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Botulinum toxin type A combined with neurodynamic mobilization for upper limb spasticity after stroke: a case report

Jorge H. Villafañe PT, MSc, PhD [a, b,*], Guillermo B. Silva MSc, PhD [c, d], Alessandro Chiarotto PT [e], Orazio L.F. Ragusa MD [f]

[a] *Physical Therapist, Department of Physical Therapy, Residenze Sanitarie Assistenziali "A. Maritano," Sangano, Italy*
[b] *Physical Therapist, Private Practitioner, Turin, Italy*
[c] *Principal Investigator, Department of Physiology and Hypertension, Mons. Carlos V. Cruvellier Foundation and J. Robert Cade Foundation, Cordoba, Argentina*
[d] *Assistant Professor, Departament of Research, Chemistry Sciences, Catholic University of Cordoba, Consejo Nacional de Investigaciones Cientificas y Tecnicas (CONICET), Argentina*
[e] *Physical Therapist, Education Office, Associazione Italiana Fisioterapisti Piemonte Valle d' Aosta, Turin, Italy*
[f] *Physician, S.C. di Medicina Fisica e Riabilitazione, A.S.L. TO 3. Area Metropolitana, Italy*

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Abstract

Objective: The purpose of this study is to report a case in which combinatory therapy of botulinum toxin type A (BoNT-A) and neurodynamic mobilization (NM) was used as treatment for a patient with severe upper limb spasticity and pain after stroke.

Clinical Features: A 76-year-old male patient had spastic muscles in the upper limb 10 months after an ischemic stroke.

Intervention and Outcome: The patient underwent combined treatment with BoNT-A and NM of the upper limb in 6 monthly applications. Evaluation was performed pretreatment, 3 months after the first injection, 3 months after the second injection, and at a follow-up session 9 months after starting the treatment. The following outcomes were measured: pain by using a numeric rating scale, spasticity by the Modified Ashworth Scale for Grading Spasticity, acceptance and emotional reaction to the treatment by the Hospital Anxiety and Depression Scale, and functionality by ranges of motion. The patient improved in all outcomes after treatment, and results were maintained during the follow-up sessions.

* Corresponding author. Jorge H. Villafañe PT, MSc, PhD, Regione Generala 11/16, Piossasco (10045), Italy. Tel.: +39 011 9065495; fax: +39 339 5857563.
E-mail address: mail@villafane.it (J. H. Villafañe).

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Conclusion: The combined NM and BoNT-A treatment appeared to decrease pain and improve joint ranges of motion during treatment for this patient. The patient showed decreased anxiety and depression during and after the treatment.
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Introduction

Poststroke upper-extremity spasticity may cause severe functional limitations and pain.[1-3] Botulinum toxin type A (BoNT-A) has been used to treat spasticity and other forms of muscle overactivity.[4] Botulinum toxin type A derived from *Clostridium botulinum*, when injected into a spastic muscle, inhibits acetylcholine release, causing a blockade of the neuromuscular patches without affecting the antagonist muscles.[5] Botulinum toxin type A has already been shown to reduce poststroke upper limb spasticity in double-blind and placebo-controlled randomized controlled trials.[5-9] Moreover, BoNT-A has been used in the past with mild improvements in conjunction with physiotherapeutics,[10,11] occupational therapy, stretching,[2] constraint induced movement therapy,[12,13] and ultrasonography or electric stimulation.[14,15]

However, to our knowledge, it has been never used in concomitance with neurodynamic mobilization (NM). Neurodynamic mobilization is targeted to treat the global mobility of a nerve by sliding and gliding in relation to muscles and joints. This technique also induces mechanical and neurophysiological effects to allow the nerve to return to optimal function.[16] Neurodynamic mobilization is a treatment aimed to address dysfunctions of a specific nerve that may alter its conduction, produce pain, and reduce mobility.[17] Symptoms coming from the nervous system are considered to be a physiological as well as a mechanical phenomenon.[18]

Preliminary evidence suggests that NM may be beneficial for reducing pain and improve function in other disorders of the upper limb.[19,20] However, NM in combination with BoNT-A therapy has never been presented as a treatment for a subject with stroke-related spasticity. The purpose of the present study is to describe treatment of a patient with stroke using a combination of BoNT-A and NM, aimed at decreasing severe upper limb spasticity and pain, and the patient's anxiety and depression reactions to the treatment.

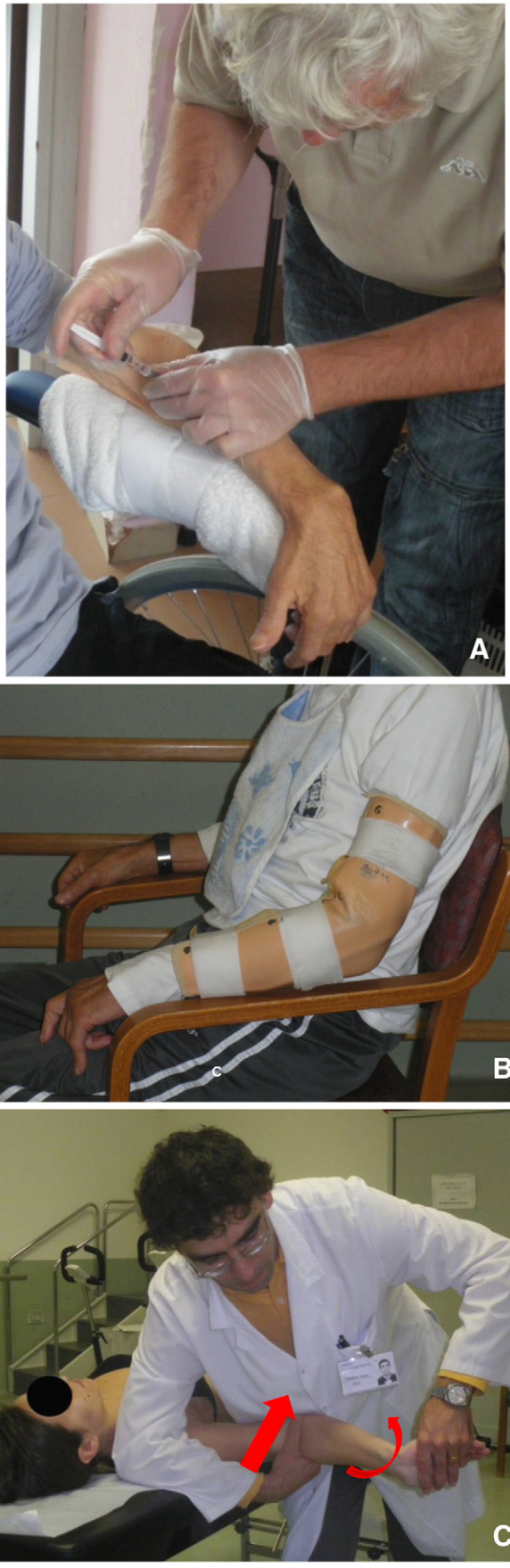
Case report

A 76-year-old white man, weighing 68 kg with a height of 170 cm, presented with a relapsing right temporal-parietal primary hemorrhage from 9 months ago. Sequelae of his stroke included left hemiplegia and severe spasticity of the upper limb. The patient and the patient's family were advised to undergo the combined treatment. The patient signed an informed consent form giving us the permission to publish the patient's information. Evaluations were performed before the first BoNT-A inoculation, after 3 months of NM treatment (before the second BoNT-A inoculation), and at the end of NM treatment (3 months after the second injection); and follow-up data were taken 3 months after the end of treatment. Assessment of the patient's response to therapy was monitored by the use of the following assessment tools: Numerical Rating Scale (NRS) to measure pain intensity,[21,22] the Modified Ashworth Scale for Grading Spasticity (MAS) to measure spasticity,[23,24] the Hospital Anxiety and Depression Scale (HADS) to measure acceptance and emotional reaction to the treatment,[25,26] and the range of motion (ROM) with a goniometer to measure functionality.[27]

The treatment consisted of 2 sessions of BoNT-A (Xeomin, Merz Pharmaceuticals, Milan, Italy) therapy in different upper-limb muscles (Fig 1A). During the first session, BoNT-A (in international units), was used in the following: major pectoralis (100), biceps brachii (150), coracobrachialis (100), radial flexor (40), ulnar flexor (40), flexor digitorum superficialis (40), and flexor digitorum profundus (40). In addition, during the second session, 3 months after starting treatment, BoNT-A (in international units) was used in the following: flexor carpi radialis (80), flexor carpi ulnaris (60), flexor digitorum superficialis (60), flexor digitorum profundus (60), and brachioradialis (150). These muscles were localized by standard anatomical landmarks as used in needle electromyography.[3]

Inoculation was followed by a static upper-limb orthosis that was applied during 4 hours by day to support, immobilize, and stabilize the elbow to prevent contractures and facilitate the healing of soft tissues (Fig 1B). During the treatment, symptoms of skin breakdown or infection were 100% absent.

Neurodynamic mobilization treatment started the day after the first BoNT-A injection and continued for 5 sessions per week for a total period of 6 months. The NM consisted of a sliding mobilization of the proximal-



distal radial and median nerves (Fig 1C). Every session, NM techniques were applied to the injured upper limb 3 times for a 4-minute period with a 1-minute pause between each application.

The NM of the median nerve consisted of the alternation of elbow extension (loads the median nerve) and wrist flexion (unloads the median nerve) with elbow flexion (unloading) and wrist extension (loading).[20] Furthermore, the NM of the radial nerve consisted of the shoulder depression applied simultaneously with elbow flexion and wrist extension, and then was performed with elbow extension and wrist flexion and ulnar deviation.[19] These motions were alternated at a rate of 2 seconds per cycle (1 second into extension and 1 second into flexion).

The outcomes are summarized in Table 1. The combined therapy produced clinical changes, with major improvements in functional and patient's comfort. The clinical presentation of the patient was improved following the performed treatment if compared with his clearly deteriorated upper limb function after stroke. The patient's compliance with the treatment was 100% with full tolerance of the treatment. In addition, signs of anxiety or depression decreased during and after the treatment.

Range of motion improved during and after treatment. At baseline, the patient's shoulder ROMs (abduction/flexion/lateral-rotation), were 20°, 30°, and 5°, respectively. Elbow ROM was −100° to extension, forearm supination was 0°, and wrist extension was 15°. In contrast, 3 months after the first BoNT-A injection, shoulder ROMs increased to 90°, 90°, and 10°, respectively. Elbow ROM reached −20° to extension, but forearm supination and wrist extension reported the same measurements. At the end of treatment, shoulder abduction and flexion both increased, reaching 110°, whereas lateral-rotation remained 10°. Forearm supination was 45°, wrist extension was 30°, and elbow ROM further increased to −10° to extension. At the follow-up, these results were approximately maintained; shoulder ROMs were 100°, 110°, and 10°, respectively. Elbow ROM was −20°, wrist extension was 30°, and forearm supination was 55°. These data indicate that the combination of BoNT-A and NM improved ROM in all the measured joints.

Spasticity also decreased after treatment. The MAS scores at the pectoralis, biceps, brachioradialis, and

Fig 1. Applied combinatory treatment. A, Physician applying botulinum toxin. B, Static upper-limb orthosis. C, Neurodynamic mobilization of the median nerve.

Table 1 Summarized outcomes observed pre-, intra-, and after treatment

	Pretreatment	1st dose	2nd dose	Follow-up
MAS				
Pectoralis	4	2	1	2
Biceps	4	2	1	2
Brachioradialis	5	4	1	2
Superior finger flexor	4	4	2	2
HADS				
AS	6	2	1	1
DS	6	5	3	3
NRS	8	3	1	1
ROM shoulder (°)				
Abduction	20°	90°	110°	100°
Flexion	30°	90°	110°	110°
Lateral-rotation	5°	10°	10°	10°
ROM elbow (°)				
Extension	−100°	−20°	−10°	−20°
Supination	0°	0°	45°	55°
ROM wrist (°)				
Extension	15°	15°	30°	30°

AS, anxiety; *DS*, depression.

superior finger flexor were 4, 4, 5, and 4, respectively. In contrast, 3 months following the first BoNT-A injection, spasticity decreased in the pectoralis, biceps, brachioradialis, and superior finger flexor muscles to 2, 2, 4, and 4, respectively. In addition, 3 months after the second injection, spasticity decreased in the pectoralis, biceps, brachioradialis, and superior finger flexor muscles to 1, 1, 1, and 2, respectively. Therefore, the spasticity was reduced by 71% by the end of the treatment.

Similarly, pain intensity decreased. The NRS improved from 80 to 10 after 6 months of treatment. In addition, after 3 months of follow-up period, pain levels were maintained at 10. Therefore, the general pain was decreased by 87% by the end of the treatment and during the follow-up.

The anxiety and depression measurements for this patient were reduced. The HADS scores for anxiety and depression were 6 and 6, respectively. In contrast, after 6 months of treatment, anxiety/depression decreased to 1 and 3, respectively. In addition, 3 months following the formal treatment period, the HADS scores for anxiety and depression were maintained at 1 and 3, respectively.

Discussion

We report the improvements of a poststroke patient after 6 months of NM of median and radial nerves in conjunction with BoNT-A therapy. The treatment produced increased ROM, decreased pain, decreased spasticity, and relieved distressing symptoms that were maintained up to a 3-month follow-up after the end of the treatment.

This report on spasticity and pain responses is similar to others. Botulinum toxin type A alone reduces spasticity.[5-9] Others have reported the effectiveness of BoNT-A as an instrument to decrease pain in the upper limb. Yelnik et al tested the effects of subscapular shoulder injections of BoNT-A, finding it a useful tool in the management of shoulder pain in spastic patients after stroke.[2] In addition, BoNT-A has also been used as a supportive therapy to physical therapy with clinically relevant results.[12,13]

The NM component of the treatment could have led to improvements in ROMs, something difficult to achieve in these pathologies. We propose that the improvements may be due to the fact that sliding techniques are aimed to induce biomechanical effects that permit to reestablish optimal movement of the nerve and its surrounding tissues. Regarding these effects, there is supporting evidence from postmortem studies that showed that a sliding technique for the median nerve could improve longitudinal excursion of the nerve.[16] Both NM techniques used in this study were shown to be effective in reducing pain in previous research in participants with thumb carpometacarpal osteoarthritis.[19,20] However, other types of sliding mobilizations that were successful in other pathologies may not have the same results.[28,29] About the effects of NM on pain and spasticity, some neurophysiological mechanisms can be used to explain them. For instance, it is suggested that NM stimulates the periaqueductal gray matter in a key area in the descending and ascending control of nociception.[30] However, future studies are necessary to validate this theory for NM.

We evaluated the patient mood status during treatment by using the HADS, and we found a sharp decrease in the emotional component. These results contrast those that found no significant changes in mood[9] using different combinations of treatments.

It is plausible that a combination of BoNT-A injection with NM could be responsible for the decrease in spasticity found in this study.[12]

To our knowledge, this is the first report where NM of the radial and median nerve in combination with BoNT-A therapy has shown promising results by decreasing pain and distress and by improving spasticity and ROM. On the whole, our results are consistent with previous work by our group and others, showing that the intervention had an immediate effect

on mechanical restoration of function, decreased pain, and increased general relief of the patient. Because of the nature of the study, our results cannot be generalized; but they are promising enough to justify a further testing of this combined approach in a clinical trial with a control group. Although there is evidence about the effectiveness of BoNT-A in improving poststroke upper limb spasticity, the role of NM for changing this dysfunction remains unknown.

Limitations

This case report has limitations. A limitation of this case report may be represented by the lack of an outcome to measure daily functionality. Considering the nature of this study, a cause-effect relationship cannot be established, thus limiting the generalizability of findings. Although this patient showed relief from care, this does not mean that others will respond in a similar manner. It cannot be excluded that the patient would have improved alone following the normal course of the disorder.

Conclusion

The combined physiotherapy and BoNT-A treatments decreased pain and spasticity, and improved joint ranges of motion for this patient. At the follow-up evaluation, the same results were maintained. In addition, the patient showed decreased anxiety and depression after the treatment. These findings justify the testing of this intervention in a future clinical trial.

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No funding sources or conflicts of interest were reported for this study.

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