Revista Eletrônica
Acervo Saúde
Electronic Journal Collection Health ISSN 2178-2091

Asymmetric myoelectric activity pattern of spinal and hip muscles during sit-to-stand and gait tasks in adolescents with idiopathic scoliosis

Padrão assimétrico da atividade mioelétrica de músculos espinhais e do quadril durante as tarefas de sentar-levantar e caminhar em adolescentes com escoliose idiopática

Patrón asimétrico de actividad mioeléctrica de los músculos espinales y de la cadera durante las tareas de sentarse y levantarse y de caminar en adolescentes con escoliosis idiopática

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RESUMO

Objetivo: O estudo teve como objetivo investigar os padrões de recrutamento dos músculos longuíssimo lombar (Long), iliocostal (Ilio) e glúteo médio (Gme) de ambos os lados (Cv e Cx) da coluna lombar de adolescentes com EI, durante os movimentos de sentar para levantar e marcha, e correlacionar sua ativação mioelétrica com a magnitude da escoliose. **Métodos:** Quinze adolescentes destros (4 homens; idade: 14,7 ± 1,9 anos) participaram do estudo. A raiz média quadrática foi extraída dos registros de um minuto dos sinais em cada tarefa motora. **Resultados:** Foram encontradas diferenças significativas entre os lados Cv e Cx para o Long durante os movimentos de ficar em pé (P=0,026) e sentar (P=0,015). Houve também diferença significativa no recrutamento do Long no início da fase de apoio da marcha (P=0,007). A atividade do Ilio no lado Cx correlacionou-se com o ângulo de Cobb durante a postura em pé (P=0,003; r=0,71) e sentada (P=0,03; r=0,55). **Conclusão:** O Long exibiu recrutamento assimétrico, mais pronunciado na convexidade. O sEMG do Ilio correlacionou-se positivamente com o ângulo de Cobb, potencialmente indicando a progressão da curva escoliótica.

Palavras-chave: Escoliose, Eletromiografia, Coluna Vertebral.

ABSTRACT

Objective: The study aimed to investigate the recruitment patterns of the lumbar longissimus (Long), iliocostalis (Ilio), and gluteus medius (Gme) muscles from both sides (Cv and Cx) of the lumbar spine of adolescents with IS, during the sit-to-stand and gait movements, and to correlate their myoelectric activation with the magnitude of scoliosis.**Methods:** The sEMG signals from these muscles were recorded in fifteen right-handed adolescents (4 males; age: 14.7 ± 1.9 years). A footswitch synchronized sEMG recordings during 1-minute motor tasks. The root-mean-square value was extracted from the sEMG signals. **Results:** Significant differences were found between Cv and Cx sides in Long sEMG activity during standing (P=0.026) and sitting (P=0.015). Besides, there was a significant difference in Long recruitment at the beginning of the support

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SUBMETIDO EM: 7/2024 | ACEITO EM: 8/2024 | PUBLICADO EM: 3/2025

phase of gait (P=0.007). Ilio activity on the Cx side correlated with the Cobb angle during standing (P=0.003; r=0.71) and sitting (P=0.03; r=0.55). **Conclusion:** Long exhibited an asymmetric recruitment, more pronounced in the convexity during sit-to-stand tasks and early stance phase. Ilio activity correlated positively with the Cobb angle during sit-to-stand and gait, potentially indicating scoliotic curve progression.

Keywords: Scoliosis, Electromyography, Spine.

RESUMEN

Objetivo: El estudio tuvo como objetivo investigar los patrones de reclutamiento de los músculos longissimus lumbar (Long), iliocostal (Ilio) y glúteo medio (Gme) de ambos lados (Cv y Cx) de la columna lumbar de adolescentes con escoliosis, durante los movimientos de sentarse a pararse y de marcha, y correlacionar su activación mioeléctrica con la magnitud de la escoliosis. **Métodos:** Quince adolescentes diestros (4 hombres; edad: 14,7 ± 1,9 años) participaron en el estudio. La raíz media cuadrática se extrajo de 1 minuto de las señales de sEMG en cada tarea motora. **Resultados:** Se encontraron diferencias significativas entre los lados Cv y Cx para el Long durante los movimientos de ponerse de pie (P=0,026) y sentarse (P=0,015). También hubo una diferencia significativa en el reclutamiento del Long al inicio de la fase de apoyo de la marcha (P=0,007). La actividad del Ilio en el lado Cx se correlacionó con el ángulo de Cobb durante la postura de pie (P=0,003; r=0,71) y sentada (P=0,03; r=0,55). **Conclusión:** El Long mostró un reclutamiento asimétrico, más pronunciado en la convexidad. El sEMG del Ilio se correlacionó positivamente con el ángulo de Cobb, indicando potencialmente la progresión de la curva escoliótica.

Palabras clave: Alimentos Funcionales, Dieta, Enfermedad Crónica.

INTRODUCTION

Scoliosis describes a spinal curvature of more than 10°, which can be a steady deviation (COBB JR, 1948; NEGRINI S, et al., 2005; KONIECZNY MR, et al., 2013). As the rotation of individual parts of the spine makes it a three-dimensional deformation (NEGRINI S, et al., 2005), it may lead to changes in the muscle recruitment pattern in adults (GAUDREAULT N, et al., 2005) and adolescents with idiopathic scoliosis (IS) (BASSANI E, et al., 2008; DE OLIVEIRA AS, et al., 2011). In this regard, the magnitude of the scoliotic curve in the frontal plane and the vertebral deformation is usually measured in radiography and referred to as Cobb angle (COBB JR, 1948; ROMANO M, et al., 2013). Thus, the radiographic examination has provided the basis for diagnosing, measuring and monitoring the evolution of spine deformities, including scoliosis. In addition, measuring the Cobb angle (DUN J, et al., 2018) has proven to be the simplest and most widely used method to diagnose scoliosis for several decades. However, although the radiographic measure provides some important anatomical details about scoliosis, it lacks information on how muscle activity can contribute to its manifestation. Thus, some authors have investigated the myoelectric activity of paravertebral muscles in scoliotic patients. For instance, Gaudreault N, et al. (2005) found a symmetrical myoelectric activation simultaneously on the concave (Cv) and the convex sides (Cx) of individuals with IS during isometric contractions in spinal extension. Similarly, Bassani E, et al. (2008) and De Oliveira AS, et al. (2011) did not also observe asymmetries in paravertebral muscle activation in adolescents with IS during spinal extension. In contrast, Chwala W, et al. (2014) evaluated the myoelectric activity of paravertebral muscles of adolescents with IS while they performed symmetrical and asymmetric isometric exercises and observed different muscle activation patterns.

Despite the divergences observed in some previous studies, it is imperative to emphasize the lack of research investigating the effects of IS on the muscle recruitment patterns of muscles that can be remotely affected and contribute to lower limb control, especially under dynamic conditions. Given the small number of studies conducted, there seems to be little clarity regarding muscle activity in patients with IS. Accordingly, Farahpour et al. (13) investigated the electromyographic activity of spine erector and external oblique muscles during trunk tilt and rotation movements in adolescents with and without scoliosis. They found that asymmetric muscle activity is not clearly determined in all tested movements. However, to our knowledge, in addition to the few studies conducted on muscle activity profiles under dynamic conditions, even less seems to be understood in dynamic tasks related to activities of daily living such as standing, sitting and gait in adolescents with IS.

Therefore, the present study aimed to investigate the recruitment patterns of the lumbar longissimus (Long), iliocostalis (Ilio), and gluteus medius (Gme) muscles from both sides (Cv and Cx) of the lumbar spine of adolescents with IS, during the sit-to-stand and gait movements, and to correlate their myoelectric activation with the magnitude of scoliosis.

METHODS

Participants and Study Design

Fifteen right-handed adolescents (4 males; age: 14.7 ± 1.9 years; body mass: 51.5 ± 10.5 kg; height: 1.6 ± 0.1 m; body mass index (BMI): 20.1 ± 1.9 kg/m²) participated in the study. Twelve participants had IS type I, and 3 had type IV according to King's classification (COBB JR, 1948); eleven adolescents presented scoliosis with lumbar convexity on the left side, and four presented it on the right side. The Cobb angle varied between 12º and 32º (21.6 ± 5.7º).

Adolescents with BMI and Cobb angle greater than 25 kg/m² and 32º, respectively; history of spinal surgery; nerve compression symptoms; spondylolisthesis; spinal stenosis; inflammatory diseases or cancer; and lower limb dysmetria greater than 1 cm, and using any orthosis or under physical therapy treatment were excluded from this study. The study was approved by the local ethical committee (protocol number: 2.253.351; CAAE: 66959117.0.0000.5147) and performed according to the Declaration of Helsinki. All the adolescents and their parents or guardians have freely signed a consent form before the data recording.

Data Acquisition

An X-ray of the spine in anteroposterior incidence was taken to determine the curvature type and quantify each participant's Cobb angle. Also, a lower limb scanometry was performed to check for possible asymmetries in the lower limb length.

According to each participant's type of scoliotic curve, the Long, Ilio, and Gme muscles had their surface electromyographic (sEMG) signal activity recorded from both sides and lately grouped into Cv and Cx. The sEMG signals were recorded according to SENIAM recommendations (HERMENS HJ, et al., 2000). Surface EMG signals were recorded and amplified with an 8-channel system (A/D converter: 16 bits; frequency of sampling: 2 kHz per channel; gain: 2000 ×; Filter [Butterworh 4th order: 20 – 500 Hz; EMG System do Brasil Ltda, São José dos Campos, SP, Brazil). The sEMG signals were visualized and monitored using the software EMGLab (V1.1; version 2012; Lynx Tecnologia Eletrônica Ltda, São Paulo, SP, Brazil). A pair of surface electrodes (Ag/AgCl; with fixation adhesive) was placed in a bipolar montage with an inter-electrode distance of 20 mm on each muscle. Before placing the surface electrodes, each participant had the skin cleaned with sterilized gauze and alcohol 70%. Whenever necessary, trichotomy was performed with a disposable shaving blade, and the skin was scrubbed with a loofah to keep the impedance below ten kΩ (KONRAD P, 2005).

Motor Tasks Performed by Participants

A footswitch was placed under the calcaneus to synchronize the recording of the sEMG signals. It allowed determining the exact timing of the sit-to-stand movements' beginning and ending and each cycle of the stance and swing phases during gait.

At the first stage of the data recording, i.e., the sit-to-stand phase, the participants were instructed to sit down and maintain the spine erect in a chair with a fixed seat height (45 cm) so that the knee would reach approximately 90º angle. The sEMG signals were recorded continuously during the whole task, i.e., from the touch of the participant's calcaneus on the floor and while standing up, throughout the movement until the volunteer was instructed to sit again. The sit-to-stand task was performed for 60 seconds. In the second stage, the adolescents were asked to stand and start walking on a treadmill (Movement; ProAction model) for 60 seconds at a 4 km/h speed. This speed was kept constant to minimize any kinematic influence in the study. Additionally, this speed corresponds to the most economical rate in energy expenditure (LENKE LG, et al., 2001; MAHAUDENS P, et al., 2009). Before the experiment, the participants were carefully instructed to perform a few trials for learning purposes. During the test, the adolescents were observed to avoid compensatory movements or any other attitude or posture deviant from the experimental purpose.

Surface EMG Signal Processing

Surface EMG signals were visually inspected and processed offline using the *SignalHunter* software (SOUZA VH, et al., 2015), written in Matlab 2015a (The Mathworks, Natick, USA). Initially, the DC component of the sEMG signals was removed using a linear detrend. Then, a third-order low-pass Butterworth filter with a cutoff frequency of 10 Hz was applied to obtain the envelope of the sEMG signals (DE LUCA CJ, 1993, 1997; GARCIA MAC and VIEIRA TMM, 2011).

To analyze the sEMG signals of the sit-to-stand tasks, the footswitch signal peak was considered to represent the instant when the participant stood erect after standing up from the sitting position. The Gme, Long and Ilio muscles were divided into right and left, and PRE and POST instants, i.e., the PRE indicating the moment the participant was standing up and the POST indicating the moment the participant was sitting down. The average sEMG was calculated in a 1.5s time window ending at the stand instant for the PRE activation and in a duration of 1.5s at the moment starting from the sit-down instant for the activation POST. The time window was centred on the new peak identified in the average signal in the standing task, lasting for 1.0s. Each adolescent performed approximately 50 stand-ups and sit-downs.

For the analysis in the gait task, the instant of each step with the right foot was identified from the peaks in the footswitch signal. After visual inspection of both signals for all participants, a period of contraction of the right Gme was identified during the entire stance phase and a period of contraction of the left Gme throughout the stance phase. For the Long and Ilio muscles, on both sides, periods of muscular activation were identified in the sEMG signals at the beginning and end of the stance phase. In a complete data acquisition from the left and right Gme muscles in gait tasks, the sEMG and footswitch signals were windowed and averaged between 500 ms before and after each step. Then, the peak activation of the average signal, extracted from all steps, was computed. The signal from every single step was then selected from a time window with 900 ms duration centred at the instant of the average signal peak. In this way, it was possible to define a window of time that covered the entire Gme activation interval for all steps.

For the right and left Long muscles, two-time windows were defined, one with 500 ms ending at the start of the stance phase (PRE activation) and another with the same 500 ms stopping at the end of the stance phase (POST activation). The PRE and POST activation peaks were identified for the average signals in the corresponding time windows. Next, the sEMG signal from each step was cut in a 600 ms time window centred in the peak of the PRE and POST average signals. The same procedure was performed for the Ilio muscles, but the time window for each step was 300 ms centred on the peak of the average signal. About 40 steps were identified for each adolescent when performing the gait task. During data processing, the sEMG signal was checked for outliers from movement artefacts or poor electrode contact. Outliers were considered to have activation peaks greater than three absolute deviations from the median and removed from subsequent steps.

The interval between the muscle activation peak and the step instants was calculated for each repetition throughout the execution of the task. On the raw sEMG signal, the root mean square (RMS) amplitude was calculated according to equation 1. Finally, the median RMS amplitude and time interval were calculated across all task repetitions for each participant.

$$RMS = \sqrt{\frac{1}{N}\sum_{n=1}^{N} EMG[n]^2} \quad (1)$$

where N represents the number of samples (=15) in the intervals established for analysis.

Statistical Analyses

Mean and standard deviation were used to characterize the age, weight, height, BMI, and Cobb angle obtained from the participants in this study. The data was grouped in Cv and Cx, and a Shapiro-Wilk test was performed. The results are presented in medians (MED) and interquartile ranges 1 and 3 (Q1-Q3). The

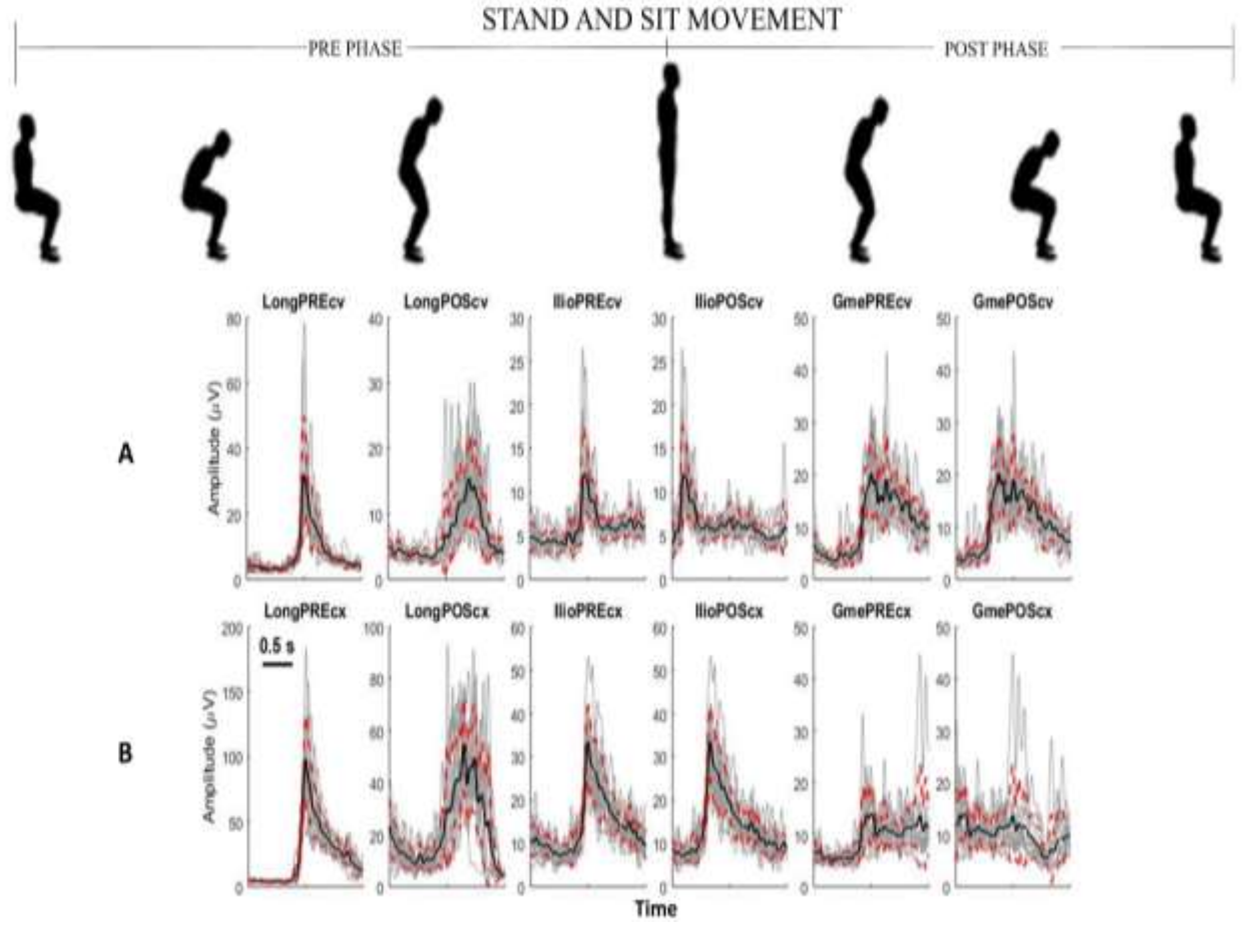
Wilcoxon test was applied to compare the RMS between the Cv and Cx sides, and the Spearman test was performed to correlate the RMS with the Cobb angle. The significance level was set at 5% (α=0.05) for all tests, and all statistical analyses were performed in R (AT&T, Lucent Technologies).

RESULTS

Stand-Sit Task

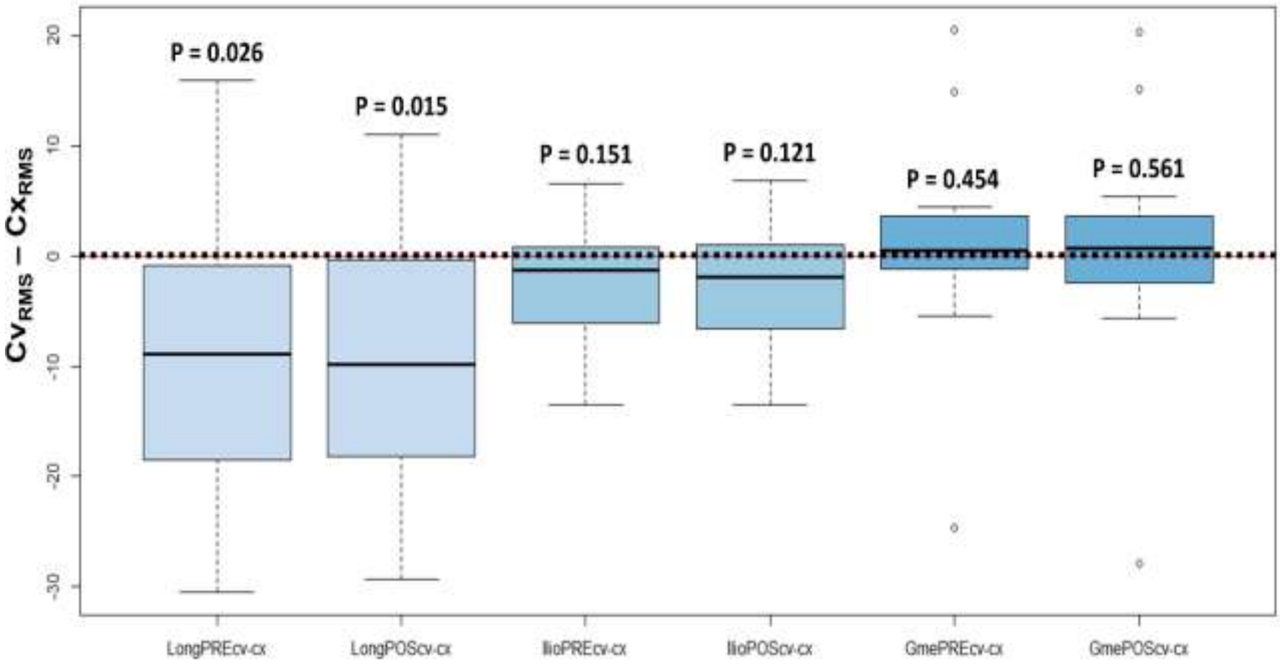
The Long, Ilio, and Gme muscles showed sEMG signal peaked simultaneously, i.e., just before the participants reached the upright position (LongPRE, IlioPRE, GmePRE). These muscles also presented a second myoelectric peak after the upright position posture (LongPOST, IlioPOST, GmePOST) while the participants sat down (**Figure 1**). A significant difference between the median RMS amplitudes between the Cv and Cx sides could be observed for the LongPRE (P = 0.025) and LongPOS (P = 0.015). Differences were more prominent on the Cx side (**Figure 2**), as shown in **Table 1**.

Figure 1 - Schematic representation of the stand (PRE phase) and sit (POST phase) movements. Result of the sEMG analysis during the stand-up task of a participant with left lumbar convexity. There are two activation peaks, one in the phase of standing (PRE) and the other in the phase of sitting (POST) in the lumbar longissimus (Long), iliocostalis (Ilio) and gluteus medius (Gme) muscles, both on the concave side (A; LongPREcv, LongPOSTcv, IlioPREcv, IlioPOSTcv, GmePREcv, GmePOSTcv) and the convex side (B; LongPREcx, LongPOSTcx, IlioPREcx, IlioPOSTcx, GmePREcx, GmePOSTcx). The black line indicates the average sEMG signal. The grey lines represent the individual sEMG at each repetition of standing up and sitting; the dashed red line indicates the standard deviation of the average signal.



Source: Rossi BP, et al., 2025.

Figure 2 - Boxplot representing the difference between the concave (Cv) and convex (Cx) sides of the root mean square (RMS) amplitude of the lumbar longissimus (Long), iliocostalis (Ilio), and gluteus medius (Gme) muscles in the stand PRE phase movement (LongPRE, IlioPRE, GmePRE) and the sit POST phase movement (LongPOST, IlioPOST, Gme) for adolescents with idiopathic scoliosis (n = 15).



Source: Rossi BP, et al., 2025.

Table 1 - Median (MED) and range interquartile 1 and 3 (IQ1-3) of the root mean square (RMS) amplitude of each muscle during the stand-sit task (PRE = stand; POST = sit) on the concave side (Cv) and on the convex side (Cx) in adolescents with IS (n = 15).

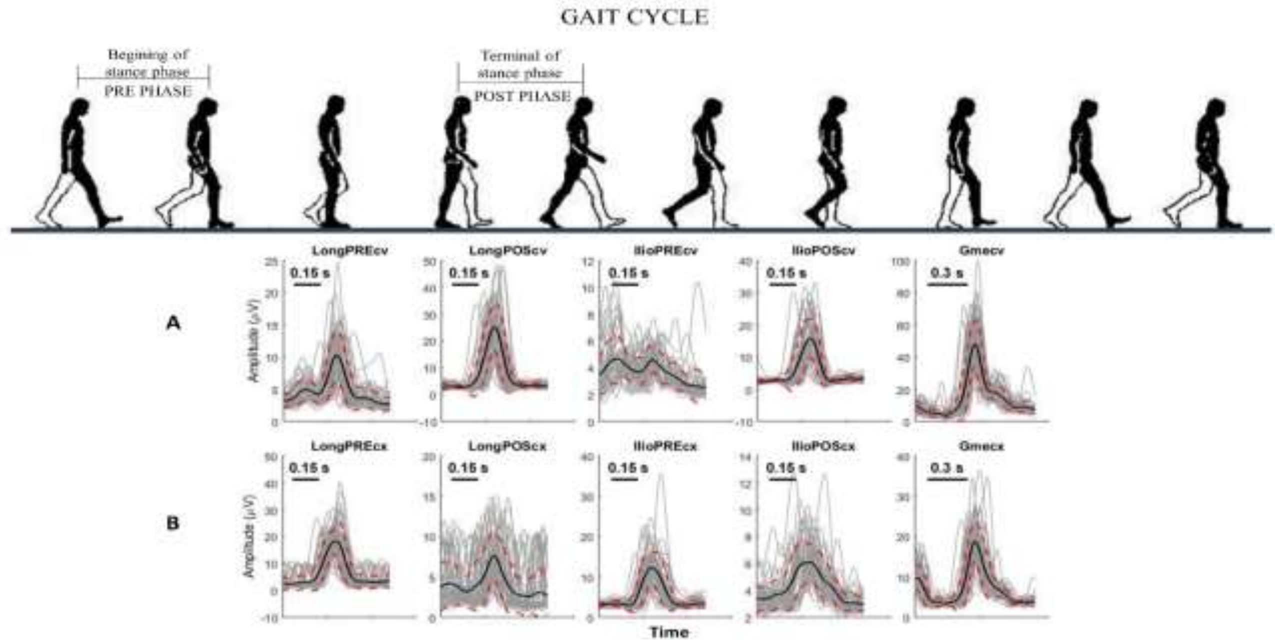
Muscle	RMS (µV) (MED; IQ$_{1-3}$)	P
Long$_{PREcv}$	21.2; 15.3 – 26.2	
Long$_{PREcx}$	32.8; 20.5 - 37.4	0.025*
Long$_{POScv}$	21.9; 16.8 - 24.1	
Long$_{POScx}$	31.3; 23.3 - 36.0	0.015*
Ilio$_{PREcv}$	10.4; 9.2 - 12.5	
Ilio$_{PREcx}$	11.3; 10.6 - 16.8	0.100
Ilio$_{POScv}$	10.3; 9.0 - 12.0	
Ilio$_{POScx}$	11.9; 10.7 - 15.9	0.061
Gme$_{PREcv}$	21.4; 12.6 - 24.5	
Gme$_{PREcx}$	13.6; 10.4 - 21.4	0.427
Gme$_{POScv}$	16.7; 12.9 - 23.8	
Gme$_{POScx}$	14.3; 10.0 - 21.7	0.532

Source: Rossi BP, et al., 2025.

Gait Task

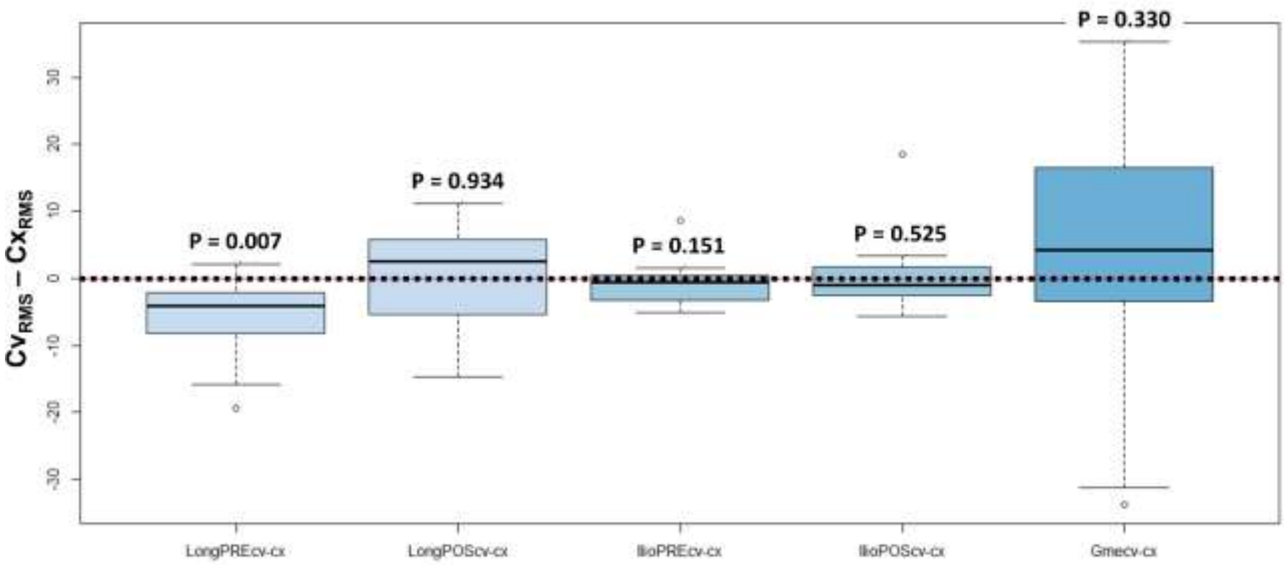
Long and Ilio showed two sEMG activation peaks during the gait task: one at the beginning (LongPRE, IlioPRE) and another at the end of the stance phase (LongPOST, IlioPOST). Gme presented only a single activation peak throughout the gait cycle (**Figure 3**). When measuring the median RMS amplitudes at the beginning of the stance phase, the Long showed a significant difference between the Cv and Cx sides, higher on the Cx side (P = 0.006). All the other muscles did not present significant differences between the Cv and Cx sides during the cycle performed by adolescents with IS (**Figure 4**), as shown in **Table 2**.

Figure 3 - Schematic representation of the gait cycle. The start of the stance phase (PRE phase) and the end of the stance phase (POST phase) are highlighted. B) sEMG during gait of an adolescent with idiopathic scoliosis (IS) with left lumbar convexity. Two activation peaks of the longissimus lumbar (Long) and iliocostalis (Ilio) muscles at the beginning of the stance phase (PRE) and the end of the stance phase (POST), both on the concave side (A; LongPREcv, LongPOSTcv, IlioPREcv, IlioPREcv) and the convex side (B; LongPREcx, LongPOSTcx, IlioPREcx, IlioPOSTcx). The gluteus medius (Gme) presented only one peak of activation, both on the concave side (GmeCv) and on the convex side (GmeCx). The black line indicates the average signal. The grey lines represent the individual sEMG at each task repetition; the dashed red line indicates the standard deviation of the mean sEMG signal.



Source: Rossi BP, et al., 2025.

Figure 4 - Boxplot representing the difference between the concave (Cv) and convex (Cx) sides of the root mean square (RMS) of the lumbar longissimus (Long), iliocostalis (Ilio) and gluteus medium (Gme) muscles, both in the PRE (LongPRE, IlioPRE) and the POST (LongPOST, IlioPOST) phases for adolescents with idiopathic scoliosis (IS). The Gluteus medius (Gme) showed only one peak of activation during gait, both on the concave side and on the convex side (Gmecv-cx); (n = 15).



Source: Rossi BP, et al., 2025.

Table 2 - Median (MED) and range interquartile 1 and 3 (IQ1-3) of the root mean square (RMS) amplitude of each muscle during gait (PRE = beginning of the stance phase; POST = end of the stance phase), both on the concave side (Cv) and the convex side (Cx) in adolescents with IS (n = 15).

GAIT	RMS (μV) (MED; IQ_{1-3})	P
$Long_{PREcv}$	10.3; 6.5 - 13.1	
$Long_{PREcx}$	13.7; 11.9 - 17.7	0.006*
$Long_{POScv}$	13.2; 10.1 - 17.7	
$Long_{POScx}$	9.5; 8.1 - 19.9	0.910
$Ilio_{PREcv}$	8.1; 7.4 - 10.3	
$Ilio_{PREcx}$	9.5; 8.1 - 12.9	0.140
$Ilio_{POScv}$	8.6; 7.7 - 10.6	
$Ilio_{POScx}$	10.6; 7.4 - 12.7	0.496
Gme_{PREcv}	21.9; 17.2 - 31.7	
Gme_{PREcx}	18.2; 12.8 - 35.0	0.307

Source: Rossi BP, et al., 2025.

Cobb Angle

Only Ilio presented a positive correlation with the Cobb angle on the Cx side during the stand-up (PRE phase) (P = 0.003; r = 0.71) and sit-down (POST phase) (P = 0.03; r = 0.55). During gait, no muscle presented a correlation with the Cobb angle.

DISCUSSION

For decades, several studies have described the paravertebral muscles as vital in the IS mechanism (BARBA N, et al., 2021; WANG W, et al. 2022). However, there still seems to be a lack of understanding of how these muscles play out in dynamic tasks (BASSANI T, et al., 2024). Therefore, this study aimed to evaluate the sEMG activation pattern of the Long, Ilio, and Gme muscles in adolescents with IS during the sit-to-stand and gait movements. Such movements were defined due to their clinical relevance to daily life activities.

The asymmetric myoelectric activity observed in this study for the Long muscle only during the standing and sitting movements can be explained in part by the differences in the composition of the muscle fiber types on the Cv and Cx sides (CHEUNG J, et al., 2005; KWOK G, et al., 2015), by the weakness of the muscles on the Cx side and for a possible deficit in their neuromuscular system (MANNION AF, et al., 1998).

Ilio and Gme presented no asymmetry between Cv and Cx sides during the standing and sitting tasks. These results for Ilio and Gme were probably found because this study evaluated small Cobb angles (up to 32º).

Syczewska M, et al. (2012) state that the spinal musculature does not undergo significant changes in minor curvatures. According to Goulart FR and Solé J (1999), a possible explanation could be that Gme does not appear as an agonist in the biomechanics of standing and sitting movements of healthy individuals. Spine erectors referred to as synergists in all phases were not segmented to indicate if the Long or the Ilio is more recruited.

Similarly to the present study, other authors (GAUDREAULT N, et al., 2005; DE OLIVEIRA AS, et al., 2011) reported a symmetric myoelectric activity in the paravertebral muscles for adolescents with IS during isometric contraction of spinal muscles in extension for the Ilio and the Gme muscles. This pattern of asymmetric recruitment (MAHAUDENS P, et al., 2009; CHEUNG J, et al., 2005; KWOK G, et al., 2015; FARAHPOUR N, et al., 2014, 2015; ZETTERBERG C, et al., 1984; LEE SK, et al., 2014) or symmetrical erector muscles (GAUDREAULT N, et al., 2005; DE OLIVEIRA AS et al., 2011) can be explained in part by the differences in the types of tasks and movements (KUO FC, et al., 2011; SCHMID AB, et al., 2010) and by the muscle adjustment before imbalances (FARAHPOUR N, et al., 2014; KUO FC, et al., 2011). These differences in the conclusions from different authors support the need for further studies to develop more quantitative patient assessments and more assertive therapies.

Corroborating the findings of Mahaudens P, et al. (2018), there was an asymmetric myoelectric activity in the recruitment of the Long between the Cv and Cx sides without describing the gait phase or subphase. In this study, all the other muscles analyzed during the gait task did not present differences between the Cv and Cx sides. Syczewska M, et al. (2012) observed that asymmetries during the gait depend on the severity of the scoliotic curvature – usually higher than 40º Cobb – and associated pelvic rotations – generally greater than 60º Cobb. During the gait movement, the erector muscles are not affected severely enough to show the effects of scoliosis on muscle function in smaller curvatures (CHAN YL, et al., 1999; KWOK G, et al., 2015). Additionally, the pelvic muscles, as in the case of Gme, change only with curvatures large enough to rotate the pelvis in the transverse plane (SYCZEWSKA M, et al., 2012).

It was verified that the Gme did not show an asymmetric myoelectric pattern while standing and sitting among adolescents with IS. However, given the importance of this muscle in the stabilization of the transverse plane of the hip (SCHMID AB, et al., 2010), other studies analyzing Gme and pelvic alterations in adolescents should be encouraged.

Another objective of this study was to correlate the sEMG activation of the Long, Ilio, and Gme with the Cobb angle during the sit-to-stand and gait movements. For the standing and sitting tasks, the higher the Cobb angle is, the higher the recruitment of the Ilio muscle, indicating that the greater the severity of the scoliotic curvature, the higher the recruitment of this muscle on the Cx side. It was expected that greater recruitment on the Cx side would lead to lower recruitment on the Cv side as a compensatory mechanism, but this hypothesis was not confirmed. Therefore, it demonstrates that the Ilio recruitment increases by the curve's progression but not as compensation to prevent this progression, as noted by Cheung J, et al. (2005) and Gaudrealt N, et al. (2005) for the erector muscles. The results of non-correlation between the Gme and the Cobb angle during sit-to-stand movements could not be confronted with any other study.

In agreement with the findings of Syczewska M, et al. (2012), there was no correlation between the Cobb angle and the Long, Ilio, and Gme activation during gait. This finding was probably observed due to the mild IS grade of the adolescents under study. Muscle properties alterations and pelvic repositioning seem to be found only in curves higher than 40º Cobb (SYCZEWSKA M, et al., 2012; MAHAUDENS P, et al., 2018) to correct the centre of gravity concerning the midline. The participants of this study presented variations in physical characteristics that may limit the findings. It is suggested that evaluations through sEMG should be encouraged in these individuals before and after rehabilitation protocols and that erector muscles should be targeted for a complete assessment.

CONCLUSION

The study's results suggest an asymmetry in the Long muscle recruitment, greater in the convexity of adolescents with IS, during the sit-to-stand tasks and at the beginning of the stance phase of gait. Besides, in the standing and sitting movements, the Ilio correlates directly with the Cobb angle, which could be one of the relevant indicators for the progression of the scoliotic curve. Therefore, this study suggests that more considerable attention should be given to the treatments of IS in the Long muscles related to the studied movements. Furthermore, such findings may address physiotherapeutic interventions focused on existing muscle imbalance.

ACKNOWLEDGEMENTS AND FINANCIAL SUPPORT

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001, and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq). This research was also supported by Fundação de Amparo à Pesquisa do Estado de Minas Gerais [FAPEMIG process CDS APQ 00230-11] assigned to EJDV and DCF. VHS received funding from the Jane and Aatos Erkko Foundation, the Academy of Finland [decision #349985], and the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme [grant agreement #810377].

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