EFFICACY OF FOCAL MECHANIC VIBRATION TREATMENT ON BALANCE IN CHARCOT- MARIE-TOOTH 1A DISEASE: A PILOT STUDY.

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ORIGINAL COMMUNICATION

Efficacy of focal mechanic vibration treatment on balance in Charcot-Marie-Tooth 1A disease: a pilot study

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BACKGROUND AND AIM

The cause of postural instability in Charcot –Marie-Tooth (CMT) is still a matter of debate. Different factors contribute in CMT imbalance and a major challenge to maintain postural control has been attributed not only to the progressive loss of proprioception,[1,2] caused by both altered large myelinated fibers [2,3] and small fibers,[4] but also to the reduced muscle strength and ankle instability. [5]

In the last years, a non-invasive approach based on a mechanical vibratory stimulation has been proposed to enhance balance and muscle performance.[6] Focal muscle vibration (fMV) was demonstrated as a highly selective stimulus for Ia spindle afferents[6-11]. In fact, vibratory stimuli with specific parameters (i.e., frequency of 100 Hz, peak-to-peak amplitude of 0.20–0.50 mm) may activate different mechanoceptors, in particular spindle afferents and Golgi tendon organs. Activation of peripheral contractile elements strongly influences the activity of the motoneuron system, and therefore the muscle spindle in providing afferent information. [6] This activation is able to determine a long-term reorganization of central nervous system both at spinal and cortical level [12] determining an improvement on several function such as motor performance and postural stability. [9,13]

The aim of our study was to evaluate the effects of focal mechanical vibration (fMV) on the balance of Charcot-Marie-Tooth (CMT) 1A patients.

MATERIAL AND METHODS

We enrolled 14 genetically confirmed CMT1A patients (8 female and 6 male, mean age 49.2 yrs, range 32-74, mean BMI: 25.2, range: 18.78- 33.98, mean duration of disease: 13 years, range 1-30), regularly attending to our neurophysiological laboratory for periodic controls. Patients were excluded if they had other causes of peripheral neuropathy, previous chemotherapy or diseases that may cause or contribute to peripheral nerve damage (e.g., diabetes, renal insufficiency, alcohol abuse, vitamin B12 deficiency).

Outcome Meaures:

The primary outcome measure was the Berg Balance Scale (BBS) and the secondary were the dynamic gait index (DGI), the 6 Minutes Walking Test (6MWT), the muscular strength of lower limbs, the Quality of Life (QoL) questionnaire and the stabilometric variables.

fMV Protocol:

Patients underwent a 3-days fMV treatment on quadriceps and triceps surae and were evaluated before the treatment (T0), 1 week after the end of the treatment (T1), and then after 1 month (T2). All patients received fMV over two muscular groups: 1) the quadriceps to improve stance control and muscle performance[8] and 2) triceps surae muscles to enhance plantar-flexor muscles force production by increasing muscle activation and proprioceptive messages.

Patients were first asked to lie supine to treat the quadriceps and then prone during the application of fMV in the triceps surae muscles. During the application on both muscles, patients were asked to perform an isometric muscle contraction; in the first case they were asked to keep the popliteal cavum in contact with the bed, while for the second muscle, they were asked to keep the plantar flexion; the examiners clinically verified the muscle contraction throughout the whole fMV application.

fMV was delivered by using a specific device consisting of an electromechanical transducer, a mechanical support, and an electronic control device.

The transducer was positioned bilaterally on the quadriceps tendon close to the rectus femoris insertion at about 2 cm from the medial edge of the patella and on the triceps surae muscles at the myotendinous junction. For each muscle group, fMV was applied for 3 sessions of 10 minutes each, with an inter-session interval of 1-minute. The same protocol was repeated for 3 consecutive days in order to elicit "cumulative after-effects" and according to previously reported techniques.

The mechanical support for delivering fMV allowed the compression of soft tissues overlying the muscle-tendon complex with low amplitude (200-500 μm) and high frequency (100 Hz) sinusoidal displacement.

Note that the baseline and the follow up evaluations were performed by a blind examiner, this means that the examiner did not know the kind of treatment the patients underwent or whether the whole sample would receive an effective treatment.

RESULTS

Patient	Age	Gender	CMTES
Pt 1	36	M	4
Pt 2	50	M	6
Pt 4	46	F	6
Pt 5	74	M	7
Pt 6	56	F	2
Pt 7	46	M	5
Pt 8	37	F	1
Pt 9	44	M	8
Pt 10	65	F	9
Pt 11	40	F	1
Pt 12	65	F	8
Pt 13	39	F	2
Pt 14	32	M	4

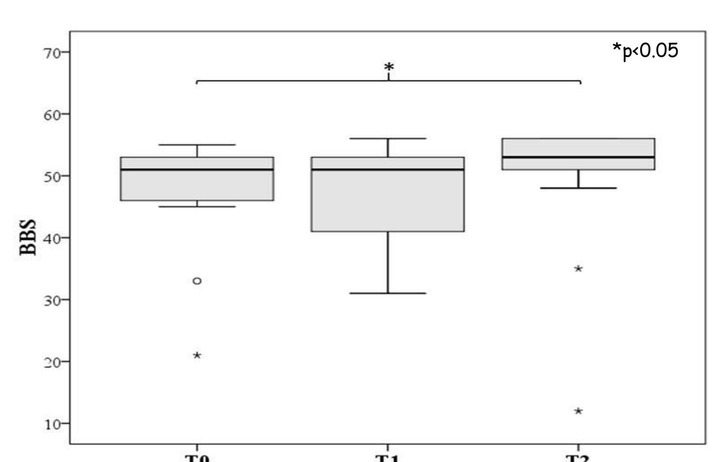
Table 1 shows the demographical and clinical data of CMT 1 A patients

Variables	T0 Median (IQR)	T1 Median (IQR)	T2 Median (IQR)	P value
Berg Balance Scale	49 (45 - 53)	51 (41 - 53)	53 (50 - 56)	**0.024**
Dynamic Gait Index	20 (18 - 23)	20 (14 - 24)	23 (20 - 24)	**0.018**
6 Minute Walking Test	349 (282 - 381)	342 (303 - 384)	363 (337 - 402)	0.583
MRC				
Hip Flexion (LS)	5 (4 - 5)	5 (5 - 5)	5 (5 - 5)	0.064
Hip Flexion (RS)	5 (3.5 - 5)	5 (5 - 5)	5 (4 - 5)	0.161
Knee Extension (LS)	5 (4 - 5)	5 (5 - 5)	5 (4.8 - 5)	0.504
Knee Extension (RS)	5 (4.5 - 5)	5 (5 - 5)	5 (4 - 5)	0.192
Knee Flexion (LS)	5 (5 - 5)	5 (5 - 5)	5 (5 - 5)	0.071
Knee Flexion (RS)	5 (5 - 5)	5 (5 - 5)	5 (4.8 - 5)	0.173
Foot Dorsiflexion (LS)	2 (1 - 4)	2.5 (2 - 4)	2 (0 - 4)	0.507
Foot Dorsiflexion (RS)	2 (0 - 3)	2.5 (1 - 4)	2 (0 - 4)	0.223
Foot Plantarflexion (LS)	3 (2 - 4)	4.5 (3 - 5)	4 (2 - 5)	0.131
Foot Plantarflexion (RS)	3 (2 - 4)	4 (3 - 5)	3 (2 - 5)	0.131
Hallux Ext Long (LS)	1.5 (0 - 3)	0.5 (0 - 4)	0 (0 - 3)	0.630
Hallux Ext Long (RS)	1 (0 - 3)	1 (0 - 4)	0 (0 - 4)	0.630
SF-36				
Bodily pain	62 (41 - 84)	52 (41 - 100)	84 (47 - 100)	0.641
General health	55 (30 - 67)	52 (30 - 72)	50 (38 - 70)	0.678
Mental composite score	47 (36 - 53)	46 (34 - 53)	47 (35 - 52)	0.861
Mental health	68 (56 - 80)	68 (52 - 80)	64 (59 - 80)	0.716
Physical composite score	43 (35 - 49)	44 (34 - 51)	44 (35 - 52)	0.099
Physical function	63 (50 - 85)	73 (50 - 85)	80 (39 - 90)	0.281
Role physical	63 (25 - 100)	75 (0 - 100)	75 (0 - 100)	0.771
Role emotional	67 (0 - 100)	67 (33 - 100)	67 (0 - 100)	0.416
Social function	50 (38 - 88)	57 (38 - 88)	63 (38 - 78)	0.902
Vitality	50 (35 - 55)	50 (30 - 60)	50 (40 - 65)	0.839

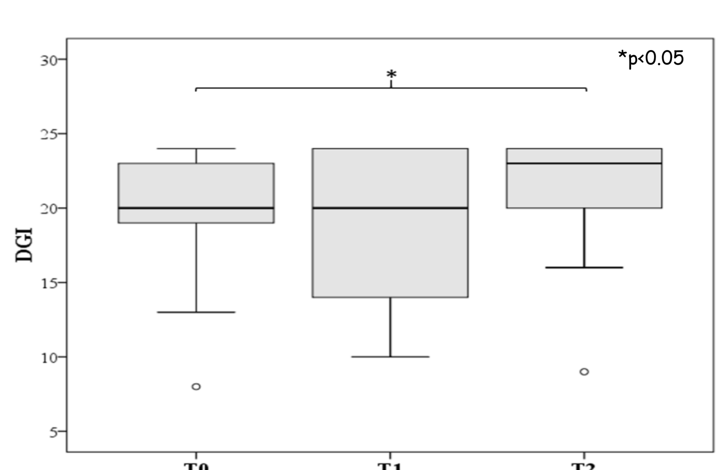
Table 2 shows the values (median and interquartile range) of the clinical scales at baseline (T0), after 1 week (T1) and after 1 month (T2) from the focal mechanical vibration treatment and the results of statistical analysis.

Variables	T0 Median (IQR)	T1 Median (IQR)	T2 Median (IQR)	P value
Eyes open				
$Sway_{AP}$ (mm)	4.5 (4 - 5)	4 (3 - 5)	4 (3 - 6)	0.539
$Sway_{ML}$ (mm)	4 (2 - 4)	3.5 (3 - 5)	3 (2 - 4)	0.122
$Velocity_{AP}$ (mm/s)	12 (7 - 15)	10 (7 - 13)	10 (7 - 14)	0.063
$Velocity_{ML}$ (mm/s)	9 (5 - 11)	10 (6 - 13)	7 (4 - 9)	0.083
Sway path length (mm)	497 (330 - 596)	514 (318 - 650)	391 (320 - 515)	0.465
Area (mm^2)	247 (202 - 341)	264 (213 - 299)	204 (124 - 306)	0.238
Eyes closed				
$Sway_{AP}$ (mm)	6.5 (5 - 8)	5 (5 - 9)	5 (4 - 7.3)	0.159
$Sway_{ML}$ (mm)	6 (3 - 9)	6 (4 - 7)	4 (3 - 6.2)	0.138
$Velocity_{AP}$ (mm/s)	17 (13 - 32)	17 (13 - 22)	13 (10 - 24)	0.441
$Velocity_{ML}$ (mm/s)	15 (8 - 19)	15 (9 - 19)	11 (5.8 - 16)	**0.038**
Sway path length (mm)	706 (524 - 885)	667 (549 - 948)	607 (420 - 831)	**0.043**
Area (mm^2)	570 (272 – 1044)	571 (356 - 647)	318 (201 - 544)	0.198
$Romberg_{Length}$	1.6 (1.4 - 2.3)	1.7 (1.4 - 2)	1.7 (1.3 - 2)	0.397
$Romberg_{Area}$	2.3 (1.3 - 4.9)	2.1 (1.1 - 3.9)	1.6 (1.2 - 3.5)	0.583

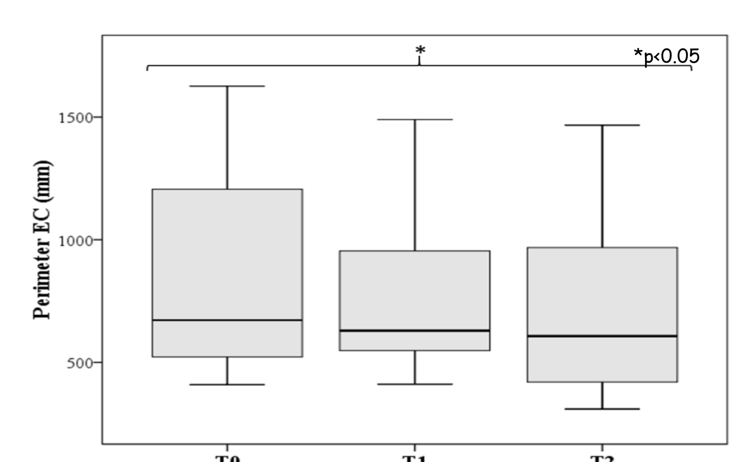
Table 3 shows the values (median and interquartile range) of the stabilometric assessment at baseline (T0), after 1 week (T1) and after 1 month (T2) from the focal mechanical vibration treatment and the results of statistical analysis.

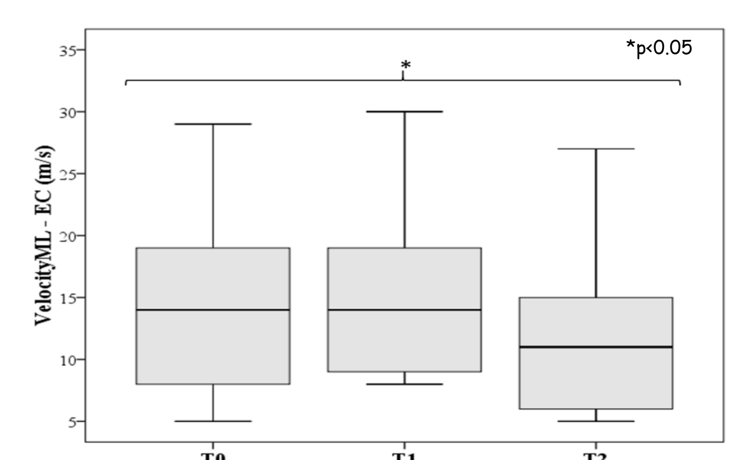


The statistical analysis showed a statistically significant modification of the **Berg Balance Scale (BBS)** due to the effect of treatment



A statistically significant modification was also found in the **Dynamic Gait Index (DGI)**





Concerning the **stabilometric variables** we found significant changes only for the **eyes closed condition**;

in particular, a statistically significant decrease was found in $Velocity_{ML}$ and Perimeter .

CONCLUSIONS

Our pilot study, although based on a small sample, showed that fMV is able to determine an improvement of balance in CMT 1 A patients.

More studies, conducted on a larger sample of CMT patients of different genetic mutations and with different scores of disability, are needed to confirm this preliminary data.

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