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ORIGINAL ARTICLE

Very short-term effect of brace wearing on gait in adolescent idiopathic scoliosis girls

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Abstract
Purpose Adolescent idiopathic scoliotic (AIS) deformity induces excessive oxygen consumption correlated to a bilateral increase of lumbo-pelvic muscles timing activity (EMG) during gait. Wearing a brace, the usual treatment for AIS, by supporting the spine and the pelvis, would generate lumbo-pelvic muscular relaxation and consequently reduce excessive oxygen consumption. The purpose of this study was to evaluate the short-term effect of bracing on gait biomechanics in scoliotic spine when compared with normal braced spine.
Methods Thirteen healthy volunteers were compared to 13 AIS girls. In both samples, gait analysis was assessed using a three-dimensional motion analysis, including synchronous kinematic, electromyographic, mechanical and energy measurements, first without brace, then wearing a brace.
Results For scoliotic patients, comparison of in-brace and out-brace situations revealed a significant decrease of frontal pelvis ($p < 0.001$), hip ($p < 0.001$) and shoulder ($p = 0.004$) motion in brace associated with a significant reduction of pelvis rotation ($p = 0.003$). However, the brace did not change significantly the lumbo-pelvic muscle activity duration (EMG) or the mechanical and energetic parameters. Transversal pelvis motion was reduced by 39 % ($p = 0.04$), frontal hip and shoulder motions by 23 % ($p = 0.004$) and 30 % ($p = 0.01$) respectively, and energy cost of walking remained increased by 37 % in braced AIS girls relatively to braced healthy subjects. Mechanical and electromyographic variables were not significantly different between the two braced populations during gait except for the *gluteus medius* muscle that showed bilaterally an increase of duration of electrical activity in healthy subjects and contrarily a decrease in AIS patients (healthy: -3.5 ± 9.6 % of gait cycle vs. scoliotic: 3.7 ± 7.7 % of gait cycle; $p = 0.04$).
Conclusions Bracing changed neither the oxygen consumption nor the timing of the lumbo-pelvic muscles activity in both groups during gait. However, in brace the timing activity of bilateral *gluteus medius* muscles tended to decrease in AIS patients and increase in healthy subjects. Moreover, braced AIS patients had more restricted frontal hips and shoulder motion as well as pelvis rotation than braced healthy subjects.

Keywords Idiopathic scoliosis · Gait · Brace · Muscle

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Introduction

Bracing is commonly prescribed for skeletally immature adolescent idiopathic scoliosis (AIS) with progressive curves above 25° and aims to reduce the risk of curve progression and surgery in patients with good compliance [1].

Most studies deal with the effect of the brace treatment regarding the evolution of frontal [35] and/or sagittal [26] spinal curve patterns and pelvic tilt [7], compliance [1] or changes in daily activities [21].

Other studies deal with the immediate effect of brace. These ones are mainly focused on biomechanical spine effects such as interface pressure performed at the compression pads [4], radiological correction [13] and intragastric pressures [9]. But few studies assessed the immediate brace effect on functional activities, such as walking.

Some studies, achieved in normal subjects during walking, showed that very short-term trunk bracing (i.e. within the day) induced a stiffened gait by reducing trunk, pelvic and hip motions [17] increasing in turn muscular mechanical work done by the body muscles to move the centre of body mass (COM) [17] and oxygen expenditure [32]. In untreated AIS patients, such a stiffened gait has already been observed inducing similar restriction of trunk, pelvic and hip motions that consequently affected walk efficiency [18]. We hypothesized that, in AIS patients, the wear of brace would aggravate the stiffness and would have an immediate excessively deleterious impact on the walk efficiency.

The observation that brace wearing could immediately affect joint kinematics and mechanical work of walking is of great interest because it means that pendulum-like mechanisms of gait would be affected. Indeed, it is recognized that pathologies that affect the pendulum-like mechanisms of gait induce pathologic gait [6, 8, 31, 32].

The objectives of this study were first to assess the very short-term changes in radiological and gait parameters with and without the brace in AIS patients, second to compare the gait variables changes between the group of braced AIS patients and a group of healthy subjects experimentally braced [17] to observe if braced AIS patients provided a more stiffened gait than braced healthy subjects and third to compare between the two populations if the brace provides similar changes in the gait parameters.

Materials and methods

Study population

Thirteen progressive AIS girls [13–15] (14 years, 1.60 ± 0.06 m, 49.1 ± 7.9 kg, 19.4 ± 1.6 BMI) with a thoracolumbar/lumbar primary structural curve according to Lenke classification [14] were enrolled in the study. Patients with leg length discrepancies higher than 1 cm, any locomotor disorders, back pain, neurological abnormalities or with any previous treatment for their scoliosis were excluded. Inclusion criteria for the indication of brace were [24]: skeletal immaturity, Risser ≤2, premenarcheal or postmenarcheal by less than 1 year, a Cobb's angle between 15° and 40° on anteroposterior view radiographs and the evidence of progression of more than 5° Cobb (observed on two successive radiographies spaced by 4 months) for curves smaller than 20°.

Patients were evaluated 4 months after having worn strictly (22 h per day) a custom-made rigid thoraco-lumbosacral orthosis (TLSO). Marks were made on the straps of the brace to ensure that they applied the correct pressure.

Each subject signed on and participated freely in the study, approved by the local ethics board. They were submitted to radiological and gait assessments.

Radiological assessment

A standing anteroposterior full spine X-ray was performed to evaluate main Cobb angle curve [5], frontal body balance [15], Risser sign [25] and apical vertebral rotation [23].

Instrumented gait analysis

Gait was assessed using a three-dimensional motion analysis, including synchronous kinematic, electromyographic (EMG), mechanical and energy measurements. All data were simultaneously acquired on a motor-driven treadmill (Mercury LT med, HP Cosmos®, Germany).

Segmental kinematics and spatio-temporal parameters were measured with the Elite system (BTS, Italy). Six infrared cameras measured, at 100 Hz, the tridimensional (3D) coordinates of 22 reflective markers located on specific anatomical landmarks. Measurements allowed computation of the 3D angular displacement and angular speed of shoulder, pelvis, hip, knee and ankle [27]. On each segmental angular displacement and speed curve expressed as a function of normalized stride (as a percent), maximum and minimum angular positions were measured, as well as the range of motion, calculated as maximum angular position minus minimum angular position.

Electrical timing activity (EMG) of *Quadratus Lumborum*, *Erector Spinae*, *Gluteus Medius, Rectus Femoris*, *Semitendinosus*, *Tibialis Anterior* and *Gastrocnemius* muscles was recorded bilaterally by a telemetry EMG system (Telemg, BTS, Italy) with surface electrodes (Medi-Trace, Graphic Controls Corporation, NY, USA). Signal was digitized at 1,000 Hz, full-wave rectified, and filtered (bandwidth 25–300 Hz). Onset and cessation of muscle activity were determined as described by Van Boxtel et al. [29].

Kinematic and EMG data were normalized to 100 % of the time of stride, with 0 % corresponding to initial contact of convex side foot.

Total muscular mechanical work (W_{tot}) was the sum of external work (W_{ext}) performed by the body muscles to move the COM relatively to the surroundings, and internal work (W_{int}) performed by the muscles to move the body segments relatively to the COM [2].

W_{ext} was computed from strain gauges measuring the 3D-ground reaction forces according to Cavagna [2]. The sagittal, transverse and vertical accelerations were obtained from the respective forces and were then integrated to give the speed changes of the COM in all three directions, relatively to constants of integration. These constants were the average velocities in the vertical, lateral and forward directions [28].

From the instantaneous velocity in forward, lateral and vertical directions, the instantaneous kinetic energy $E_{kf} = 0.5(\mathrm{m}\ V_f^2)$, $E_{kl} = 0.5(\mathrm{m}\ V_l^2)$ and $E_{kv} = 0.5(\mathrm{m}\ V_v^{2)}$ can be calculated. The sum of the increments of the kinetic energy represents the positive work required to accelerate the COM of the body.

W_{int} was computed from kinematic data. W_{int} was computed from kinematic data following the method described by Willems et al. [33]. The body was divided into four rigid segments: HAT and exercising thigh, shank and foot. The internal mechanical energy of the body segments corresponded to the sum of the rotational and translational energies of these segments due to their movements relative to the COM in the sagittal plane. The internal mechanical energy–time curves of the thigh, shank and foot were summed. The W_{int} of the lower limb and the HAT segment was then calculated as the sum of the increments of the internal mechanical energy curves during one cycle [18].

Metabolic cost of walking was determined by the subject's oxygen consumption ($\dot{V}O_2$) and carbon dioxide production ($\dot{V}CO_2$) both measured with an ergospirometer (Quark b2, Cosmed, Italy). The respiratory quotient (RQ) was computed as the ratio between $\dot{V}CO_2$/and $\dot{V}O_2$. The Joules of energy expended per liter of oxygen consumed were computed depending on RQ [1]. The net energy cost (C) was calculated as "the metabolic cost of walking minus the metabolic cost of standing" divided by speed [3]. The efficiency of positive work production by the body muscles was calculated as the ratio between W_{tot} and C [3].

Protocol

Radiography and gait analysis were performed two times: first without the brace (T1), which was taken off almost 18 h ago (last evening) and secondly in-brace (T2).

A 1-h break within the brace was given between the two tests so that the body adapts to bracing. The gait sessions began with a rest period, in which the subjects stood barefoot on the treadmill for the static calibration of kinematic variables. Thereafter, the subjects were asked to walk at a constant speed of 4 km h^{-1} for a few minutes until a steady state was reached. Then, energy variables were computed for 2 min and the other variables were simultaneously recorded for 20 s and averaged for ten successive strides. The mean value for each variable was used for statistical analysis. When necessary, 3 holes were made in the TLSO to allow both repositioning of the two antero-superior iliac spinous and sacrum markers on the skin under the brace, and tracking by the cameras.

Statistical analysis

All variables, respecting the normal distribution and equality of variance, were presented in mean (±SD). Statistical analysis was performed using the software SigmaStat version 3.5, SPSS Sciences Software GmbH, Erkrath, Germany. The significance level was at $p < 0.05$.

A preliminary t paired test was performed between the pre-treatment radiological data (i.e. the data obtained at the first medical assessment, 6 months before the study) and the radiological data obtained without brace at the moment of the current study, i.e. 6 months later to evaluate the effect of brace treatment.

A t paired test was performed to evaluate very short-term bracing effect on radiological and gait variables between T1 session (out of brace) and T2 session (within the brace) in the AIS population. A Student test was performed on all gait variables at T2 session (within the brace) between healthy girls experimentally braced [17] and AIS patients.

A Student test was performed on the difference between T1 and T2 sessions for all gait variables between the AIS patients and healthy subjects.

Statistical analysis was performed only on the convex side of AIS and left side of healthy subjects because

Table 1 Results of t paired test on radiological variables between T1 (out of brace) and T2 (within the brace) in AIS patients

	Bracing effect		p value
	T1 (out of brace) Mean (±SD)	T2 (within the brace) Mean (±SD)	
Radiologic			
Thoracolumbar/lumbar Cobb angle (°)	19.8 (12.9)	13 (8.9)	**0.005**
Balance (mm)	−4.9 (18)	−6.4 (13.7)	NS
Thoracolumbar/lumbar rotation (°)	7.9 (6.2)	5.8 (5.3)	NS

Significant differences are typed in bold and are accepted for p value <0.05

NS no significant

$N = 13$ AIS

previous studies have show no significant difference between sides in these two samples [17, 18].

Results

Radiological results in AIS patients

The main structural thoracolumbar/lumbar curve was significantly reduced in brace when compared to the out-brace situation the same day (T2: 13.0 ± 8.9° vs. T1: 19.8 ± 12.9°; $p = 0.005$), but the frontal imbalance and the apical rotation did not present any significant difference (Table 1).

The mean (±SD Cobb angles of the main curve were 26.6 (±9.8°) at the pre-treatment radiological assessment and 13.0 (± 8.9°) after a 6-month period within the brace, with an average curve correction of 48 % in brace.

Gait results in AIS patients (Table 2)

Comparison of the immediate in-brace (T2) and out-brace (T1) situations revealed no significant changes in speed, length step, cadence and stance phase duration.

The brace mainly affected frontal plane motions. Frontal pelvis ($p < 0.001$), hip ($p < 0.001$) and shoulder ($p = 0.004$) motion was significantly decreased in brace

Table 2 Results of *t* paired test on gait variables between T1 (out of brace) and T2 (within the brace) in the AIS sample

	Bracing effect		*p* value
	T1 (out of brace) Mean (±SD)	T2 (within the brace) Mean (±SD)	
Spatio-temporal variables			
Speed (km h^{-1})	4	4	NS
Step length (m)	0.69 (0.04)	0.7 (0.03)	NS
Cadence (step min^{-1})	109 (7.4)	109.6 (4.6)	NS
Stance phase (%)	64 (0.9)	64 (1.2)	NS
Segmental kinematic variables (°)			
PPA frontal pelvis motion	7.5 (1.5)	3.7 (1.3)	**<0.001**
PPA sagittal pelvis motion	2.7 (0.9)	2.8 (0.8)	NS
PPA transversal pelvis motion	7.5 (2.9)	4.5 (2.3)	**0.003**
PPA frontal hip motion	11.4 (2.7)	8.1 (1.8)	**<0.001**
PPA sagittal hip motion	42.3 (3.9)	43.6 (3.6)	NS
PPA transversal hip motion	15.2 (4.4)	13.4 (3.9)	NS
PPA frontal shoulder motion	7.4 (1.6)	5.6 (2)	**0.004**
PPA sagittal shoulder motion	4 (2.4)	4.5 (3.4)	NS
PPA transversal shoulder motion	3 (1.6)	2.5 (1.5)	NS
PPA sagittal knee motion	54 (6.3)	55.2 (5.6)	NS
PPA sagittal ankle motion	27.9 (6.9)	30.1 (7.4)	NS
PPA transversal ankle motion	16.4 (5.5)	17.1 (5)	NS
EMG variables (%)			
QL duration	42.8 (12.8)	39.8 (9.3)	NS
ES duration	28.4 (5.5)	34.3 (9.7)	NS
GM duration	46.9 (5.9)	43.2 (3.8)	NS
RF duration	48.8 (9.2)	42 (10)	NS
ST duration	44.5 (12.7)	41.5 (1.6)	NS
TA duration	43.8 (5.7)	48.9 (9.2)	NS
G duration	36.6 (3.7)	36.2 (3.7)	NS
Mechanics			
W_{ext} (J kg^{-1} m^{-1})	0.26 (0.03)	0.28 (0.04)	NS
W_{int} (J kg^{-1} m^{-1})	0.26 (0.02)	0.26 (0.02)	NS
W_{tot} (J kg^{-1} m^{-1})	0.53 (0.03)	0.54 (0.04)	NS
Recovery (%)	62.3 (4.4)	61 (4.6)	NS
Energetics			
Energy cost (J kg^{-1} m^{-1})	2.2 (1.1)	1.8 (0.6)	NS
Muscle efficiency (%)	31.7 (18.8)	30.5 (9.5)	NS

Significant differences are typed in bold and are accepted for *p* value <0.05

NS no significant

$N = 13$ AIS

Table 3 Results of Student test on gait variables at T2 (within the brace) between healthy subjects and AIS patients

	Healthy subjects ($N = 13$) Mean (±SD)	AIS patients) ($N = 13$) Mean (±SD)	p value
Segmental kinematic variables (°)			
PPA transversal pelvis motion	7.4 (4.3)	4.5 (2.3)	**0.04**
PPA frontal hip motion	10.5 (2)	8.1 (1.8)	**0.004**
PPA frontal shoulder motion	8.1 (2.6)	5.6 (2)	**0.01**
Energetic variables			
Energy cost (J kg^{-1} m^{-1})	1.6 (0.2)	2.2 (0.7)	**0.01**

Only significantly changed variables are typed in the Table

Significant differences are typed in bold and are accepted for p value <0.05

Table 4 Results of Student test on the difference between T1 and T2 sessions for all gait variables between the AIS patients and healthy subjects

	Healthy subjects ($N = 13$) Mean (±SD)	AIS patients) ($N = 13$) Mean (±SD)	p value
EMG variables			
GM duration (%)	−3.5 (9.6)*	3.7 (7.7)	**0.04**

Only significantly changed variables are tipped in the Table

Significant differences are typed in bold and are accepted for p value <0.05

* A negative value means that the EMG activity is increased in the brace

associated to a significant reduction of pelvis rotation ($p = 0.003$) without any change in the lower limb motions.

There were no significant changes in the lumbo-pelvic muscle activity duration (EMG) in the brace.

Mechanical and energetic variables were not significantly modified by the brace.

Comparison of gait within the brace between AIS patients and healthy subjects (Table 3)

In AIS girls, transversal pelvis motion was reduced by 39 % ($p = 0.04$), frontal hip and shoulder motions by 23 % ($p = 0.004$) and 30 % ($p = 0.01$), respectively, relatively to healthy subjects.

Electromyographic and mechanical variables were not significantly different between the two-braced populations during gait. However, energy cost of walking remained increased by 37 % in braced AIS patients as compared to braced healthy subjects (healthy subjects at T2: 1.6 ± 0.2 J kg^{-1} m^{-1} vs. AIS patients at T2: 2.2 ± 0.7 J kg^{-1} m^{-1}; $p = 0.01$).

Comparison of brace effect during gait in AIS patients and healthy subjects (Table 4)

In the brace during gait, between T1 and T2 sessions, it was observed that *Gluteus Medius* muscles bilaterally showed an increase in duration of electrical activity in healthy subjects and contrarily a decrease in AIS patients (healthy: −3.5 ± 9.6 % of gait cycle vs. scoliotic: 3.7 ± 7.7 % of gait cycle; $p = 0.04$). The changes between T1 and T2 sessions for the other gait variables did not differ significantly between the 2 populations.

Discussion

This study aimed to observe the combined effect of very short-term brace wearing and scoliotic curves on gait in AIS patients.

Bracing provided an immediate radiological correction (T2 vs. T1) of 34 % for the main thoracolumbar/lumbar curve, which was concordant with other studies (Korovessis: 32.6 % and Labelle: 31 %) [10, 12].

During gait, within the brace, frontal shoulder, pelvis and hip motions as well as pelvic rotation significantly decreased in AIS patients when compared to pre-brace situation. As also observed by Wong et al. [34] and Kramers-de-Quervain et al. [11], it is mainly the pelvis whose motion seems to be the most blocked by the brace. In our study, pelvis motion was restricted by 50 and 40 % in frontal and transverse planes, respectively. Frontal hip and shoulder motions were reduced by 29 and 24 %, respectively. A previous study has already showed that thoracolumbar/lumbar AIS patients before any orthotic treatment, walked with a decrease of frontal pelvis, hip and shoulder motion (minus 27, 28 and 21 %, respectively) as compared to healthy subjects [18].

Consequently, it appears that brace in thoracolumbar/lumbar AIS patients mainly accentuates the frontal pelvis restriction of motion during gait. But, physiologically, the frontal pelvis motion plays an important role as determinant of gait as it limits the excessive up and down movement of the centre of body mass (COM) to limit any excessive muscular mechanical work of the body during walking. It would be expected that the important frontal pelvis restriction of motion in braced AIS, as compared to healthy subjects walking normally, induces an excessive muscular mechanical work. However, in the current study,

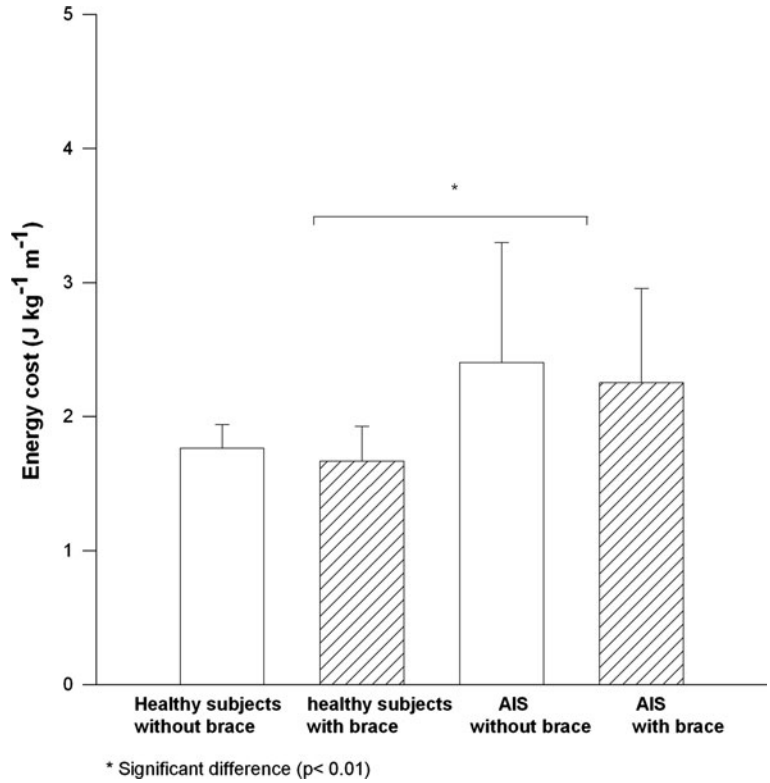

Fig. 1 The rate change of energy cost with and without bracing both in healthy and AIS girls during gait. This figure showed that bracing has no effect on the energy cost of walking in both samples. However, walking, both with and without brace, induced an energy cost significantly increased in AIS girls, i.e. an important increase of oxygen consumption as compared to healthy girls. The mean (*vertical bar chart*) ±SD (*vertical bars*) are drawn without brace (*white bar chart*) and within the brace (*grey lined bar chart*) at the speed of 4 km h^{-1}

very short-term bracing in AIS has no significant effect on muscular mechanical work. Specifically, the external work, which was observed to be excessively weak in untreated AIS patients as compared to healthy subjects [19], was not significantly modified by the brace. Braced AIS patients seem to keep a surprising economic mechanical work. In comparison, we had previously observed, in healthy subjects bearing experimentally a TLSO brace, that frontal pelvic restriction of motion contributed to both a 10 % increase in external work by increasing the vertical displacement of the COM, and a decrease (approximately 7 %) in the efficiency of the pendulum-like mechanism of walking [17]. As it has been previously hypothesized in unbraced AIS patients, that the occurence of a reduced mechanical work could help limiting the excessive energy consumption during gait [19], the lack of change in mechanical work, observed in braced scoliotic girls, could meet the same explanation. For example, it has been observed that a bouncing walking in healthy subjects induced an increase of vertical COM displacement with consequently an increase of mechanical work and energy consumption [20]. Such economic mechanical work observed in AIS patients within and without the brace would generate a decrease of O_2 consumption. However, the energy consumption, although not influenced by the brace, was 30 % above the normal values in AIS patients both within and without the brace [19] (Fig. 1). Comparatively, Lindh's study [16], assessing gait in AIS patients with and without a Milwaukee brace, showed that, in brace, the total oxygen uptake tended to decrease, though not significantly, at low walking speed (3 km h^{-1}) and increase at higher speeds (4.5 and 6 km h^{-1}). She concluded that trunk and pelvis motion restriction due to bracing was compensated for by altering other movements which may increase work of other muscles and thus energy uptake. The excessive energy consumption, found in our study, has been previously explained in untreated AIS patients [19] by the bilaterally prolonged activation timing of the lumbo-pelvic muscles. In the current study, the timing of EMG activity of the lumbo-pelvic muscles remained excessive because it did not differ within and without the brace. The brace affects neither the energy consumption nor the EMG activity of the lumbo-pelvic muscles. However, any decrease in the load on the trunk structures brought by wearing an orthosis would decrease the muscle contraction forces needed to perform a task; this result should be further evidenced by decreases in measured myoelectric activities. Conversely to our attempts, trunk muscular activity was not reduced by very short-term bracing. Yet, van Poppel et al. [30] showed no evidence that lumbar supports reduce immediately the EMG activity of *Erector Spinae* muscles. Lantz et al. showed that, on both *Erector Spinae* muscles, none of the orthoses used were consistently effective in reducing EMG activity [22]. The same results were reported in normal subjects experimentally wearing a brace during gait [17].

This observation argued the hypothesis that AIS would be associated to a significant primitive dysfunction of the lumbo-pelvic muscles and that the orthotic treatment does not modify the trunk muscular activity during functional activity such as walking.

Further investigation is necessary to elucidate the reason of this persistence of both excessive energy expenditure and more permanent duration of EMG activity of lumbo-pelvic muscles.

As a result, braced AIS patients, as compared to braced healthy subjects, walked with a more restrictive transversal pelvis motion (minus 39 %), as well as frontal hip motion (minus 23 %) and shoulder motion (minus 30 %). However, the effect of brace on these kinematic variables was similar in the 2 populations. Thus, the more important restriction of gait kinematics observed in AIS patients would be explained by the presence of the scoliotic curve. However, this straight gait noted in AIS patients has no more damageable very short-term effect on trunk muscular activity, mechanics and energy consumption than in braced healthy subjects during walking. Furthermore, the brace produced a similar effect on back and lower limb EMG activity, mechanical and energetic gait variables for the two samples except for the duration of EMG activity of bilateral muscles. With the brace, the EMG activity duration of bilateral *Gluteus Medius* muscles was observed to be more increased in healthy subjects (without brace: 38.4 ± 10.0 % vs. in brace: 41.9 ± 7.6 % of gait cycle; $p = 0.21$), although decreased in AIS patients (without brace: 46.9 ± 5.9 vs. in brace: 43.2 ± 3.8 % of gait cycle; $p = 0.1$). This adverse effect of very short-term bracing between healthy subjects and AIS patients could be explained as follows: the brace certainly more encompassed the two hips in the scoliotic group relatively to the healthy group, reducing much more hip frontal motion, although not significantly. Because frontal hip motion was limited by the brace, the muscles responsible for this motion, i.e. the *Gluteus Medius* muscles, were less activated, although not significantly, as observed in the scoliotic group with and without the brace. Further studies will be necessary to both argue this hypothesis and identify the long-term effect of brace on EMG activity of muscles that were enclosed in the brace.

Conclusion

Very short-term wearing of a TLSO brace in thoracolumbar/lumbar AIS girls reduces the main structural curve by 34 %, but alters the normal gait by reducing mainly the frontal (−50 %) and transversal (−40 %) pelvic motion and, and to a lesser extent, the frontal hip (−29 %) and shoulder (−24 %) motions. Compared to braced healthy subjects, braced AIS patients had less frontal hip (−23 %), shoulder (−30 %), and transversal pelvis (−39 %) motion.

However, very short-term bracing in AIS patients has no significant effect on EMG activity of lumbo-pelvic muscles, muscular mechanical work and energy consumption during gait.

In summary, the changes due to the brace were similar in the two populations except for the duration of EMG activity of both *Gluteus Medius* muscles that had a tendency to increase in braced healthy subjects and to decrease in braced AIS patients.

Further investigation is needed to explain the cause of the persistence of prolonged EMG activity of lumbo-pelvic muscles and excessive energy cost of walking in braced AIS girls.

Conflict of interest None.

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