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Straighten your back! Self-correction posture and postural balance in “non rehabilitative instructed” multiple sclerosis patients

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Abstract.
BACKGROUD: Patients with MS, regardless of the complexity of the activity or sensory conditions, commonly present a significant postural control deficit compared to healthy subjects.
OBJECTIVE: To investigate which postural self-correction strategies are adopted by patients with Multiple Sclerosis versus a group of healthy-subjects and how self-correction can influence the control of postural balance.
METHODS: A case-control prospective observational study was conducted. Person with Multiple Sclerosis and a group of healthy volunteers were enrolled. Patients included were instructed with vocal commands, to reach a self-correction posture, and they were compared to healthy subjects. Clinical assessments including Balance, Stabilometry and Postural evaluation of the spine were performed.
RESULTS: Sixty patients (30: control-group; 30: treatment-group) were enrolled. In the treatment group, the analysis reported a significant statistical difference between path length and center of pressure speed in self-correction posture with closed-eyes ($p = 0{,}049$; 0,047) and an improvement in C7 and L3 levels in self-correction posture ($p < 0{,}01$–C7; $p < 0{,}01$–L3). There are significant statistical differences about path length between the two groups in all examined conditions ($p = 0{,}0001$). At sagittal plane evaluation, results show an increase of all measurements in both posture (C7-neutral posture $p = 0{,}0001$; L3-neutral posture $p = 0{,}0001$; C7-self-correction posture $p = 0{,}0001$; L3-self-correction posture $p = 0{,}0001$).
CONCLUSION: Further study should investigate dynamic situations and different Multiple Sclerosis forms to complete balance analysis and to establish a correct rehabilitative program with self-correction exercise as powerful focus.

Keywords: Self-correction, postural balance, spine, multiple sclerosis, gait analysis, rehabilitation, proprioceptions

1. Introduction

A good posture is defined as the condition of alignment of the three natural curves of healthy in the *neutral* spine [Kendall et al., 2005; Roussouly et al., 2005]. It occurs when the joints are not bent and the

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spine has the correct cervical lordosis, dorsal kyphosis and lumbar lordosis in the sagittal plane and it is not twisted in the coronal plane and straight in the frontal plane [Danis ey al., 1998]. Often, the term "*poor posture*" is used, defined as an adaptation of spine to bad ergonomics, which causes postural stress, but is not poor posture per se [Creze et al., 2019].

Indeed, the term 'posture' doesn't mean just a static position, but it also includes a dynamic pattern of reflexes, habits and adaptive responses linked to the proprioceptive system that contributes to good posture and balance [Proske et al., 2012].

Then, postural control is complex skill based on sensorimotor processes dynamic interaction where visual, vestibular and somatosensory input are combined together [Horak et al., 1996]. The two main functional goals of postural behavior are postural orientation and postural equilibrium. The postural orientation involves the active alignment of the trunk and head with respect to gravity, support surfaces, visual surround and internal references. Horak FB considered the postural equilibrium as the coordination of movement strategies to stabilize body mass center (CoM) during in-self and out-self stability disturbance triggers [Horak, 2006] with a close relationship between posture and postural control. Moreover, posture and postural control involve many different underlying physiological systems that can be affected in pathology as multiple sclerosis (MS). Patients with MS, regardless of the complexity of the activity or sensory conditions, commonly present, in addition to a sensory impairment of the lower limbs (75% of cases) [Johansson et al., 2007] and upper limbs (66 % of cases) [de Sire et al., 2019; Spooren et al., 2012], significant postural control deficits compared to healthy subjects [Comber et al., 2018]. In fact, balance disorders and falls are frequently observed in these patients because of motor impairment, sensory disorders and sensory inputs integration deficits leading to inadequate motor responses [Cattaneo et al., 2009]. Furthermore, balance-compensation strategies in MS are not well understood. The postural self-correction strategies can be analyzed in patients without postural imbalance or in normal subjects, but the clinical implications are limited because they cannot be applied to patients with balance disorders. Huisinga J et al. (2012) suggested that a lack of adaptability in segmental control strategy may contribute to abnormal postural control as shown respect of different sway patterns of the Center of Pressure (CoP). On the other hand, despite worsening with the increase in disability, in patients with MS the static and dynamic balance may seem unrelated. During standard postural assessment, a concurrent cognitive task (dual task paradigm) could highlight a postural control deficit in patients with MS from the beginning of the disease [Pau et al., 2017: Prosperini et al., 2018]. Considering these premises, *physician's correcting posture commands could be beneficial for MS patients to improve balance in quiet stance?*

A single study has shown that self-correction back posture in the standing position could be an important health-related daily activity [Barczyk-Pawelec et al., 2017]. The ability to adopt the corrected body posture determines the effectiveness of rehabilitative therapeutic programs. Anyway, few studies in literature point out the subject's individual instinctive ability to perceive properly and control his/her posture producing an improvement through a self-correction motion. D'Amico M. et al. has studied as healthy subjects were unable to modify their spinal shape in the frontal plane, presenting significant clinical changes in the sagittal plane respect to thoracic spine [D'amico et al., 2018]. Not taking into account self-correction strategies and its influence in other neurological diseases, there are no studies in literature investigating the self-correction strategy of posture in patients with MS, and not about its influence on balance control. Therefore, the aim of our study was to investigate which postural self-correction strategies are adopted by patients with MS versus a group of healthy subjects and if/how self-correction can influence the control of postural balance in quite stance.

2. Material and methods

2.1. Study design and population

A case-control prospective observational study was conducted according to Strobe Guidelines [von Elm et al., 2007] to determine the active self-correction posture expressed by the change of sagittal spinal curvatures (in standing positions) and the Center of Pressure (Cop) adaptations at stabilometry in quite stance. Patients included were instructed with vocal commands, as "quite *posture?*" and "*straighten your back*", to reach a self-correction posture (SCP), and they were compared to healthy subjects. The study took place at rehabilitation outpatient clinic of the University Hospital Umberto I of Rome (Italy).

This study was performed according to the guidelines of the Helsinki Declaration on human experimentation and was approved by the ethical committee of the University Hospital Umberto I of Rome (Italy). All patients signed written informed consent after receiving detailed information about the study's aims and procedures.

MS patients were on waiting list for rehabilitative treatment. The inclusion criteria were: 1) age between 18 and 60 years; 2) clinical define of MS-RR diagnosis based on established criteria [McDonald et al., 2001]; 3) Expanded Disability Status Scale (EDSS) score between 0 and 2,5 [Kurtzke, 1983]; 4) a Body Mass Index (BMI) <30; 5) a Mini-Mental State Examination (MMSE) score $\geq$24 [Crum et al., 1993]. We have used EDSS score because it is the landmark scale of the MS and internationally recognized. The literature reveals that it is the most widely used and best-known instrument to assess disease progression in MS and, because of this, studies that use the EDSS can easily compare results to other findings [Meyer-Moock et al., 2014], despite other authors have stated that non-significant differences were observed between the EDSS subgroups at the lower end of the spectrum (EDSS 0–2.5) in all posturography parameters [Kalron et al., 2016]. Moreover, patients with relapses within the last 30 days and with a history of psychiatric disorders, such as schizophrenia, bipolar disorder I or II, or substance-abuse disorders were excluded, as well as those with tumors, rheumatologic and diabetic pathologies, pregnancy, previous surgery on the spine, back pain, scoliosis or kyphosis, pacemaker, cardiovascular disease or rehabilitation pathways in progress and other neurological disorders. Patients were on a stable FDA-approved disease-modifying therapy regimen for at least 6 months. The patients we enrolled had never performed rehabilitation training in the past and, during the period of observation and enrollment in the study, they had no ongoing rehabilitation protocols (Time to diagnosis from onset: mean 1.8 ± 2, 2 years).

A group of healthy volunteers were enrolled, they didn't know to suffer from any significant illness relevant to the proposed study, with a regular body measurements and normal weight (BMI: $23{,}43 \pm 11{,}64$) [Breithaupt-Groegler et al., 2017; Coll, 1986].

2.2. *Evaluation scale*

2.2.1. *Balance assessment*

The Tinetti Mobility Test (TMT), or Performance-Oriented Mobility Assessment, is recommended as a way to assess mobility, balance, gait and fall risk. It is composed of balance subscale (9 items, 16 points) and a gait subscale (8 items, 12 points). Therefore, each item is rated on a scale of 0 to 2, where 0 = inability to execute the request, 1 = ability to execute it, but with adaptation, 2 = ability to perform it without adaptation and the maximum possible score is 28 points. The taken time to perform the test is approximately 10 minutes [Salhofer-Polanyi et al., 2013; Tinetti et al., 1986].

2.2.2. *Stabilometry evaluation*

The stabilometry measures the average result of body oscillations expressed as Center of Pressure (CoP) displacement. Data were collected using a baropodometric platform (Diasu Sa.Ni Corporate Tecnologies - Rome, Italy) to analyze CoP oscillations in open eyes (OE) and closed eyes (CE). We evaluated 1) the sway area (SA); 2) the path length (PL); and 3) the speed of CoP (SC). A physiatrist gived information about the test and the correct position to preserve during the exam (standing with arms along the trunk, angle's feet of about 30 degrees and their heels aligned along the mediolateral direction) In the condition of OE and CE, the stabilometric examination was performed in "*quite posture*" and in "*straighten your back*" command (SCP) without changing the position of the feet. The stabilometric test was performed collecting the position of CoP during quite standing and lasted for 51.2 seconds. Relevant adverse event did not happen during the development of test.

2.2.3. *Postural evaluation of the spine*

The measurement was made respect to sagittal plane, starting from the assumption that on the frontal plane the patients did not present asymmetries. We evaluated, according to Stagnara [Stagnara et al., 1982], the sagittal distances from the plumb line of C7 and L3 (cm) in two condition: 1) patient fixed in natural position or " *quite posture*" and 2) when the physician asked him/her, through"*straighten your back*" command (SCP), to stay straight with back. We decided to adopt a simple measurement test, easy and safe to perform. In according to Stagnara, the values at C7 and L3 levels should be between 2,5 and 4 cm [Stagnara, 1985].

2.2.4. *Statistical analysis*

Demographic and clinical data at baseline included the following for: sex (female or male), age, BMI, Tinetti Scale, stabilometry parameters and posture assessments. Differences in baseline characteristics between the 2 groups (experimental group and control group) were analyzed by Fisher exact test, or Mann-Whitney U test, as appropriate. The critical alpha level was set to 0.05 for all analyses. The descriptive data were presented as means and SDs for all continuous variables. Variables were tested for normality using Shapiro–Wilk test; all the outcome measures were not normally distributed and so Mann–Whitney U-test was used to detect difference between groups. The significance level was set at $p < 0.05$. Data were analyzed using MedCalc 12.2.1.0 (MedCalc Software).

2.2.5. Sample size calculation

The sample size was determined, considering as main outcome the "Velocity moment" (Vel. Moment) of the CoP (in mm^2/s), which is the area covered by the horizontal displacement of the CoP within the support base in a second. We evaluated Velocity moment both with open (OE) and closed eyes (CE) condition. Student *t*-test was used for independent variables, considering a power of 95%, α significance of 0,05, a mean value of 34,2 and a standard deviation (SD) of 8,2 for OE condition and a mean value of 108.9 and a standard deviation of 120,2 for the CE condition [Reguera-García et al., 2017]. With these parameters, assuming the required sample size was 26 patients per group, as calculated using G * Power, version 3.1.9.2.

3. Results

A total of thirty healthy patients (9 males and 21 females, mean age 43.00 ± 10.16 years) and thirty-four patients with MS were enrolled in this case-control prospective observational study. Four patients were excluded, three of these due to worsening of the disease (8 males and 22 females, mean age 41.93 ± 6.67 years). As shown on Table 1, there weren't statistically significant differences between healthy and patients with MS group in gender ($p = 0.986$), age ($p = 0.604$)and BMI ($p = 0.629$).

3.1. Balance assessment

As shown on Table 1, there weren't statistically significant differences between healthy (24.83 ± 1.80) and patients with MS (24.3 ± 3.1) group in Tinetti Scale ($p = 0.363$).

3.2. Stabilometry evaluation

Table 2 shows the results of the *stabilometry evaluation*.

There are significant statistical differences about path length between the two groups in all examined conditions (Normal posture–OE: Healthy 1100.29 ± 324.92, patients with MS 727 ± 171–$p = 0.0001$; Normal posture-CE: Healthy 1023.28 ± 229.15, patients with MS 769 ± 269–$p = 0.0001$; Self-postural correction-OE: Healthy 1106.03 ± 253.06, patients with MS 703 ± 166 – $p = 0.0001$; Self-postural correction-CE: Healthy 1064.18 ± 326.98, patients with MS 773 ± 180–$p = 0.0001$). We find the same results about the CoP Speed (Normal posture-OE: Healthy 21.57 ± 6.37, patients with MS 14.3 ± 3.4–$p = 0.0001$; Normal posture-CE: Healthy 19.36 ± 6.37, patients with MS 15 ± 5.2–$p = 0.01$;

Table 1
Sample characteristics

Descriptive Parameters	Healthy group	MS group	*p*-value	Statistic
Patients (Number)	30	30	–	–
Gender (%)	8M–22F (73%)	9M–21F (70%)	0.986	χ^2 test
Age (years)	41.93 ± 6.67	43.00 ± 10.16	0.604	*t*-test
BMI (kg/m^2)	23.43 ± 11.64	24.63 ± 4.3	0.629	*t*-test
EDSS	–	1.3 ± 0.7	–	–
TINETTI Scale*	24.83 ± 1.80	24.3 ± 3.1	0.363	*t*-test
Level of education	25G–5NG (83%)	20G–10NG (33%)	–	–
Civil Status	10NS–20 S (33%)	15NS– 15 S (50%)	–	–
Son	23S–7NS (76%)	26S–4NS (13%)	–	–
Dominant Hand	28R–2 L (7%)	28R–2 L (7%)	–	–
Physical Exercise	10S–20NS (33%)	7S–23NS (77%)	–	–
Time of illness	-	5.53 ± 3.7	–	–

Legend: MS: Multiple Sclerosis; EDSS = Expanded Disability Status Scale; *M* = Male; *F* = female; *G* = graduate; NG = not graduate; *S* = Single; NS = not Single; *M* = Married; *S* = Son, NS = not Son; *R* = rightly; *L* = lefty; *S* = sport activity (at least 60mins/week); NS = not sport activity. *(Balance Score: 0–16; Gait Score: 0–12).

Table 2
Stabilometric evaluation Media, SD and p-value in the two groups

Stabilometric evaluation	Healthy	Patients with MS Group	p value
Normal OE			
SA [mm^2]	51.87 ± 53.37	371 ± 873	0.079
PL [mm]	1100.29 ± 324.92	727 ± 171	0.0001*
CS [mm/s]	21.57 ± 6.37	14.3 ± 3.4	0.0001*
Normal CE			
SA [mm^2]	69.43 ± 121.45	501 ± 1268	0.040
PL [mm]	1023.28 ± 229.15	769 ± 269	0.0001*
CS [mm/s]	19.36 ± 6.37	15 ± 5.2	0.01*
Self-correction OE			
SA [mm^2]	74.034 ± 137.66	234 ± 359	0.153
PL [mm]	1106.03 ± 253.06	703 ± 166	0.0001*
CS [mm/s]	21.67 ± 4.96	13 ± 3.2	0.0001*
Self- correction CE			
SA [mm^2]	153.7 ± 275.52	246 ± 284	0.045*
PL [mm]	1064.18 ± 326.98	773 ± 180	0.001*
CS [mm/s]	20.87 ± 6.41	15.1 ± 3.5	0.001*

Legend: OE = open eyes; CE = closed eyes; SA = sway area; PL = path length; CS = CoP speed; *=significant.

Table 3
Media, SD and p-value of posture clinical parameters in two groups

POSTURE	Healthy	Patients with MS	p value
Normal			
C7	4.40 ± 0.78	8.67 ± 2.14	0.0001*
L3	2.63 ± 1.50	4.3 ± 1.6	0.0001*
Self-correction			
C7	3.83 ± 0.97	7.2 ± 1.9	0.0001*
L3	2.47 ± 1.49	5.2 ± 1.7	0.0001*

Legend: C7 = seventh cervical vertebra; L3 = third lumbar vertebra; *=significant.

Self-postural correction-OE: Healthy 21.67 ± 4.96, patients with MS 13 ± 3.2–p = 0.0001; Self-postural correction-CE: Healthy 20.87 ± 6.41, patients with MS 15.1 ± 3.5–p = 0.001).

3.3. *Postural evaluation of the spine*

At sagittal plane evaluation, results show an increase of all measurements in both posture (Normal posture-C7: Healthy 4.40 ± 0.78, patients with MS 8.67 ± 2.14–p = 0.0001; Normal posture-L3: Healthy 2.63 ± 1.50, patients with MS 4.3 ± 1.6–p = 0.0001; Self-correction posture-C7: Healthy 3.83 ± 0.97, patients with MS 7.2 ± 1.9–p = 0.0001; Self-correction posture-L3: Healthy 2.47 ± 1.49, patients with MS 5.2 ± 1.7–p = 0.0001).

3.4. *Posture clinical parameters in healthy and patients with MS Group*

In the patients with MS group the analysis reported a significant statistical difference between path length and CoP speed with CE (PL: Normal posture 769 ± 269, Self-postural correction 773 ± 180–p = 0.049; SC: Normal posture 15 ± 5.2, Self-postural correction 15.1 ± 3.5–p = 0.047). About the healthy group there aren't any significant statistical differences in both of postures between OE and CE. There is a significant statistical difference about C7 level measurement that changes in self-postural correction (Normal posture: 4.40 ± 0.78; Self-postural correction: 3.83 ± 0.97–p = 0.02). In the patients with MS group the analysis reported a significant statistical improvement in C7 and L3 levels in self-postural correction (C7: Normal posture 8.67 ± 2.14, Self-postural correction 7.2 ± 1.9–$p < 0.01$-; L3: Normal posture 4.3 ± 1.6 Self-postural correction 5.2 ± 1.7–$p < 0.01$ -) (Table 4).

The Fig. 1 showed an example of a stabilometric examination in a healthy individual and in a patients with MS at the four analyzed conditions.

4. Discussion

According to the literature, the movements and force trajectories of subjects with MS are slower, less fluid and less precise, especially at the beginning and completion of the force trajectory [Casadio et al., 2008; Vergaro et al., 2010]. MS could affect the movement of both body parts asymmetrically [Kraft et al., 2014], due to the lack of coordination in the activation of muscle synergies. For this reason, patients, in order to complete the motor task, are forced to develop compensation strategies. The aim of this study was to investigate the self-correction postural strategy in patients with MS and how it could influence balance postural control. Both groups included in the study (healthy and patients with MS) did not have postural imbalance as shown for the Tinetti scale and, according to their clinical history, all of them were classified as no-fallers subjects. Despite this, considerable differences were found between healthy and patients with MS about stabilometry parameters. In all examined conditions patients with MS group shown a slower balance-compensation strategy than healthy group. In particular, path length (PL) is shorter and a CoP speed is longer than healthy

Table 4
Media, SD and *p*-value of posture clinical parameters in Healthy and patients with MS Group

	HEALTHY		
Stabilometric evaluation	Normal OE	Self-correction OE	*p* value
SA [mm2]	51.87 ± 53.37	74.034 ± 137.66	0.77
PL [mm]	1100.29 ± 324.92	1106.03 ± 253.06	0.69
SC [mm/s]	21.57 ± 6.37	21.67 ± 4.96	0.69
	Normal CE	Self-correction CE	
SA [mm^2]	69.43 ± 121.45	153.7 ± 275.52	0.158
PL [mm]	1023.28 ± 229.15	1064.18 ± 326.98	0.83
SC [mm/s]	19.36 ± 6.37	20.87 ± 6.41	0.73
Posture	Normal	Self-correction	
C7	4.40 ± 0.78	3.83 ± 0.97	0.02*
L3	2.63 ± 1.50	2.47 ± 1.49	0.19
	Patients with MS GROUP		
Stabilometric evaluation	Normal OE	Self-correction OE	*p* value
SA [mm2]	371 ± 873	234 ± 359	0.53
PL [mm]	727 ± 171	703 ± 166	0.11
SC [mm/s]	14.3 ± 3.4	13 ± 3.2	0.11
	Normal CE	Self-correction CE	
SA [mm^2]	501 ± 1268	246 ± 284	0.20
PL [mm]	769 ± 269	773 ± 180	0.049*
SC [mm/s]	15 ± 5.2	15.1 ± 3.5	0.047*
Posture	Normal	Self-correction	
C7	8.67 ± 2.14	7.2 ± 1.9	<0.001*
L3	4.3 ± 1.6	5.2 ± 1.7	<0.001*

SA = Sway Area; PL = Path Length; SC = Speed of CoP; *=significant.

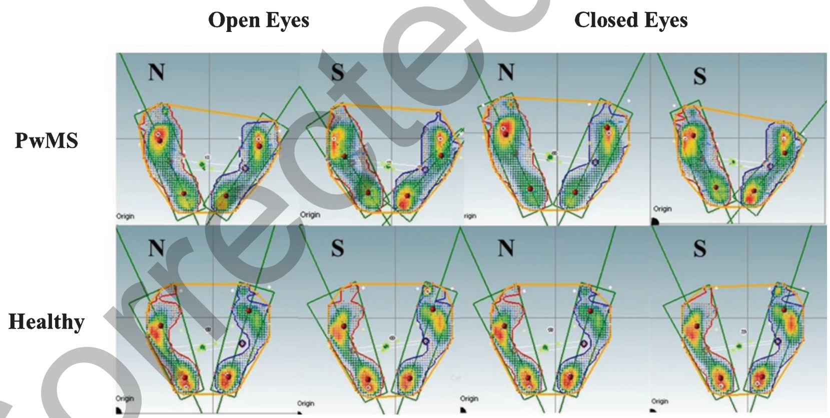

Fig. 1. Stabilometric individual examination in a patient with SM and in a healthy. Legenda:MS: Multiple Sclerosis; N = Neutral position; S = Self-correction position.

group ones. Patients with MS have a bigger sway area of CoP oscillations but they move slowly inside it. Our results suggested as healthy make a greater number of oscillations but with a shorter duration than patients with MS. Therefore, starting from the assumption that the stabilometry parameters in the patients with MS group's, as an increase of the path length, could be a balance-compensation strategy related to disability, we could hypothesize a constant, efficient, gradual and research-oriented strategy for center of gravity equilibrium by patients with MS group respect healthy, with greater expenditure of energy and fatigue but on the other hand these results need further comparison and in-depth studies for a complete interpretation. Patients with MS try to be more stable and adopted an "hyper stable" attitude with a reduction of segmental control and stiffening the body. Furthermore, it is important to consider how MS patients would present impaired upper limb movement and decreased trunk control with high correlation between them, even in a very mild form of the disease [Cetisli Korkmaz et al., 2018]. People with MS have the capacity to improve use of a feed-forward postural strategy with practice and retain the learned behavior for temporal not spatial control of CoM, despite their significant postural response impairments [Gera et al., 2016]. Postural control deficit can be managed by means of rehabilitation, which is the most important way to improve balance in patients with MS, but there are also suggestions of a beneficial effect of some pharmacologic interventions. On the other hand, it would be useful to pay attention to some drugs that are currently used to manage other symptoms in daily clinical setting because they can further impair postural controls of patients with MS [Prosperini et al., 2018]. Busa MA et al. studied how the loss of postural complexity of CoP was associated with reduced adaptability that occur MS disease and also how complexity is strongly correlated with skin sensitivity, thus suggesting the unique contribution of alteration of somatosensory systems on postural control deficits in patients with MS [Busa et al., 2016]. Postural control relies on the visual, somatosensory and vestibular systems inputs integration which are frequently impaired in patients with MS and an increase of the CoP sway area as an indicator of poor balance capabilities in MS [Kalron, 2017]. Stabilometry is the gold standard objective measure of standing postural control in people with multiple sclerosis in early and late stage. Sway area, CoP, path length, sway rate oscillation and CoP trajectories are the main parameters and appropriate outcomes indicating disability deterioration in patients with MS [Kalron et al., 2016]. Our analysis highlighted that patients with MS, trying to self-correct his/her posture, improved cervical and lumbar lordosis respect the sagittal plane. Each subject can be conscious of his/her own body posture improving it with self-correction maneuvers. Rehabilitation treatment, teaching correct standing posture through self-correction exercises, could represent a key element to help patients with MS in their ADLs avoiding falls [D'amico et al., 2018]. Moreover, a lot of healthy people have poor postural patterns in standing, sitting and recumbent positions with non-ergonomic postural behaviors. It could be an interesting topic, still rarely studied in literature and, also, there is a gap in knowledge of anticipatory postural adjustment alterations in MS patients in the early stage [Massot et al., 2019; Nowotny-Czupryna et al., 2013].

4.1. Strengths and limitations of this study

Strengths: This study is the first attempt to investigate postural self-correction MS patients' skills in a quiet condition. These results could have significant repercussions on the rehabilitative field because they shed light on the importance of postural control and balance exercises, even in slight no-fallers MS patients.

Limitations: A limitation is represented by the fact that the patients included in this study did not differ from the controls in terms of mobility, balance, gait and risk of falling performance.

Furthermore, just RR-MS patients with EDSS score between 0 and 2,5 were included making a homogeneous sample, excluding other MS forms and worst EDSS score.

5. Conclusion

MS patients in the initial phase of the illness compared to the healthy control group showed a postural bradykinesia having a slower CoP oscillation and a shorter path of oscillation that could be their safety comfort zone as in CE and in OE. Moreover, as in the healthy, the function of self-correction functionally perceived by the patient as the one that gives greater stability, is performed with a reduction in cervical lordosis and a slight increase in lumbar lordosis. Respect the elf- correction command in CE condition, MS patients further reduced the CoP oscillation speed and the length of the path of the oscillations: could it be a compensation to save energy during postural control? Or on the other hand, could this postural bradykinesia in quite stance delay postural adjustment compensation and favor falls during the continuation of the MS?

Further study should be desirable to deepen these aspects and to investigate dynamic balance conditions to establish a correct rehabilitative program with self-correction exercise as powerful focus.

Conflict of interest

None to report.

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