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Effect of dry needling plus static stretching on plantar flexor spasticity, function, and quality of life in a patient with chronic stroke: a case report

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Abstract

Background Static stretching is a treatment that reduces spasticity by elongating the muscle fibers. Dry needling is also a novel intervention that reduces spasticity by destroying dysfunctional endplates. Plantar flexor spasticity can cause gait disturbances and impaired balance in patients who have had a stroke. Therefore, reducing the spasticity of these muscles can improve the patient's independence and overall function. This study reported the additional effects of dry needling on static stretching in reducing spasticity and function in a chronic stroke patient.

Case presentation The patient was a 47-year-old Iranian woman with a past-7-month history of stroke and plantar flexor muscle spasticity. In this study, interventions were conducted for 5 days. In the treatment session, first dry needling (60 seconds × 3 days/week for 1 week total) was applied on the gastrocnemius, and then, an orthosis was used for static stretching (20 minutes × 5 days/week for 1 week total). The outcome measures were the Modified Modified Ashworth Scale, active and passive range of motion, the timed up and go test, and the European Quality of Life questionnaire . The patient was assessed at baseline (T0), immediately following treatment (T1), and at 1-week follow-up (T2). The results were reported as follows: The Modified Modified Ashworth Scale score decreased from 2 at T0 to 1 at T1 and remained 1 at T2. Active range of motion increased from 10° at T0 to 25° at T1 and decreased again to 15° at T2. Passive range of motion increased from 40° at T0 to 50° at T1 and decreased again to 45° at T2. The timed up and go test decreased from 50 seconds at T0 to 40 seconds at T1 and increased again to 42 seconds at T2. Her European Quality of Life questionnaire score increased from 0.25 at T0 to 0.39 at T1 and remained unchanged at 0.39 at T2.

Conclusion This case study reported a patient with post-stroke spasticity. After dry needling in combination with static stretching, spasticity and overall function improved. It would be beneficial to conduct a randomized clinical trial study with a control group to comprehend the additional impact of dry needling on static stretching.

Trial registration IRCT20230719058844N1, Registered 7 August 2023, https://irct.behdasht.gov.ir/trial/71395.

Keywords Stroke, Spasticity, Stretching, Dry needling, Plantar flexors

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Introduction

Stroke is a common cause of disability in adults annually [1]. According to the American Stroke Association (ASA) an acute focal injury of the central nervous system (CNS) by a vascular cause is called a stroke [2]. Every year, 15 million individuals suffer from stroke around the world [3]. Spasticity is a common complaint after a stroke. Physiologically, the alpha motor neuron hyperexcitability increases the stretch reflex sensitivity after a stroke. This may lead to an increase in velocity-dependent muscle tone, called spasticity. Spasticity occurs in 25% of patients who have had a stroke [4]. Although the onset time of spasticity is variable, it usually manifests around 6 months post-stroke [5]. Spasticity is more often found in the plantar flexors of the lower limb in patients who have had a stroke [6]. Due to the key role of these muscles in the gait cycle, finding a more effective treatment is important.

For this purpose, static stretching (SS) is a noninvasive intervention for spasticity treatment. Physiologically, SS causes a temporary increase in the flexibility of soft tissue, which disappears immediately after stretching [7, 8]. Although there are studies that support SS as an effective treatment to reduce the spasticity of the plantar flexors [9], dry needling (DN) has also been demonstrated to be a novel, minimally invasive, and cost-effective treatment for reducing spasticity [10, 11] in subacute [12] or chronic [13] stroke. It seems that DN breaks dysfunctional endplates [14] and produces a quick stretch [15], which leads to reducing spasticity in patients who have had a stroke.

Given the role of the plantar flexors in balance and gait, spasticity in these muscles may cause balance impairments, and reduce the patient's quality of life (QoL) [16]. Finding an effective treatment for reducing spasticity and its maintenance is of great importance to increase patient satisfaction and QoL. Some researchers investigated the additional effects of DN in conjunction with other physiotherapy interventions such as hand exercise therapy [17], seeking the maintenance of DN effects even for at least 1 week. Nevertheless, there was no evidence regarding the additional effects of DN with SS for reducing hypertonicity in either the upper or lower extremities.

To our knowledge, this is the first study that has reported simultaneously objective findings (Modified Modified Ashworth Scale) alongside the balance and QoL findings on plantar flexors' spasticity. The latter is very important because patient participation is the end goal of neurologic physiotherapy based on the International Classification of Functioning, Disability and Health (ICF) model [18]. So, this study seeks to report the above concerns in a patient with chronic stroke.

Case presentation

A 47-year-old Iranian woman (weight 68 kg; height 160 cm) with an ischemic stroke diagnosed 7 months ago by a neurologist, on the basis of a computed tomography (CT) scan taken at the onset of the stroke (Fig. 1), was studied. She was bedridden in the Stroke Ward at Rofeideh Hospital for 3 weeks, and all the interventions and assessments were conducted there. Despite undergoing conservative physical therapy, she still complained of a balance disorder and muscle stiffness in the plantar flexors (MMAS = 2) on her left side. She was fully conscious and able to understand the therapist's commands (Mini Mental State Examination score = 28). She was able to walk at least 10 m independently with an elbow crutch on the affected side. There was no contracture of the muscles on the affected side. She did not receive any drugs for 3 months or Botox injections in the last 6 months. She also had no history of other neuromuscular disorders, surgeries, or pain in the lower limbs. This study was approved by the Ethics Committee of Tehran University of Medical Sciences. After informing the patient about her rights and interventions, a written consent form was signed by the patient.

Assessments

Figure 2 presents the timeline of assessments and interventions in general. The assessments were conducted at baseline (T0), immediately following treatment (T1), and at 1-week follow-up (T2) by an experienced physiotherapist (Fig. 2), with a 3-minute break to minimize the interference effects of each assessment on another.

Spasticity

In this study, spasticity was assessed by the Persian version of the Modified Modified Ashworth Scale (MMAS) [19], which was administered once. The patient was supine on the bed in a relaxed position. The patient's head was placed in the middle line. The knees were extended. Then the assessor stood on the left side of the patient and fixed the proximal ankle with one hand and held the sole of the foot with the other hand. Then, in 1 second the assessor passively moved the patient's ankle toward the maximum range of dorsiflexion, and scored the level of resistance according to the MMAS scale using 0 (no increase in muscle tone), 1 (slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension), 2 (marked increase in muscle tone, manifested by a catch in the middle range and resistance throughout the remainder of the range of motion, but affected part(s) easily moved), 3 (considerable increase in muscle tone;

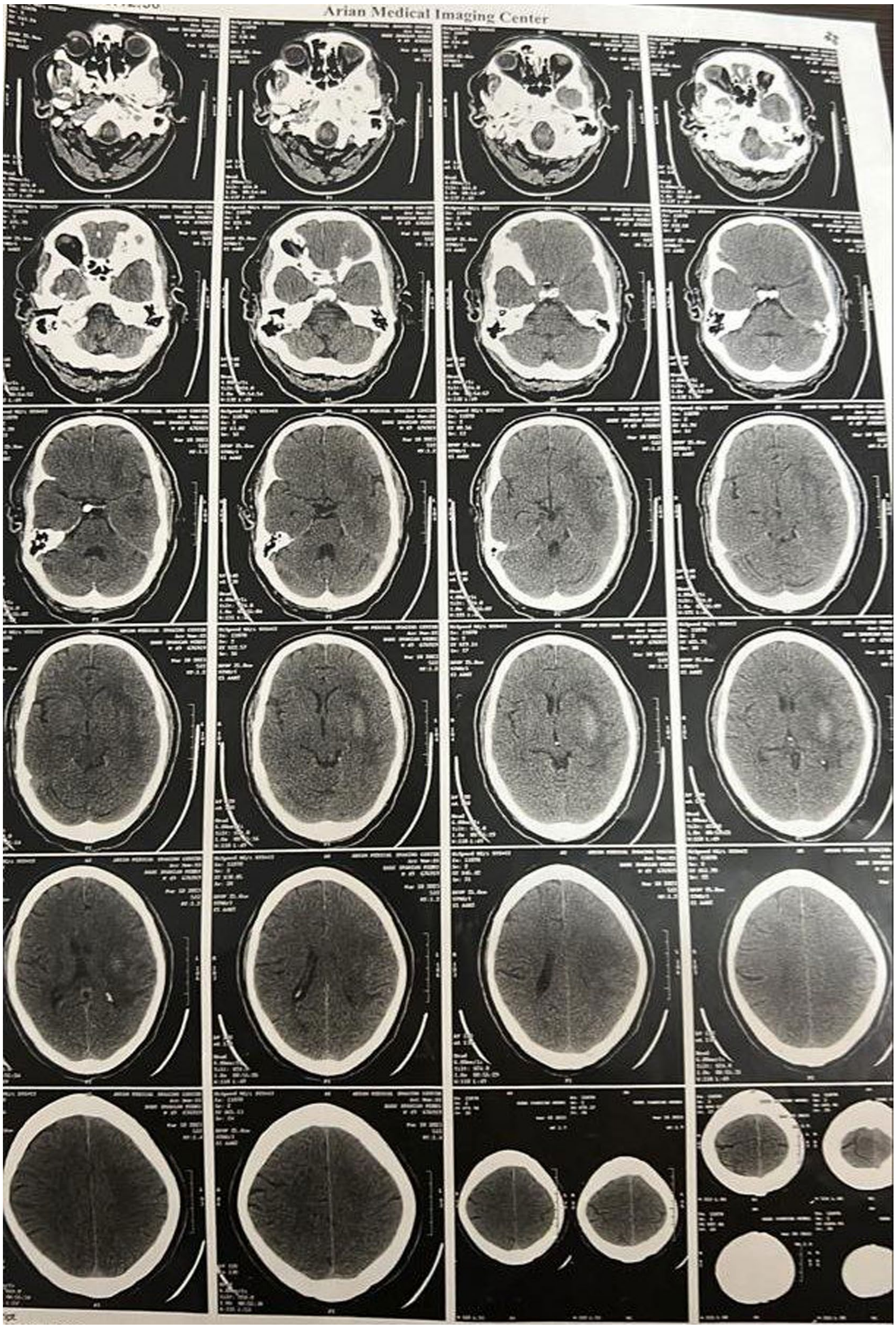

Fig. 1 Computed tomography scan of the patient at the onset of the stroke

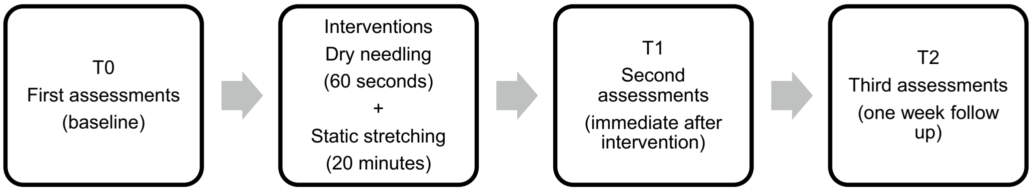

Fig. 2 Timeline of interventions and assessments

Fig. 3 Measurement of active and passive range of motion

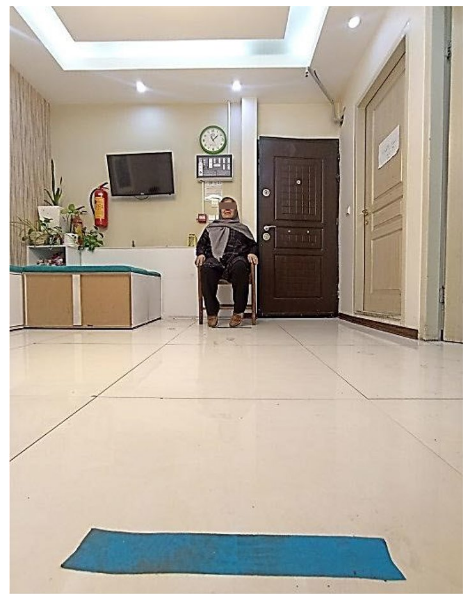

Fig. 4 Timed up and go test

passive movement difficult), or 4 (affected part(s) rigid in flexion or extension)[19].

Active and passive range of motion

A goniometer (Ghamatpooyan, Iran) was used to measure active and passive range of motion (ROM), which was administered once. The patient was supine on the bed. The patient's knees were extended. The assessor set the goniometer so that the stationary arm was parallel to the fibula and the movement arm was parallel to the fifth metatarsal [20]. The assessor held the proximal ankle of the patient with one hand and the sole of the foot with the other hand. Then, for active ROM, the patient was asked to actively move the ankle to the maximum available dorsiflexion. With an interval of 3 minutes from the first test, for passive ROM, the assessor moved the patient's ankle passively to the maximum available dorsiflexion slowly. The maximum active and passive ROM was measured and reported in degrees from the resting position [21] (Fig. 3).

Timed up and go test

To perform this test, the patient sat on a chair with handles. A blue stripe was placed 3 m away from the patient. The patient was asked to get up from the chair and move toward the stripe with elbow crutch on the affected side and turn around it and come back and sit on the chair. The test time was measured and reported in seconds from the time the patient stood up to the time the patient sat on the chair again (Fig. 4) [22, 23].

European Quality of Life

This questionnaire has five dimensions: mobility, self-care, daily activities, pain or discomfort, and depression. Each dimension has five levels: no problem (score 1), low problem (score 2), moderate problem (score 3), severe problem (score 4), and very severe problem (score 5). The patient reported the severity of her problem in every dimension, the scores were entered into the Iranian scoring system of this questionnaire as a five-digit code, and finally, this system calculated a score between 1 (no problem) and −1.19 (the most severe problem) [24].

Interventions

A physiotherapist with a BSc degree and legal qualifications for DN performed the interventions. In this study, the patient first received DN for 60 seconds and then SS for 20 minutes. The reason for this sequence is that the destruction of dysfunctional endplates by DN seems to enhance ROM during SS.

Dry needling

A sterile needle (size 0.30 mm × 0.50 mm; SMC, Seoul, Korea) was used for DN. The patient was made to lie in prone position. For DN location, a line was drawn from the popliteal fossa to the calcaneus. At 2 cm inside and outside in the upper third of this line, the needle entered the medial and lateral heads of the gastrocnemius muscle [25, 26]. The DN was performed using the Fast in, Fast out technique [25] once daily for three sessions and every other day for a 5-day period (Fig. 5).

Static stretching

For SS the patient was made to lie in supine position. Then, an orthopedist-made hinged ankle–foot orthosis (AFO) was applied at the ankle (Fig. 6). This orthosis consisted of an upper plate, on which the calf was placed, and a lower plate, on which the sole was placed, which were connected by an adjustable screw. After placing the patient's foot in this AFO, it was set in maximum dorsiflexion for 20 minutes. Static stretching was administered for five sessions once a day for a 5-day period.

Adverse effects

Some minor adverse effects such as bleeding and soreness happened after DN. We provided cold packs after every treatment session to minimize these reactions.

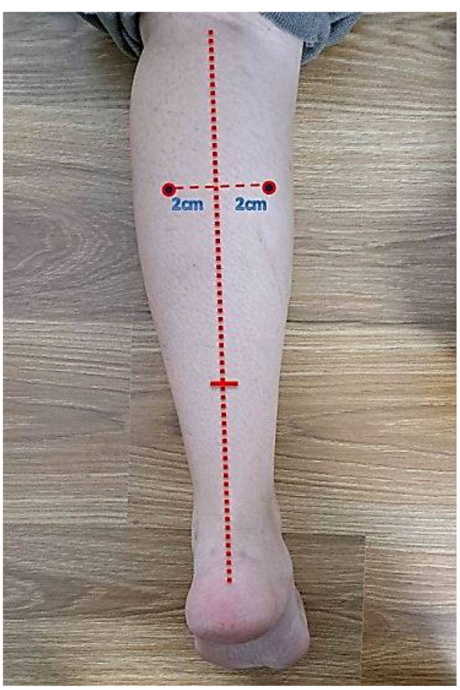

Fig. 5 Dry needling of the gastrocnemius muscle

Fig. 6 Adjustable ankle foot orthosis used for the purpose of static stretching

Results

The spasticity of the plantar flexors according to the MMAS decreased from 2 to 1 at T1 and remained unchanged at T2. Active ROM increased from 10° to 25° at T1, but it had again decreased to 15° at T2. Passive ROM increased from 40° to 50° at T1, and again decreased to 45° at T2. The changes in the timed up and go (TUG) test were from 50 seconds at T0 to 40 seconds at T1, and 42 seconds at T2. The changes in European Quality of Life (Euro QoL) questionnaire scores reported 0.25 at T0 and 0.39 at T1 and remained unchanged at T2. Table 1 presents the follow-up results at baseline, immediately following treatment, and at 1 week.

Discussion

In this case report, we presented the outcomes of a patient with post-stroke spasticity in the plantar flexors who underwent a combination of DN followed by SS.

Our results showed a 1 score decrease in plantar flexor spasticity, sustained after 1 week. Additionally, both

Table 1 Changes in outcome measures

Variables	Baseline (T0)	Post-treatment (T1)	Follow-up (T2)
MMAS	2	1	1
Active DF ROM, degrees	10	25	15
Passive DF ROM, degrees	40	50	45
TUG test, seconds	50	40	42
Euro QoL	0.25	0.39	0.39

T0 is pre-study/at baseline, T1 is after 1 week of intervention, and T2 is at 1-week follow-up. MMAS, Modified Modified Ashworth Scale; DF, dorsiflexion; ROM, range of motion; TUG, timed up and go; Euro QoL, European Quality of Life active and passive ankle ROM improved, with ROM at the follow-up assessment surpassing the initial measure. Moreover, the duration of the TUG test decreased and the Euro QoL questionnaire score increased post-intervention, demonstrating improved outcomes even 1 week after the intervention compared with before (8 seconds and 0.14 score, respectively). In general, the combination of DN plus SS improved spasticity, ROM of dorsiflexion, gait function, and QoL, with better outcomes after 1 week compared with preintervention.

A study carried out in 2020 by Kerr *et al.* revealed that stretching by splints is not effective in upper limb spasticity [27], whereas a study in 2019 by Ahmed *et al.* reported that prolonged stretching can reduce plantar flexors' spasticity [9]. It seems that the contradictions in the previous studies are due to the differences in stretching methods and their durations. Despite these contradictions, different studies seem to confirm that prolonged stretching (equal to or longer than 20 minutes) is used as an effective method to reduce spasticity by elongating muscle fibers [9, 28]. Therefore, in this study, the stretching duration was set to 20 minutes, and the gastrocnemius muscle was selected. DN is also a novel approach to reduce spasticity by destroying dysfunctional endplates [14]. Some other studies hypothesized that DN seems to produce a quick stretch in muscle fibers, leading to a reduction in alpha motor neuron excitability [15]. The decrease in alpha motor excitability leads to reduction in spasticity. Another hypothesis is that DN may enhance oxygen delivery to the muscles and alleviate spasticity and pain through vasodilation in small blood vessels [15]. A study in 2020 by Cortes *et al.* indicated that DN reduced spasticity in most of the muscles evaluated [29]. According to recent studies, using 60 seconds of fast in, fast out DN improved plantar flexor spasticity [25]; thus, we followed the same approach.

It seems that improvements in gait function may be attributed to an increase in ankle active and passive ROM as a result of spasticity reduction [30]. In addition, improving gait function may be associated with an increase in the QoL [31]. However, as this is a case report, the primary objective was to present preliminary insights on the potential effects of DN in combination with SS in a patient with chronic stroke. Future studies, including *N*-of-1 designs or randomized controlled trials, are necessary to better assess the effectiveness of DN plus SS and to provide stronger clinical evidence. Additionally, future research should investigate the effects of DN and SS on blood tests and their possible contribution to spasticity reduction. Moreover, while our study assessed short-term retention of outcomes over 1 week, further investigations should consider the long-term sustainability of these effects through longer follow-up periods.

Conclusion

This case report study provides preliminary evidence supporting the use of DN followed by SS as a promising intervention for improving outcomes in patients who have had a stroke who have plantar flexor spasticity. By addressing study limitations and building upon these initial findings, future research has the potential to further clarify the effectiveness of this intervention and optimize its implementation in clinical practice.

Abbreviations

DN	Dry needling
SS	Static stretching
DF	Dorsiflexion
ROM	Range of motion
MMAS	Modified Modified Ashworth Scale
TUG	Timed up and go
QoL	Quality of life

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Author contributions

Conceptualization: ME and NGH. Methodology: ME, NGH, KM, NNA and SM. Writing original draft: ME. Writing, review, and editing: ME, NGH, KM, NNA, PH, SHJ and EL. All authors read and approved the final manuscript for submission.

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Availability of data and materials

All data analyzed during this study are included.

Declarations

Ethics approval and approval and consent to participate

Ethical approval for this study was obtained from the Ethics Committee of Tehran University of Medical Sciences (TUMS) under approval ID IR.TUMS.FNM.REC.1402.097.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests

The authors declare no conflict of interest.

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