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Case Report

Concurrent Effects of Dry Needling and Electrical Stimulation in the Management of Upper Extremity Hemiparesis

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Abstract
Stroke is one of the leading causes of disability in western countries. A variety of rehabilitation programs for the treatment of patients after stroke have been proposed. We describe the outcomes of a 49-year-old female patient with a 5-year history of right upper extremity hemiparesis after stroke. Physical examination revealed a right wrist extensor strength grade of 1 according to the Medical Research Council Manual Muscle Testing scale, Stage 4 according to the Brunnstrom hand functional recovery, and Grade 1 in finger flexor and in wrist flexor according to the Modified Modified Ashworth Scale system of muscle spasticity. Magnetic resonance imaging taken immediately after the stroke was indicative of an abnormal signal in the left paraventricular and lentiform nucleus. After receiving a single session of dry needling and electrical stimulation, the patient had significant improvement including a strength grade of 3 for the right wrist extensor muscles, Stage 6 according to the Brunnstrom hand functional recovery, and Grade 0 in finger flexor and in wrist flexor according to the Modified Modified Ashworth

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Scale system of muscle spasticity. This case report found that dry needling combined with electrical stimulation may be effective in hand function recovery, wrist extensor muscles strength, and decreased wrist and finger spasticity.

1. Introduction

One of the major causes of disability in the world is cerebral stroke, and unfortunately, in western countries, the rate is increasing [1]. Upper extremity hemiplegia is one of the leading contributors to disability of activities of daily living after a stroke [2]. Therefore, rehabilitation of motor deficits after a stroke is crucial. Electrical stimulation (ES) is a modality that can potentially be used for the rehabilitation of the upper extremities after stroke [3]. ES could potentially assist with increasing the activation of upper extremity muscle activity by increasing both afferent and efferent [4]. Dry needling (DN) is an intervention which uses a thin monofilament needle which is manipulated into the muscle to stimulate underlying neural, muscular, and connective tissues [5]. In patients after stroke, DN has been and most often is used to reduce pain and upper limb spasticity [6,7]. To date, little has been published regarding the impact of one session of multimodal therapy in individuals after stroke, and most reports have used a single therapy in isolation such as acupuncture or ES which is not representative of actual clinical practice. Likewise, data from previous studies included several treatment sessions. The novelty of this case report is related to reporting of the effects of only one session of ES and DN with focus on function of the hand. The location of the current case report was Iran, a developing country, where there is increasing incidence and prevalence of patients with stroke [7–9].

2. Case presentation

The patient was a 49-year-old woman with a 5-year history of right upper extremity hemiparesis after stroke. The patient had a history of diabetes for 23 years and had been smoking for 20 years. She had received twenty sessions of routine physiotherapy 6 month after the stroke with no improvements in right hand function. Magnetic resonance imaging taken immediately after the stroke was indicative of an abnormal signal in the left paraventricular and lentiform nucleus, which was restricted in the diffusion, weighted imaging sequence. Acute ischemic stroke at the left middle cerebral artery and its branch (lateral lenticulostriate) was the main diagnosis. No other ischemic focus was noted in the magnetic resonance imaging images.

Physical examination was indicative of right extensor muscle strength of Grade 1 as per the Medical Research Council Manual Muscle Testing scale [10]. The Brunnstrom hand functional recovery [11] stage was 4. There are 6 sequential stages of motor recovery: (1) flaccidity; (2) little or no active finger flexion; (3) mass grasp, use of hook grasp but no release, no voluntary finger extension, and possibly reflex extension of digits; (4) lateral prehension, release by thumb movement, semivoluntary finger extension, with small range; (5) palmar prehension, possibly cylindrical and spherical grasp, awkwardly performed and with limited functional use, voluntary mass extension of digits, with variable range; and (6) all prehensile types under control, skills improving, full-range voluntary extension of digits, individual finger movements present but less accurate than on the opposite side. Despite some reports about its low responsiveness to change [12], the Brunnstrom staging system was used to reflect underlying motor control based on clinical assessment of movement quality [12].

Assessment of muscle tone based on the Modified Modified Ashworth Scale (MMAS) indicated Grade 1 in finger flexor and Grade 1 in wrist flexor. The MMAS is valid and reliable and includes 5 grades: 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 (ROM) 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 ROM, but affected part(s) easily moved; 3 = considerable increase in muscle tone, passive movement difficult; and 4 = affected part(s) rigid in flexion or extension [13,14].

On the treatment session, the patient received ES after DN of large intestine 4 (LI4) point which is located on the dorsum of the hand between the 1st and 2nd metacarpal bones and in the middle of the 2nd metacarpal bone on the radial side. After cleaning the zone with alcohol, a stainless-steel needle (size, 0.25 mm × 25 mm; SMC, Seoul, Korea) was inserted in the LI4 point of the hemiparetic hand. The needle was inserted to the depth determined by the clinician's judgment based on the depth of the tissue underling the skin [15], perpendicular to the skin using fast-in and fast-out cone-shape technique for 1 minute [13]. The procedure was performed by an experienced and trained physiotherapist.

After the DN, ES (RehaMove2; Hasomed GmbH, Germany) was applied at a frequency of 35 Hz, pulse width of 400 ms, amplitude of 30 MA, and interval of 2 seconds for a duration of 15 minutes. Two surface electrodes (5 × 9 cm) (RehaTrode; Hasomed, Germany) were placed on the wrist extensor muscles of the paretic hand.

The day after the treatment session, strength of the right wrist extensor muscles improved to Grade 3 (two level increase) according to the Medical Research Council Manual Muscle Testing scale and the motor recovery based on the Brunnstrom hand functional recovery stage was 6 (two-level increase). Grade 0 in finger flexor spasticity (one-level improvement) and Grade 0 in wrist flexor (one-level improvement) spasticity were detected according to the MMAS scale. After 4 weeks, a follow-up assessment was performed which revealed the same findings (see Fig. 1).

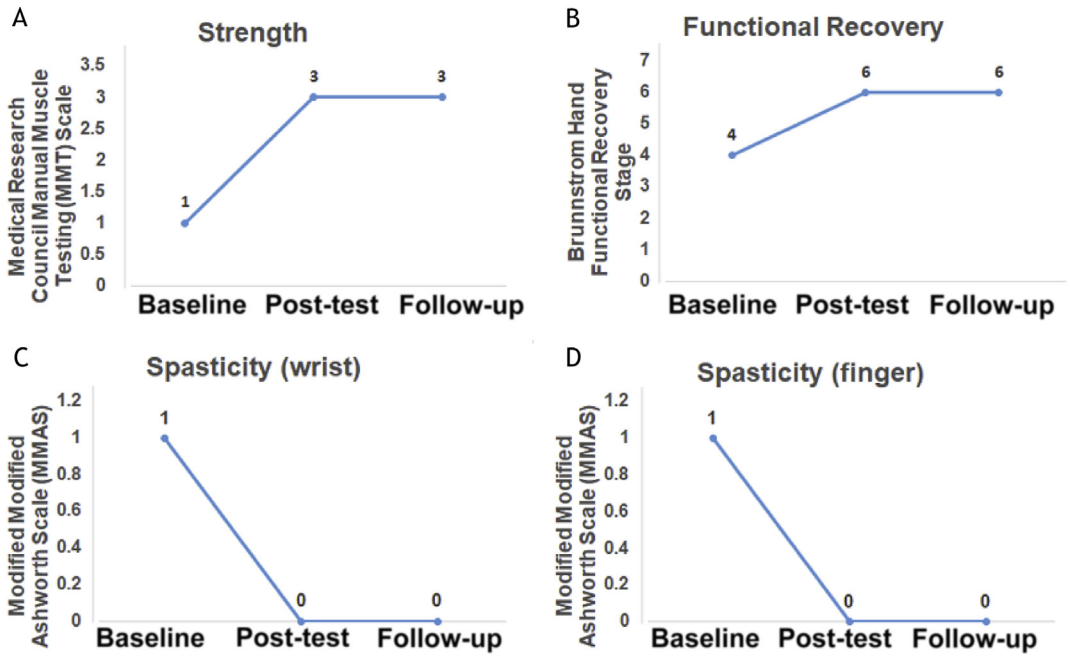

Figure 1 Effects of a single session of dry needling and electrical stimulation on the paretic hand. (A) The strength of right extensor muscle, (B) functional recovery of the finger, and (C) muscle tone of the wrist flexor and (D) the finger muscle before (baseline), at 2 days (Post-test) and 28 days after the session (follow-up). Note that the single session of dry needling (LI4) and electrical stimulation (wrist extensor muscles) increased the strength of the right extensor muscle and function of the finger muscle and reduced muscle tone in the wrist flexor and the finger muscle in the paretic hand at 2 days after the session. All these improvements remained at 28 days after the session. LI4 = large intestine 4.

This case report was approved by the Research Ethics Committee of the Sports Medicine Research Center, Tehran University of Medical Sciences (approval number: IR.TUMS.REC. 2871), and informed consent was obtained from the patient.

3. Discussion

In the present study, the outcomes of an individual with chronic hemiparesis secondary to a stroke were described. We treated the patient with a single session of ES combined with DN which might have been the reason the patient experienced a considerable increase in strength and spasticity improvements [16]. The patient made rapid and significant improvements. Further studies in the form of randomized clinical trials are necessary to test the true effectiveness of these techniques in combination.

Various rehabilitation techniques are used for the management of individuals with hemiparesis after stroke. One of the primary deficits in patients after stroke leading to disability is reduced motor dysfunction [4]. ES has been shown to improve motor function and activity performance. It stimulates contraction of muscles with both sensory and visual feedback to the participant [4]. Results of a recent meta-analysis indicated that ES can moderately improve activity and can be applied to potentially improve motor control for individuals in poststroke rehabilitation programs [4]. Other rehabilitation methods targeting the upper extremity in patients after stroke includes mirror therapy which has been shown to result in improvements in upper extremity motor function, motor impairment, and activities of daily living [17]. In addition, virtual reality and interactive video gaming have been shown to improve upper limb function and activities of daily living (ADL) function in rehabilitation of patients after stroke [18]. Although most of these protocols are costly, they likely need to be performed for a longer duration to maximize outcomes [6,12]. In the current case, with a single session of ES and DN, the patient achieved considerable improvement in the motor status of her right upper hand.

DN has recently been considered as a novel method and adjunctive therapy in rehabilitation of patients after stroke [12]. The main purpose of applying DN after stroke is to reduce spasticity and improve function [13,19]. The results of the recent studies found that DN on wrist flexor muscles can reduce spasticity in patients after stroke [6,13]. In this study, we only used one session for treatment and patient recovery was persistent in a 1-month follow-up. DN can also potentially result in reductions of pressure pain in the hemiparetic shoulder and increased range of motion [19,20]. In addition, DN has been shown to decrease spasticity and improve pain pressure thresholds in the lower extremity after stroke [21]. Spasticity is a motor disorder associated with upper motor syndromes; it can result in spasms or clonus. Both passive changes in muscle properties and neuronal mechanisms can lead to muscle stiffness [22]. DN can cause biomechanical changes at the local level of treated muscle and connective tissues. In this case, however, the dramatic improvements seem to be explained by its impact on the central nervous system [13]. DN may decrease excitability of spinal reflexes by manipulating

synaptic transmission from muscle afferents to spinal motor neurons, causing modulation in motor neuron activity [15]. In addition, the alterations of the new afferent from the treated point toward the sensory area and premotor area of motor organization could have a positive effect on regional brain activity [15]. In addition, because spasticity can be associated with pain [6] and it has been shown that some physiotherapy modalities such as transcutaneous electrical nerve stimulation on LI4 can reduce pain [23], we assumed that DN application in this point may result in a similar mechanism on the central nervous system through the antinociceptive effect in spasticity reduction [21].

Spasticity is considered as one of the most significant factors that interfere with motor recovery, especially when there exists spastic antagonist selective voluntary muscle activity [24]. However, it has suggested that functional impairment in the upper limb after stroke is the result of neural drive impairment to the muscles and reduced connectivity to the corticospinal system [6]. Our findings in wrist extensor strength and hand functional recovery improvements in this patient can potentially be explained by the hypothesis that one session of needling may alter central motor neuron network and neural drive [6,13], although this requires further consideration.

In the present study, DN to the LI4 point along with ES led to improved strength of wrist extension, improved hand function according to the Brunnstrom hand functional recovery scale, and improved spasticity according to the MMAS system dramatically. Future trials including a control group should examine these findings.

Declaration of conflicting interests

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jams.2019.04.004.

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