Hippotherapy as a new treatment strategy for gait and balance in patients affected by Down syndrome

S. Portaro[1], A. Cacciola[1], A. Bramanti[4], A. Quartarone[1], G. Gemelli[2] , F. Cavallaro[3], P. Bramanti[1], D. Milardi[1]

[1]IRCCS "Bonino-Pulejo" Research institute, SS 113, c.da Casazza, 98124, Messina, Italy
[2] ASD "THES", via Scaccia, 98057, Milazzo, Italy
[3] Department of Clinical and Experimental Medicine, University of Messina, Messina, Italy
[4]Institute of applied sciences and intelligent systems «E. Caianello» (ISASI) – National research council of Italy (CNR), Messina, Italy

Background

✓Patients with Down syndrome (DS) are characterized by delays in motor development, due to the reduced size of the cerebrum, brain maturation impairments and pathophysiological processes, so that DS subjects show a unique pattern of locomotion in clinical settings[1].

✓Hippotherapy is a field of rehabilitation therapy to achieve physical, social and psychological well-being through therapeutic horse riding[2].

✓ This technique may provide a new stimulus related to gait and it may help balance and postural control in patients with DS[3].

✓Herein, we assess the six-months hippotherapy exercise program in DS patients, in order to evaluate movement reaction time, muscle activation, functional mobility, muscle strength and balance before, during and after hippotherapy, providing objective clinical data on the improvement of sensory integration and postural stability.

Results

Functional mobility assessment and balance:

✓TUG: 10 " (8 - 12) before treatment; 9" (8 - 12) after three months; 8" (7 – 10) after treatment

✓BBS (step 1-7): 24" (19 - 28) before treatment; 28" (28 - 28) after three months; 28" (28 - 28) after treatment

✓ MRC scale for muscle strenght: normal in all patients (5/5)

Baropodometric evaluation:

Training is accounted for an improvement of Pressure distribution during the passage of the pression itself from hindfoot to forefoot. This pressure was assessed to be significantly lower in hindfoot before HBR.

Plantar imprint area and Plantar peak pressure assessment was the same before and after HBR.

Stabilometric evaluation:

Both the extension of CoP area and a higher degree of fluctuations were reported before HBR.

Gait analysis underlined significantly raised values of walking velocity and step length after HBR.

Table 1	Before treatment		After 6 months of treatment		P level
	Mean	SD	Mean	SD	
Static evaluation Baropodometry					
Right plantar surface (cm2)	95.6	20.6	102.9	29.0	NS
Left plantar surface (cm2)	106.1	25.7	104.3	29.9	NS
Right plantar pressure (%)	45.2	5.9	48.5	3	NS
Left plantar pressure (%)	54.9	5.9	51.7	3.1	NS
Right hind pressure (%)	54.3	20.3	67.9	10.4	P<0.05
Left hind pressure	50.2	17.4	68.3	9.5	P<0.005
Stabilometry					
CoP area (OE)(mm2)	62.3	97.8	17.0	22.2	NS
CoP area (CE)(mm2)	121.1	176.1	43.7	67.8	P<0.05
CoP sway (OE)(mm2)	138.7	102.1	74.9	18.9	P=0.05
CoP sway (CE)(mm2)	254.9	189.3	120.1	65.4	P<0.01
Antero-posterior velocity (OE)(mm/s)	2.2	1.5	1.5	0.5	NS
Antero-posterior velocity (CE)(mm/s)	4.2	2.7	2.5	1.4	P=0.06
Medio-lateral velocity (OE)(mm/s)	3.1	2.1	1.6	0.4	P<0.02
Medio-lateral velocity (CE)(mm/s)	5.7	4.2	2.5	1.5	P<0.002
Dynamic evaluation: Walking					
Right step lenght (cm)	49.3	7.5	56.5	7.8	P<0.02
Left step lenght (cm)	47.7	7.0	55.3	7.2	P<0.005
Right step width (cm)	9.5	7.2	7.5	3.8	NS
Left step width (cm)	8.9	8.2	7.6	5.9	NS
Right step velocity (m/s)	0.8	0.2	0.9	0.2	P<0.03
Left step velocity (m/s)	0.7	0.2	0.9	0.2	P<0.003

Table 1. Static and dynamic balance data: comparison between before treatment and after 6 months of treatment

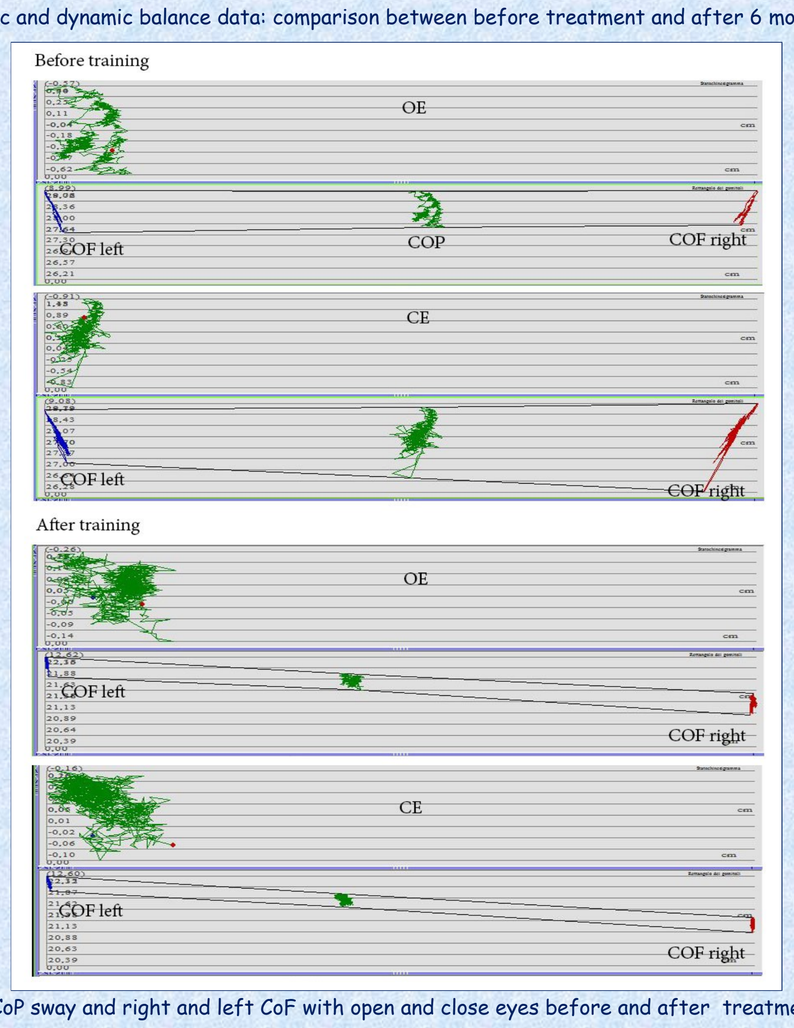

Fig. 1. CoP sway and right and left CoF with open and close eyes before and after treatment

Patients & Methods

- ✓ Twelve male individuals affected by DS, aged from 19 to 36 years old
- ✓ All patients were vaccinated for tetanus and they were previously screened for any controindications to practice hippotherapy, such as cardiac abnormalities, atlanto-occipital instability and epilepsy.
- ✓ The therapeutic protocol included a six-months period of horseback riding exercise (HBR), performed weekly for 20 minutes and under the supervision of a specialized neurologist
- ✓ Before starting, after three months and at the end of the HBR, functional mobility, balance and muscle strenght were assessed and measured by:
  - Time Up and Go Test (TUG)
  - The Berg Balance Scale (BBS)
  - MRC scale (0-5 points) to evaluate muscle strength
- ✓ Dynamic analysis was carried out with OPTO-Gait while static analysis was carried out with Diasu Ultrasensor systems. A wide range of data were provided: Plantar imprint, Pressure percentages both in forefoot and rearfoot, Centre of pressure spot, Subtalar angle, limbs axis and their balance both in antero-posterior and frontal planes balance, forces which were applied in different areas at plantar level as well as loads measurements in each of these areas. . In order to evaluate participants' features, all the Measurements previously mentioned were carried out through a baropodometric platform (milletrix system). [4]
- Static analysis consisted of CoP and pressure distribution parameters at plantar level during stance;
- Dynamic analysis allowed online supervision of spatio-temporal parameters during walking.

Baropodometric platform allowed gait analysis through 25,600 sensors arranged in a 40x160 surface with a sampling rate of 40 Hz.

- ✓ Baropodometric evaluation detected pressure values all over the contact surface. Pressure values were collected and divided in respect of distinct plantar regions: forefoot and rearfoot. Several parameters were assessed for right and left foot: Plantar imprint area; Pressure Percentage of each foot on the overall pressure applied by the feet during a quiet stance period of 30 seconds; Pressure percentage of both Forefoot and rearfoot; CoP position and oscillation were assessed with eyes closed (EC) and eyes open (EO).
- ✓ Static analysis:

- Center of pression position together with postural sway and postural area were investigated during quiet stance.
- Velocity of oscillations in different directions (medio-lateral and antero-posterior) was assessed through 30 second-long tests both with eyes closed and eyes open.

- ✓ Dynamic analysis:

The following parameters were considered for both the right and left foot:

- Step length: The distance between the conctact point of right foot heel and the left foot one along the line of progression.
- Step width: the transverse distance between the conctact point of heel of both feet and the line of progression.
- Step velocity: step lenght/step time.

Different aspects such us foot position, visual references, instructions given by the operator, duration of the task itself were highlighted time by time, during tests execution in order to guarantee an accurate analysis.

During Static analysis, the following instructions were given to patients: they have to maintain a standing position with an angle of 30° between the right foot and the left foot, arms in a neutral position, eyes open and gaze directed towords a target which was placed in front of them at a distance of 3m.

During dynamic analysis, the following instructions were given to patients: they have to cover the lenght of the mat without wearing shoes (in order to avoid shoe stiffness) with their standard walking speed at least four times. The task lasted 20 minutes and the mean value of each parameter was calculated.[4]

Discussion

- ✓ Gait analysis underlined significantly raised values of walking velocity and step length in patients affected by DS, after 6-months HBR.
- ✓ In terms of musculoskeletal factor, horseback riding resulted in functional improvement and increased stability in patients affected by DS; in neurological terms, therapeutic riding stimulated proprioceptive sense input.
- ✓ Hippotherapy has demonstrated to be a good strategy to increase functioning in DS patients
- ✓ Hippotherapy-related physical and functional effects improved spatiotemporal parameters, such as gait speed, rhythm, width, and bilateral symmetry, as well as gross motor function and balance in DS patients.
- ✓ The limitation of the study is the small sample size and the short duration of the HBR protocol.

References

1. Lee NC, Chien YH, Hwu WL. Integrated care for Down syndrome. Congenit Anom (Kyoto). 2016 May;56(3):104-6
2. Rigby BR, Grandjean PW. The Efficacy of Equine-Assisted Activities and Therapies on Improving Physical Function. J Altern Complement Med. 2016 Jan;22(1):9-24
3. Champagne D, Dugas C. Improving gross motor function and postural control with hippotherapy in children with Down syndrome: case reports. Physiother Theory Pract. 2010 Nov;26(8):564-71
4. I. Aprile, L. Padua, M Iosa, A Gilardi, C Bordieri, R. Frusciante, G. Russo, C. Erra, F. De Santis, E. Ricci. Balance and Walking in facioscapulohumeral dystrophy: multiperspective assessment. Eur J Phys Rehabil Med 2012;48:393-402