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Case report

Non-invasive brain stimulation and kinesiotherapy for treatment of focal dystonia: Instrumental analysis of three cases

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ABSTRACT

Dystonia is a disabling movement disorder characterized by co-contraction of antagonist and agonist muscles, leading to abnormal sustained postures and impaired motor control. Cervical Dystonia (CD) and Hand Focal Dystonia (HFD) have been the most common forms of focal dystonia (FD). Do Non-Invasive Brain Neuromodulation (NIBS) such as Transcranial Direct Current Stimulation (tDCS) and repetitive Transcranial Magnetic Stimulation (rTMS) modulate the excitability of the connections between the motor cortical areas and may represent a therapeutic alternative for focal dystonia? Herein, we reported three cases of focal dystonia, two of them with cervical dystonia (CD) and one with hand focal dystonia (HFD), treated with NIBS combined to kinesiotherapy. The patients were daily submitted to 15 sessions of NIBS combined simultaneously with kinesiotherapy. CD patients were treated with tDCS (2 mA, 20 min, over the primary motor cortex), and HFD patient with rTMS (1 Hz, 1200 pulses, 80% of resting motor threshold, over the premotor cortex). For the CD patient's assessment, the Modified Toronto Scale for Cervical Dystonia Assessment (MTS), quiet balance test, and visual postural assessment were applied to observe the therapeutic effects. Quality handwriting analysis, tremor acceleration amplitudes, and the *Wrinter's Cramp Rating Scale* (WCRS) were used to assess the NIBS effect on HFD symptoms. Patients were evaluated before (pretest), immediately after (posttest), and three months after treatment (retention). NIBS associated with kinesiotherapy produced a long-term improvement of dystonia symptoms in all three patients. rTMS and tDCS associated with kinesiotherapy showed to be useful and safe to relief the dystonia symptoms in individuals with different types of focal dystonia with distinct functional disorders.

Significance: The combined use of these intervention strategies seems to optimize and anticipate satisfactory clinical results in these neurological conditions, characterized by its difficult clinical management.

Dystonia is characterized by involuntary and sustained muscular contractions, which may cause postures and abnormal movements, initiated or recorded by voluntary action and associated to excessive muscular activation (Fahn, 1988). The dystonias are classified as generalized, hemidystonia, segmentary or focal, some of those been task-related or occupational [7,5]. Cervical Dystonia (CD) and Hand Focal Dystonia (HFD) are the most common forms of focal dystonias and are strongly related to distress, physical incapability, social interaction problems and deterioration in quality of life.

Currently, botulinum toxin type A (BoNT/A) injections is frequently used and recommended first- line treatment to dystonia [8]. Kinesiotherapy is also a potentially useful adjuvant therapy [3,2]. Non-invasive brain stimulation (NIBS) such as repetitive Transcranial Magnetic Stimulation (rTMS) and Transcranial Direct Current Stimulation (tDCS) modulates the excitability of the connections between the motor and cognitive cortical areas

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[12,10,6]. Some studies using NIBS over the cortex have shown relief of dystonic manifestations [12,11,10,4].

Herein, we present the first report, to our knowledge, that assessed the effects of NIBS combined to kinesiotherapy as a potential intervention for patients with focal dystonia. Three patients, two of them with CD and one with HFD, are reported. The choice of the NIBS techniques was guided by the clinical manifestation and the functional complaint in an individualized form, based on the best scientific evidence available for each case.

Kinesiotherapy sessions were composed of specific and progressive exercises for cervical and trunk muscles for CD patients, and wrists and finger extensor muscles for HFD patient, which varied in accordance with the dystonic pattern and functional complaint of each patient. Patients were evaluated before (pretest), immediately after (posttest), and three months after treatment (retention). For CD patients, the following instruments were used: Modified Toronto Scale for Cervical Dystonia Assessment (MTS) to evaluate the dystonia severity, disability and pain [13], and quiet balance test to evaluate the postural control. The Quiet balance test consists in maintaining quiet balance in upright bipedal support under a force platform (*Smart Equitest system, NeuroCom)* in four different conditions: (1) stable platform and eyes open, (2) stable platform and eyes closed, (3) sway platform (with perturbation) and eyes open, and (4) sway platform (with perturbation) and eyes closed. Each condition consisted of three trials of 20 s each (total of 12 trials). For balance analysis, the center of pressure (CoP) amplitude, root mean square (RMS) and mean velocity in the anteroposterior and mediolateral directions were considered. In addition, visual postural assessment using photographs was done. For evaluating tremor and dystonic movement of HFD patient, a simple handwriting test (writing a name and drawing a circle) in a digitizing tablet was performed and the quality of the handwriting was observed. In addition, tremor acceleration amplitudes (centimeters per square second) with supported and extended arm (right and left) through wireless accelerometer (Delsys Trigno) were calculated. The *Wrinter's Cramp Rating Scale* (WCRS) were used to evaluate the severity of HFD.

Case 1: A 79-year-old woman with a severe CD was treated with the association of kinesiotherapy and tDCS simultaneously. Direct current (2 mA) was applied with saline-soaked sponge electrodes (5 × 7 cm) by a Neuroconn DC-Stimulator during 20 min once a day for three weeks (15 sessions). The anode was placed over the primary motor cortex (Cz, 10/20 system) and the cathode over right supraorbitary area (Fp2). The results show improvement in postural control which may suggest better cervical control (Fig. 1A, B).

A

	Baseline (total)	Pos rTMS early	Pos 3mo rTMS + Kinesiotherapy
Case 1			
MTS severity	33	20	23
MTS disability	22	12	11
MTS pain	14	4	7,25
Case 2			
MTS severity	30	18	19
MTS disability		8	9
MTS pain	0	0	0

	Baseline (total)	Pos TDSC early	Pos 3mo TDSC + Kinesiotherapy
Case 3			
WCRS motor	20	8	18
WCRS velocity	2	1	2

MTS = Modified Toronto Scale for Cervical Dystonia Assessment; WCRS = Wrinter's Cramp Rating Scale; mo = months.

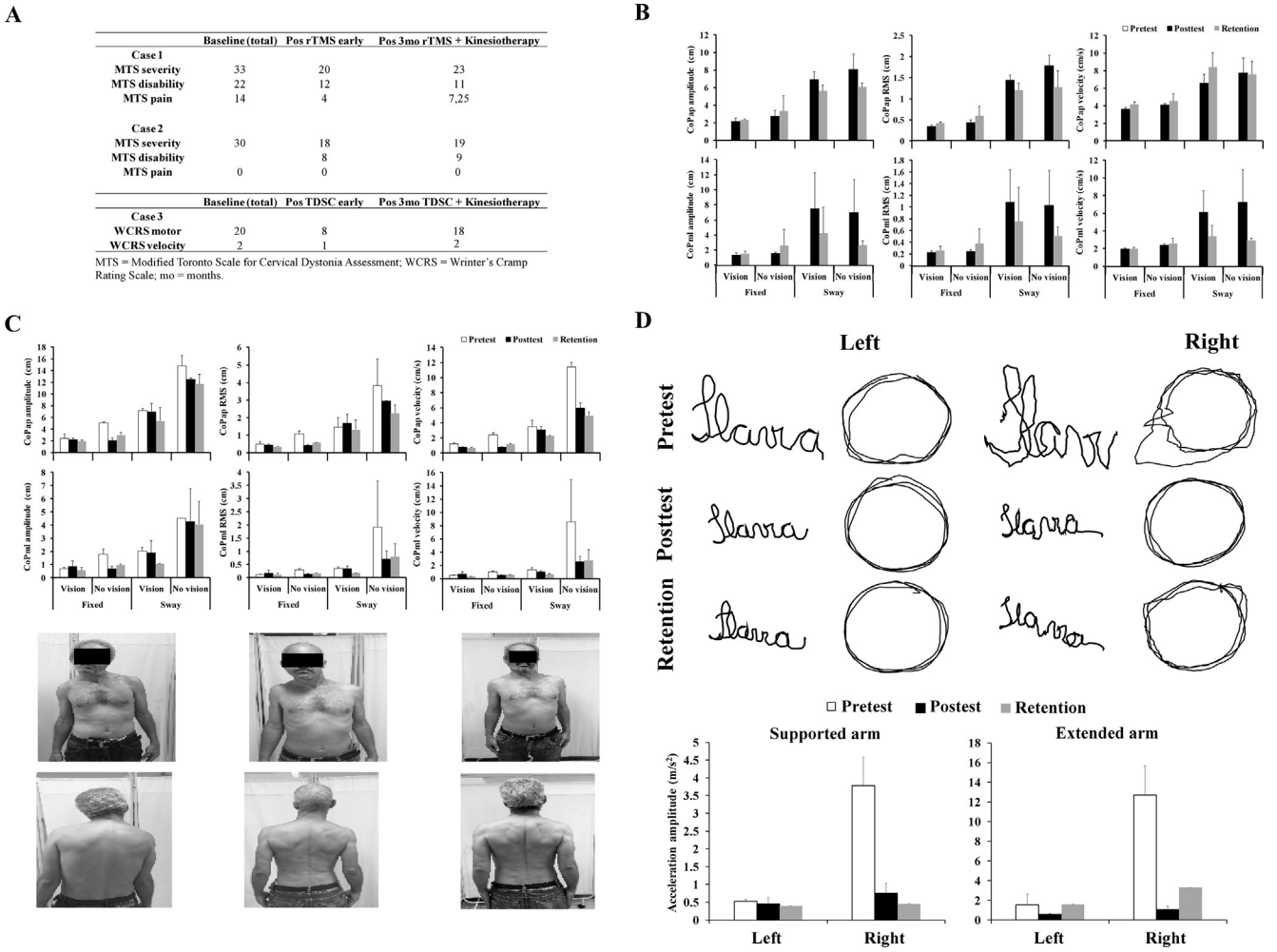

Fig. 1. (A) Results of modified Toronto scale for cervical dystonia assessment. Average values (standard deviation in vertical bars) under the conditions depending on the tests (posttest and retention), for the following variables: CoP amplitude, root mean square (RMS) and mean velocity module for the anteroposterior and mediolateral directions for (B) Case 1 and (C) Case 2. (C) Case 2 before, immediately after and three months after treatment (retention). (D) Case 3: Writing profiles: examples of handwriting of a name and circles. Average values (standard deviation in vertical bars) under the conditions (supported arm and extended arm) depending on the tests (pretest, posttest and retention) for the amplitude of acceleration of the hands.

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Case 2: A 48-year-old man with a 4-year history of CD characterized by abnormal movement and posture of the neck associated with an incapacitating pain in same region. The symptoms remained despite optimized oral medications. The patient was also submitted to daily tDCS sessions (20 min; 2 min; Cz-Fp2) associated to kinesiotherapy for three weeks, prior to botulinum toxin injections. The results show improvements in motor and pain scales and lower amplitude of CoP oscillation, evidencing a better postural control (Fig. 1A, C).

Case 3: A 46-year-old woman, right-handed, presented 18-year history of FHD with typical task-specific dystonia (writer's cramp) associated with tremor and other tasks with the same hand. Initially, she was treated with botulinum toxin A injections repeated every 3 months (5 sessions in total) but without effective response. Oral medications have also been tried with mild improvement. During 15 sessions rTMS was applied to the premotor cortex at 1 Hz at 80% resting motor threshold for 1200 pulses. Each session consisted of rTMS followed immediately by 30 min of the kinesiotherapy intervention. The results show improved dystonia symptoms (Fig. 1A, D).

The results of present study described improved FD symptoms in three patients with the use NIBS techniques combined with kinesiotherapy. Bradnam et al. [1] showed that tDCS over cerebellum and primary motor cortex might augment the effect of botulinum toxin injections in a single case of a patient with a 14-year history of CD. In the current study, we demonstrated beneficial effects for all patients applying only on the primary motor cortex or on the premotor area.

The mechanism of NIBS combined with kinesiotherapy in improving dystonic symptoms is not completely understood. According to Pirio Richardson et al. [9], the abnormal premotor–motor interactions play a role in the pathophysiology of focal dystonia, as a compensation or as a primary dysfunction. They used paired-pulse TMS to evaluate the interactions between dorsal premotor cortex (dPM) and ipsilateral primary motor cortex in patients with writer's cramp examined in three different experimental conditions: rest, isometric muscle contraction, and a pen-holding task. They found out in comparison with the control group, patients with writer's cramp the dPM exerts a greater inhibitory influence on ipsilateral M1 in all three conditions. Indeed, in our study, we demonstrated beneficial therapeutic effects when either area was stimulated alone suggesting that NIBS associated with kinesiotherapy might have positive modulatory effects on this dysfunctional brain network. Our patient showed a clinically significant improvement in her dystonic posture, her movements of the upper limb while writing and her writing speed after the treatments. These techniques associated would be able to induce plastic changes in one or more nodes of the altered network and possibly reverse the abnormalities in the dystonic patterns in the case presented. The value of our observation is limited by it being open label and the 3-case nature. Future studies should enroll a larger series of focal dystonia treated with NIBS associated with kinesiotherapy to confirm our preliminary observation. NIBS associated with kinesiotherapy showed to be useful and safe for application in individuals with different types of focal dystonia with distinct functional disorders. The combined use of these intervention strategies seems to optimize and anticipate satisfactory clinical results in these neurological conditions, characterized by its difficult clinical management.

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Disclosure

The authors declare that there are no potential conflicts of interest associated with publication of this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jocn.2020.04.025.

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