NJ: MacMillan Healthcare, 1987, pp. 153–163.
27. Siderowf A, McDermott M, Kieburtz K, et al. Test-retest reliability of the unified Parkinson's disease rating scale in patients with early Parkinson's disease: results from a multicenter clinical trial. *Mov Disord* 2002; 17(4): 758–763.
28. Huang SL, Hsieh CL, Wu RM, et al. Minimal detectable change of the timed "up & go" test and the dynamic gait index in people with Parkinson disease. *Phys Ther* 2011; 91(1): 114–121.

29. Calvo S, Quintero I and Herrero P. Effects of dry needling (DNHS technique) on the contractile properties of spastic muscles in a patient with stroke: a case report. *Int J Rehabil Res* 2016; 39(4): 372–376.
30. Gupta AD and Visvanathan R. Botulinum toxin for foot dystonia in patients with Parkinson's disease having deep brain stimulation: a case series and a pilot study. *J Rehabil Med* 2016; 48: 559–562.
31. Gupta AD, Tucker G, Koblar S, et al. Spatiotemporal gait analysis and lower limb functioning in foot dystonia treated with botulinum toxin. *Toxins* 2018; 10(12): 532.
32. Marusiak J, Jaskolska A, Budrewicz S, et al. Influence of dopaminergic treatment on resting elbow joint angle control mechanisms in patients with Parkinson's disease—a preliminary report. *Acta Bioeng Biomech* 2018; 20(4): 75–82.
33. Ding CL, Ma YT, Huang QM, et al. [Effect of dry needling stimulation of myofascial trigger point on sample entropy of electromyography of gastrocnemius injured site in rats]. *Zhen Ci Yan Jiu* 2018; 43: 127–132.
34. Yang DH, Shi Y and Jia YM. Influence of acupuncture plus drug in the amelioration of symptoms and blood antioxidant system of patients with Parkinson disease. *Chin J Chin Rehabil* 2006; 10: 14–16.
35. Ni M, Hazzard JB, Signorile JF, et al. Exercise guidelines for gait function in Parkinson's disease: a systematic review and meta-analysis. *Neurorehabil Neural Repair* 2018; 32(10): 872–886.