Gait analysis in children with cerebral palsy: Right versus left hemiplegia

V. Cimolin [1,*], C. Rigoldi [1], M. Galli [1,2], N. Tenore [2], G. Albertini [2]

[1] *Dipartimento di Bioingegneria, Politecnico di Milano, Milano, Italy*
[2] *IRCCS San Raffaele Pisana TOSINVEST Sanità, Roma, Italy*

Introduction: The CP can be defined as "a no progressive disorder of movement or posture, due to a pre-peri or postnatal cerebral lesion, before growth has been completed". Since the lack in literature of works about differences between right and left hemiplegia, the aim of this work is the assessment of the differences in walking pattern between children with cerebral palsy, pointing out the comparison between right and left hemiplegia, using gait analysis.

Methods: The subjects considered in this study are 46 children with CP, 26 children with right hemiplegia and 20 with left hemiplegia, aged between 4 and 12. Pathological subjects were divided basing on Gage hemiplegia classification [1–3]: from our data, we could define two subgroups of children which demonstrated type I and Type II features. In order to form a comparable group of control, also 26 healthy children, aged between 4 and 12, were considered. The analysis focused on: temporal-spatial parameters; kinematic plots of ankle, knee, hip and pelvic, in sagittal plane; kinematic plot of ankle in transverse plane; dynamic plots of ankle and hip.

Results: The study shows the patients with left hemiplegia are more walking movement limitation than right hemiplegia patients. In particular, impairments were mainly focused on distal joints. A further data analysis pointed out there is a relationship between severity of the disease (Gage classification) and differences between right and left hemiplegic children: there are more differences in the Type I hemiplegic children than in the Type II hemiplegic group, this means that with the increasing severity of the disease the differences between right and left hemiplegia are more pronounced.

Discussion: This study evidenced spatio-temporal, kinematic and kinetic indexes that allow us to recognized differences in walking pattern between children with right and left hemiplegia. These data are very important from a clinical point of view because of describing in a quantitative and precise way functional limitation level and identifying deeply the two walking pattern characteristics in order to plan the better solutions, in terms of rehabilitative treatment, the case needs.

References

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Breathing pattern in muscular dystrophies

M. Romei [1,*], M.G. D'Angelo [1], S. Gandossini [1], G.P. Comi [2], S. Bonato [1], D. Colombo [1], A. Lo Mauro [3], A.C. Turconi [1], N. Bresolin [1,2], A. Aliverti [3]

[1] *NeuroRehabilitation Department, Neuromuscular Unit, IRCCS E.Medea, Bosisio Parini (Lc), Italy*
[2] *Dino Ferrari Centre, IRCCS Ospedale Maggiore Policlinico, Mangiagalli e Regina Elena Foundation, Department of Neurological Sciences University of Milan, Italy*
[3] *Bioengineering Department, Politecnico di Milano, Italy*

Introduction: Muscular dystrophies (MD) are associated with loss of muscle function over time. Symptoms of respiratory insufficiency can be subtle and the routinely applied methods are not always capable to unravel early alterations [1,2]. In this study we compared spirometry, lung function and breathing pattern obtained from optoelectronic plethysmography (OEP [3,4]) of a large population of patients affected by MD.

Methods: We recruited 74 adult patients affected by MD: 32 Limb-Girdle Muscular Dystrophy (LGMD, 13 F and 19 M, age: 36.4 ± 13.6 years (y)); 18 Becker Muscular Dystrophy (BMD, age: 34.7 ± 12.2 y); 24 Facio-Scapulo-Humeral Dystrophy (FSHD, 11 F and 13 M, age: 41.3 ± 17.6 y). 33 healthy and age matched volunteers formed the Control Group (CG, age 32.4 ± 9 y). Starting from the 3D coordinates of reflective markers positioned on the trunk from clavicles to pubis, OEP is able to provide total chest wall volume variation (CW), its thoraco-abdominal compartmentalization and ventilatory parameters for each breath.

We acquired 3 min of quiet breathing (QB) in supine and seated position: tidal volume (TV [L]) and its percentage abdominal contribution (abd) were calculated.

In supine position patients were asked to perform also a slow vital capacity (SVC) on which we measured inspiratory capacity (IC [L]), vital capacity (VC [L]) and the abdominal contribution during inspiration and expiration (Abd-insp and Abd-exp, expressed as percentage of SVC). Mean parameters' values for each group were calculated and statistical analysis was performed.

Results and discussion: Spirometry data showed a mild restrictive respiratory pattern in all the three pathologic groups.

In seated position, TV of FSHD and LGMD was significantly reduced compared to CG (FSHD = 0.46 ± 0.16 L, LGMD = 0.44 ± 0.3 L, CG = 0.64 ± 0.3 L, $p < 0.05$). Only LGMD subjects showed an abdominal contribution to TV higher than CG (LGMD = $39.9 \pm 17.4\%$, CG = $32.1 \pm 10.2\%$, $p < 0.05$).

In supine position, FSHD subjects were showing TV values lower than CG (FSHD = 0.36 ± 0.1 L, CG = 0.44 ± 0.2 L, $p < 0.05$), while the abdominal contribution to CW for all the pathological groups was similar to CG.

SVC measured with the OEP was markedly altered in dystrophic subjects in respect to healthy subjects.

All the pathological groups presented statistically lower VC values than controls (LGMD: 3.4 ± 1.5 L, BMD: 4.4 ± 0.9 L, FSHD: 3.5 ± 1.1 L, CG: 4.9 ± 0.9 L), particularly evident for non ambulant patients, suggesting a worse restrictive respiratory pattern due to wheelchair use. In addition, LGMD and FSHD presented significantly lower IC (LGMD: 2.6 ± 1.3 L, FSHD: 2.9 ± 0.9 L, CG: 3.7 ± 0.6 L) that could indicate an impairment of inspiratory muscle group.

The abdominal contribution to expiration of BMD and LGMD was significantly reduced compared with CG (abd-exp BMD: $30.4 \pm 9.8\%$, abd-exp LGMD: $30.1 \pm 18\%$, abd-exp CG: $36.5 \pm 7.9\%$), a possible index of expiratory muscle weakness.

FSHD patients showed an abdominal percentage of SVC higher than CG, both during inspiration and expiration (abd-insp FSHD: $52 \pm 12.7\%$, abd-exp FSHD: $42.5 \pm 14.7\%$, abd-insp CG: $39.6 \pm 9.5\%$). These data indicated a greater activation of the diaphragm and of the abdominal muscle, probably in order to compensate the impairment of the upper trunk muscles.

In conclusion, thanks to OEP, it was possible to identify and quantify differences in the breathing pattern between MD groups and healthy subjects, but also to differentiate each dystrophy and unravel early signs of respiratory deficiency.

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