FOCAL MUSCLE VIBRATION, AN EFFECTIVE REHABILITATIVE APPROACH IN SEVERE GAIT IMPAIRMENT DUE TO MULTIPLE SCLEROSIS

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Multiple sclerosis (MS) is the commonest cause of disability in adults of working age. Gait impairment is one of the most frequent consequences of MS reported by 85% of patients, and walking dysfunction is considered by the majority of patients as the most challenging, life-altering aspect of the disease. The measured spatial and temporal characteristics of gait in MS patients has been demonstrated to be correlated with neurological disability. Specifically, pyramidal involvement was found to be associated with decreased gait velocity, decreased step length, shortened single support and swing and with prolonged double support. During the last decade, many studies have been carried out to understand the effects of focal vibratory stimuli at various levels of the central nervous system and to study the therapeutic effects of focal vibration in neurorehabilitation. Focal vibration stimulation appear to be well tolerated, effective and easy to use, and it could be used to reduce spasticity, to promote motor activity and motor learning within a functional activity, even in gait training.

The aim of this study was to evaluate the possible application of repetitive focal muscle vibration (rFMV) in patients with MS to improve gait function using Gait Analysis (GA) evaluation.

Matherials and Methods: fourteen patients with secondary progressive MS (SP-SM) has been recruited at the Don Gnocchi Rehabilitation Center where they attended a rehabilitation program. All patients presented a lower limb muscle spasticity with no response to antispastic drugs (Gabapentin, Lioresal, Sirdalud, Valium, Benzodiazepine) (Tab 1). All patients presented a 6 months confirmed EDSS stability.

Sex	8 male, 6 female
Mean age (years)	48.07 ± 11.66
EDSS score	5.7 ± 0.5
Disease duration	15.7 ± 4.2

Table 1

rFMV was delivered by using a specific device consisting of an electromechanical transducer, a mechanical support, and an electronic control device (CRO®SYSTEM, NEMOCO srl, Italy). In a single experimental session, each participant received rFMV over the quadriceps muscles first and then also over the lumbar paraspinal muscles; the application was repeated for 3 sessions of 10 minutes each, with an inter-session interval of 1-minute (total time of rFMV application: 60 minutes). The same protocol was repeated for 3 consecutive days.

GA evaluation was done before r-fMV (T0), and 1 week (T1) and 15 days (T2) after the last session of r-fMV, in order to evaluate the effect of r-fMV on gait. All patients were evaluated instrumentally using an optoelectronic system with passive markers (Smart D500, BTS Bioengineering, Milan, Italy) with 200 Hz sampling rate, one force platform (Kistler, Winterthur, Switzerland) and 2 TV camera Video systems (BTS, Italy) synchronized with the system and the platform for videorecording. Participants were asked to walk barefoot at their own natural pace (self-selected and comfortable speed) along a walkway (6 m long) where the force platform was placed.

Clinical evaluation all patients were asked to fill a series of questionnaires: the Numerical Rating Scale (NRS) and the ID pain , the Modified Fatigue Impact Scale (MFIS) for fatigue, the Beck's Depression Inventory scale for depression, and the Short Form Health Survey (SF-36) for evaluate quality of life. They underwent also the Berg Balance Scale and the timed 25 foot walk test (T25FWT). All these scales were filled before r-fMV (T0), and 1 week (T1) and 1 month (T2) after the last session of r-fMV.

Statistical analysis: All indexes were tested for normality with the Shapiro-Wilk test. Since the data were not normally distributed, non-parametric tests were performed. The within-group changes in the motor performance over time (T0 vs T1 vs T2) were assessed by using Friedman's ANOVA tests. When the tests were significant, pairwise comparisons with Bonferroni adjustment were performed. For each statistical test, the significance was set at 0.05. Statistical analyses were performed with built-in functions of SPSS 21

Conclusions

- r-FMV improves gait function and reduces spasticity in SP-SM patients with higher EDSS, non-responsive to antispastic drugs.
- r-FMV reduces fatigue and increases SF-36 score and decreases pain, resulting in an improvement in QoL
- r-FMV is safe, well tolerated, easy to use, long lasting and repeatable
- r-FMV is an effective rehabilitative approach in severe gait impairment due to multiple sclerosis

Results

	T0 Median value (range)	T1 Median value (range)	T2 Median value (range)	
Stance phase more affected limb (%)	65.0 (55.3 - 79.8)	62.6 (57.7 - 72.8)	61.5 (57.0 – 73.5)	
Stance phase less affected limb (%)	71.8 (55.0 - 90.0)	69.2 (58.2 - 86.0)	66.2 (59.4 - 81.0)	*
Swing phase more affected limb (%)	35.1 (20.2 - 44.7)	37.5 (27.2 - 42.3)	38.5 (26.5 - 44.1)	
Swing phase less affected limb (%)	28.0 (10.0 - 38.2)	30.8 (14.0 - 41.8)	33.9 (19.0 – 40.6)	**
Double support phase more affected limb (%)	19.6 (12.8 - 31.0)	15.1 (10.0 - 28.0)	14.0 (9.9 - 27.2)	**
Double support phase less affected limb (%)	17.8 (10.9 - 37.7)	13.6 (9.5 - 25.1)	13.6 (9.5 - 25.1)	**
Step Length more affected limb (m)	0.41 (0.14 - 0.48)	0.43 (0.14 - 0.54)	0.45 (0.25 - 0.55)	**
Step Length less affected limb (m)	0.38 (0.12 - 0.53)	0.48 (0.29 -0.55)	0.48 (0.29 -0.55)	**
Stride Length more affected limb (m)	0.82 (0.25 - 1.07)	0.90 (0.33 - 1.14)	1.02 (0.61 - 1.20)	**
Stride Length less affected limb (m)	0.80 (0.24 - 1.03)	0.97 (0.57 - 1.21)	0.97 (0.57 - 1.21)	***
Step Width (m)	0.17 (0.12 - 0.28)	0.19 (0.12 - 0.28)	0.17 (0.13 - 0.28)	
Cadence (step/min)	71.6 (41.2 - 92.4)	75.8 (46.0 - 104.9)	80.2 (42.3 - 108.9)	**
Walking Speed (m/s)	0.42 (0.09 - 0.71)	0.53 (0.14 - 0.91)	0.57 (0.20 - 1.02)	**
SAI	14.11 (5.79 - 38.67)	12.08 (1.99 - 42.74)	7.25 (3.24 - 42.48)	*
TAI	19.45 (7.24 - 69.37)	14.29 (1.49 - 78.88)	15.98 (2.51 - 83.20)	*

Table 2: Spatio-temporal parameters before (T0) and after one week (T1) and one month (T2). The symbol * indicate a statistical significance, with p<0.05; the symbol ** indicate a statistical significance, with p<0.01; the symbol *** indicate a statistical significance, with p<0.001.

	T0 Median value (range)	T1 Median value (range)	T2 Median value (range)	
ID PAIN	1 (-1-3)	0 (-1-3)	1 (-1-4)	*
BERG	42 (27-56)	48 (38-55)	47.5 (36-56)	**
25FTWT	10.15 (5.9 – 52.7)	9.65 (5.5 – 40.2)	7.28 (5 – 18.2)	**
SF 36 GH	38.5 (10-82)	45 (10-82)	53.5 (10-82)	*

Table 3: Clinical evaluation results before (T0) and after one week (T1) and one month (T2). The symbol * indicate a statistical significance, with p<0.05; the symbol ** indicate a statistical significance, with p<0.01.

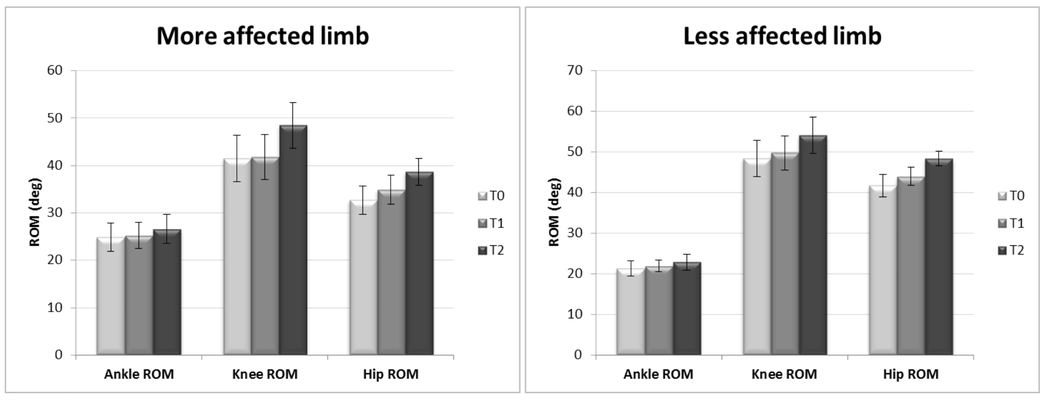

Fig. 1: Kinematic parameters

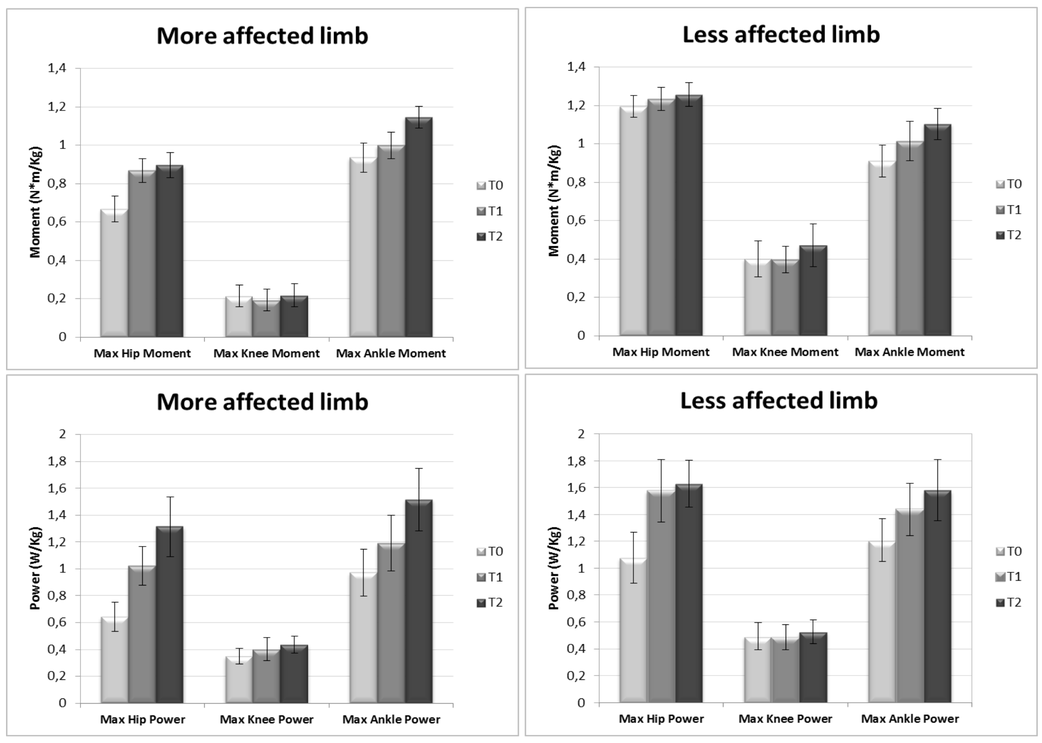

Fig. 2: Kinetic parameters

Bibliografia

- *Larocca NG. Impact of walking impairment in multiple sclerosis: perspectives of patients and care partners. Patient 2011;4:189–201.*
- *Givon U, Zeilig G, Achiron A. Gait analysis in multiple sclerosis: characterization of temporal-spatial parameters using GAITRite functional ambulation system. Gait Posture. 2009;29:138-42.*
- *Paoloni M, Giovannelli M, Mangone M, Leonardi L, Tavernese E, Di Pangrazio E, Bernetti A, Santilli V, Pozzilli C. Does giving segmental muscle vibration alter the response to botulinum toxin injections in the treatment of spasticity in people with multiple sclerosis? A single-blind randomized controlled trial. Clin Rehabil. 2013;27:803-12.*