Changes in Spasticity, Widespread Pressure Pain Sensitivity, and Baropodometry After the Application of Dry Needling in Patients Who Have Had a Stroke: A Randomized Controlled Trial

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Abstract

Objective: The purpose of this study was to determine the effects of deep dry needling (DDN) on spasticity, pressure sensitivity, and plantar pressure in patients who have had stroke.

Methods: A randomized controlled trial was conducted. Thirty-four patients who previously had a stroke were randomly assigned either an experimental group that received a single session of DDN over the gastrocnemius and tibialis anterior muscles on the spastic leg or a control group that received no intervention. Spasticity (evaluated with the Ashworth Scale); pressure pain thresholds over the deltoid muscle, second metacarpal, and tibialis anterior muscle; and plantar pressure (baropodometry) were collected by a blinded assessor before and 10 minutes after intervention.

Results: A greater number of individuals receiving DDN exhibited decreased spasticity after the intervention ($P < .001$). The analysis of covariance showed that pressure pain thresholds increased bilaterally in patients receiving DDN compared with those who did not receive the intervention ($P < .001$). The analysis of covariance also found that patients receiving DDN experienced bilateral increases of support surface in the forefoot, unilateral increase of the support surface in the rear foot of the treated (affected) side, and bilateral decreases in mean pressure (all, $P < .02$) as compared with those who did not receive DDN.

Conclusions: Our results suggest that a single session of DDN decreases spasticity and widespread pressure sensitivity in individuals with poststroke spasticity. Deep dry needling also induced changes in plantar pressure by increasing the support surface and decreasing the mean pressure. (J Manipulative Physiol Ther 2014;37:569-579)

Key Indexing Terms: *Stroke; Muscle Spasticity; Pain Threshold; Acupuncture*

Stroke is a leading cause of disability with an estimated annual incidence of 144 per 100 000 people in Iceland[1] and 118 per 100 000 in Spain.[2] A recent study found that the incidence of ischemic stroke in Sweden has decreased (3.7% per year) in older people (>65 years), slightly decreased (0.4% per year) in middle-aged people (45-65 years), but increased (1.3% per year) in young people (18-44 years) in the last 25 years.[3] Although stroke has dropped from being the third main leading cause of death to the fourth cause in the United States of America and Europe,[4] it still remains the leading cause of physical disability, particularly due to the presence of spasticity.

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Paper submitted April 12, 2014; in revised form May 26, 2014; accepted June 10, 2014.

0161-4754

http://dx.doi.org/10.1016/j.jmpt.2014.06.003

Patients with spasticity exhibit lower motor activity performance than patients who do not have spasticity.[5] In fact, stroke patients with spasticity in the lower extremity exhibit several impairments associated with standing and walking resulting in high levels of disability.[6]

Spasticity usually develops slowly, peaking 1 to 4 months after the onset of stroke,[5] and is present in 38% of the patients 1 year after stroke.[7] It is defined as "a motor disorder characterized by velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex, as a component of upper motoneuron syndrome."[8] Although the primary lesion in subjects with spasticity is neural in origin, profound secondary changes occur in the muscle itself at the protein, single-fiber, and whole-muscle levels. For instance, electron microscopy found the presence of expanded connective tissue, decreased mitochondrial volume fraction, and appearance of intracellular amorphous material in spastic muscles.[9] It is widely accepted that muscle contractures occurring secondary to spasticity are due to a reduction in muscle fiber length and a decrease in the number of serial sarcomeres within muscle fibers.[10]

Intramuscular botulinum toxin A (BTX-A) injection is the most popular tool for the management of spasticity.[11] A recent meta-analysis found that application of BTX-A in patients who have experienced a stroke was associated with moderate improvement in upper extremity performance.[12] Recent case reports also support the use of BTX-A in combination with other manual therapy modalities, for example, neurodynamic interventions, for the management of spasticity.[13-15] Because some individuals exhibit allergic responses to BTX-A, it has been proposed that acupuncture can be also effective for treatment of poststroke spasticity. Several studies have investigated the effects of acupuncture on poststroke spasticity; however, the results are conflicting. Some studies have observed that acupuncture was effective for reducing spasticity,[16,17] but others did not find any significant effect.[18,19] Discrepancies between these studies may be related to the fact that these trials needled classical acupuncture points, which implies that the needle was not introduced into the spastic muscle. Therefore, it is possible deep dry needling (DDN) may be a viable alternative intervention for spastic musculature where the needle is inserted into the targeted muscle.[20]

Both mechanical and neurophysiological mechanisms are associated with DDN. It is purported that mechanical effects include disruption of contraction knots, localized stretch of the contractured cytoskeletal structures, and reduction of the overlap between actin and myosin filaments.[21,22] It has been demonstrated that contractured taut bands have greater stiffness than surrounding tissue[23] and that DDN is able to reduce muscle stiffness as assessed by ultrasound shear wave elastography.[24] Therefore, it is possible that DDN may decrease poststroke spasticity. In addition, it is also suggested that DDN can modulate the central nervous system through an antinociceptive effect.[25] Hence, DDN may also induce sensory changes in patients with stroke.

To our knowledge, no previous study has investigated the effects of DDN in patients with poststroke spasticity. The purpose of this randomized clinical trial was to determine the effects of a single session of DDN on spasticity, widespread pressure pain sensitivity, and plantar pressures (baropodometry) in individuals with chronic stroke. We hypothesized that patients receiving a single session of DDN would exhibit a greater reduction in spasticity and pressure pain sensitivity than those who did not receive DDN.

Methods

Design

A randomized controlled trial was performed (registered with ClinicalTrials.gov, NCT 01950338). The study protocol was approved by human research committee of the Universidad Rey Juan Carlos, Spain (URJC 52/2012), and all subjects signed an informed consent before participation in the study.

Participants

Consecutive subjects who had experienced a stroke were screened for eligibility criteria from January 2013 to October 2013. Participants were recruited from the local community and had a documented diagnosis of stroke from their neurologist. To be included, they must have met the following criteria: (1) first-ever unilateral stroke, (2) hemiplegia resulting from stroke, (3) unilateral equinovarus gait with independent walking, and (4) able to ambulate without supportive device. Participants were excluded if they exhibited any of the following: (1) recurrent stroke; (2) previous treatment with nerve blocks, motor point injections with neurolytic agents for spasticity at any time, or with BTX-A in the 6 months preceding the study; (3) not independent in the basic activities of daily living; (4) severe cognitive deficits; (5) progressive or severe neurologic diseases, for example, heart conditions, unstable hypertension, fracture, or implants in the lower extremity; (6) fear to needles; or (7) any contraindication for deep dry needling, for example, anticoagulants, infections, bleeding, or psychotic.

Spasticity: Modified Modified Ashworth Test

Spasticity in the affected ankle joint was evaluated with the Modified Modified Ashworth Scale (MMAS).[26] The examiner passively moved the ankle in a dorsiflexion direction, back and forth at least 5 times, and evaluated the degree of resistance to the movement on a scale from 0 to 4. The MMAS comes from a modification of the modified Ashworth Scale,[27] which is the most commonly used scale