The Electromyographic Responses of Paraspinal Muscles during Isokinetic Exercise in Adolescents with Idiopathic Scoliosis with A Cobb's Angle Less than Fifty Degrees

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Background: Analysis of electromyographic (EMG) activities in the back during dynamic exercise is needed because more complex loading on the spine is created in comparison with that during static exercise. The purpose of this study is to investigate the difference in bilateral midback and low-back paraspinal muscle (PSM) activities during performance of different resistance isokinetic exercises in healthy subjects and those with scoliosis.

Methods: Forty-one healthy subjects and thirty-three subjects with adolescent idiopathic scoliosis (AIS) were enrolled. An isokinetic back system in combination with quantitative surface EMG was used to evaluate the dominant and non-dominant PSM activities by analyzing the root mean square (RMS) during isokinetic extension and flexion exercise at velocities of 30°/s and 90°/s.

Results: Significantly higher RMS of EMG were found in the dominant medial and lateral PSM of the lumbar region than the non-dominant muscles in the healthy control group and in those with AIS with smaller curves (< 20 degrees) during isokinetic flexion and extension exercises. In AIS patients with larger curves (20 to 50 degrees), shifting of muscle activities from the dominant to the non-dominant side occurred during isokinetic exercises, and the EMG activities of the thoracic muscle were significantly higher on the non-dominant (concave) side than on the dominant (convex) side.

Conclusions: The bilateral PSM do not act symmetrically during isokinetic back exercises. The dominant lumbar PSM supply the major action in healthy subjects and patients with small curve scoliosis. For larger curve scoliosis, compensated muscle activity is needed in the midback when doing resistance exercises. More midback protection may be needed by scoliotic subjects with large curves during resistance exercise.

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Key words: idiopathic scoliosis, isokinetic exercise, quantitative surface electromyography

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Idiopathic scoliosis (IS) is one of the most common constitutive deformities of the spine in children and adolescents. The reported prevalence of this disorder is between 1 and 13.6%.(1,2) Scoliosis in young adolescents can potentially become worse because of continuing epiphyseal growth and imbalance of the paraspinal muscles (PSM), both resulting in biomechanical instability of the spine causing progression of the curve.(3)

Ramirez et al reported 32 percent of IS patients presented with back pain, and there was a significant association with age over fifteen years,(4) skeletal maturity with a Risser sign of 2 or higher, postmenarchal status and history of injury. Studies reported that patients with moderate scoliosis, even those with a Cobb's angle < 35 degrees, still developed respiratory symptoms and impairment in cardiopulmonary function.(5-8)

In healthy subjects, the musculature and complex neuromuscular control system provide trunk stability in a given posture for daily activities and during exercise. The lumbar extensor muscles are required to produce a large internal force to respond to external loads, especially when encountering extension resistance exercise.(9) Biomechanical model study showed antagonistic co-contraction of the trunk muscles was increased to maintain spinal stability in a high risk posture.(10) Granata et al developed a biomechanical model to evaluate the influence of posture on spinal stability, and electromyographic (EMG) activity from the trunk muscles was recorded during static exertion in different trunk flexion and asymmetric postures to compare with model output.(11) The results of that study showed that an increase in the stable spinal load in asymmetric postures was supported by recruitment of antagonistic muscles, meaning greater neuromuscular control is necessary to maintain stability in asymmetric lifting postures in healthy subjects. That study also suggested that spinal stability might improve by increasing the trunk flexion angle, but the spinal load was greater. Failure to respond to an appropriate antagonistic co-contraction may increase the risk of instability and cause further injury to the back.

In the three-dimensional deformity concept of IS, vertebral wedging increases with curve severity in a relatively steady pattern for most patients with scoliosis and the axial rotation mainly increases toward curve convexity with scoliosis severity at the thoracic level, worsening the progression of vertebral body deformities.(12) Chung et al reported that a cutoff point of 1.25 for the EMG ratio of activity on the convex to that on the concave side of the scoliotic curve had a predictive value for progression of 68.9%.(13) More distinction of EMG activities in the bilateral PSM may have a higher risk for progression of the scoliotic curve. Undergoing different forms of weight-bearing activity and exercise on the back may increase the loading on the spine, requiring a greater PSM response to maintain stability. In persons with a moderate to severe scoliotic spine, these exercises may enhance asymmetric PSM activities causing more adverse effects on subsequent changes in the spine and further complications.

Some studies attempted to evaluate the activation amplitude pattern of the PSM in persons with scoliosis and healthy subjects using myoelectric activities during isometric contraction. Patients with curves of more than 25 degrees had significantly larger convex side myoelectric activities in their anterior, lateral and posterior muscles at the lumbar level than healthy subjects.(14,15) No study has reported the myoelectric activity of PSM muscle activity when doing fast and slow back resistance exercises.

We proposed that during isokinetic exercise at different angular velocities, the bilateral back muscles are not contracted symmetrically, and the dominant side has higher EMG activities. The objective of this research is to evaluate the relative activation amplitudes from the dominant and non-dominant PSM of healthy subjects and adolescents with scoliosis while performing trunk isokinetic flexion and extension exercises at different angular velocities. Then, we compared the different presentations of the activation amplitudes among healthy subjects and those with scoliosis.

METHODS

Subjects

This study included a total of 74 adolescents from 11 to 17 years old. Thirty-three had adolescent idiopathic scoliosis (AIS). Twenty-five were girls (the gender ratio was 3.1:1). The average age was 14.7 ± 2.6 years (range from 11 to 17 years). The average Cobb's angle of the major curve was 16.3 ± 9.4 degrees (range from 10 to 50 degrees).

Forty-one volunteers from a local school (average age 14.7 ± 2.8 years, range 11 to 17 years) were chosen as healthy controls (group A). Their age, sex, weight and height were relatively similar to the scoliotic group. They had no backache or history of structure deformities. Exclusion criteria were underlying neurological deficit, history of spine injury, brain injury, poliomyelitis, cerebral palsy, congenital or acquired bone deformities and spine deformities.

The curves were measured by Cobb's method with standing anteroposterior whole-spine radiography. Patients with a Cobb's angle from 10 to < 20 degrees (small curve) were defined as group B, and those with a Cobb's angle from ≧ 20 to 50 degrees (large curve) were defined as group C. All participants were right-hand dominant. The thirty-three patients with AIS enrolled in this study had double curves of right thoracic left lumbar (RTLL) scoliosis, with the apex on the right of the sixth to eighth thoracic vertebrae and on the left of the second to third lumbar vertebrae. Twenty-three AIS patients were enrolled in group B, while ten were enrolled in group C. The average Cobb's angle of the major curve was 11.7 ± 2.7 degrees (range from 10 to < 20 degrees) in group B and 29.3 ± 9.6 degrees (range from ≧ 20 to 50 degrees) in group C. The curve pattern of scoliosis is illustrated in Fig. 1.

At the first evaluation, the participants and their parents received a detailed explanation about this study. All participants provided informed consent with agreement by their parents before their participation. The subjects were well-informed about the testing machine, and were educated to familiarize with the isokinetic trunk flexion and extension exercises. Several sub-maximal exercises were performed in the isokinetic trunk system until they had learned how to do the exercises.

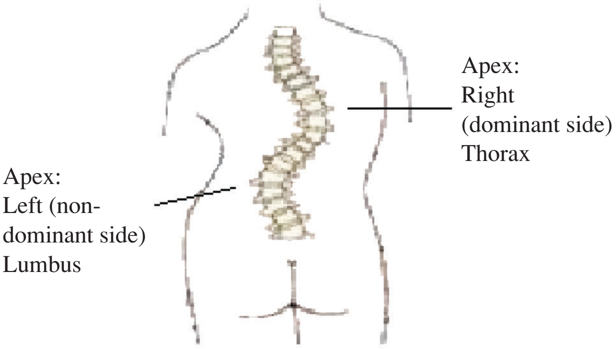

Fig. 1 The curve pattern of scoliosis in this study (right thoracic left lumbar double curve).

Isokinetic exercise protocol

Trunk flexion and extension exercises were both performed on a Cybex isokinetic back system (Cybex Norm, Back System, Cybex international, Inc. Ronkonkoma, NY, U.S.A.). Participants stood on the footplate of the back system with knees fully extended. The adapter of the back system was attached to the dynamometer at a position near the posterior midline of the bilateral superior iliac crest. The body was strapped with a chest fixation pad and then strapped to the back of the back system. Both knees were strapped, and both feet were positioned on the foot plate of the machine, with both hands holding the handle on the chest fixation pad to minimize the influence of trunk flexion and extension. The participants were asked not to use their arms while doing the isokinetic exercises. The mechanical range of motion for trunk flexion and extension exercises was set from 0° to 90° related to the horizontal axis. Before this study commenced, three isokinetic angular velocities, 30°/second, 90°/second and 120°/second, were chosen to represent slow, medium and fast isokinetic exercises. Since most of our subjects (four of seven) could not tolerate speeds faster than 120°/second in the preliminary test, we used only two exercise speeds, 30°/second and 90°/second, to represent isokinetic exercise at low and medium speed.

Electromyography

We collected the surface EMG signal using a 4-channel EMG system (Biopac System, MEC 100, Biopac System Inc, Goleta, CA. U.S.A.). The skin was cleaned with an alcohol swab before attaching the electrodes. The electrodes were 11.4 millimeters in diameter and the distance between two electrodes was 20.0 millimeters. For evaluation of the medial paraspinal muscles (MPS), four recording surface electrodes were placed on both sides of the seventh thoracic vertebrae and both sides of the second lumbar vertebrae at 2 centimeters lateral to the posterior process. The reference electrodes were placed near the recording electrodes. For evaluation of the lateral paraspinal muscles (LPS), electrodes were placed on the same level 4 centimeters lateral to the posterior process.

Experimental protocol

We evaluated the surface EMG signal of the MPS and LPS in the subjects while they were doing isokinetic trunk flexion and extension exercises at different angular velocities. The isokinetic back system was connected to multi-channel quantitative surface electromyography. The data were recorded and synchronized with a computer for analysis.

The EMG signals of the two different muscle groups (MPS and LPS) were analyzed for two different trunk isokinetic exercises (flexion and extension) at two different angular velocities (30°/s and 90°/s) in each subject. Eight measurements were performed. The average of three repeated trials for each exercise was used for statistical analysis.

The protocols of the two evaluations were identical. After a warmup for 10 minutes, the participants performed three repetitions of eccentric contractions at flexion 90°/s and concentric contractions at extension 90°/s, and then the same exercises at flexion 30°/s and extension 30°/s. The participants were asked to perform the exercise as fast and forcefully as possible. A minimum ten-minute rest period was required between two preset velocity trials to prevent fatigue.

EMG activities were assessed on two different days. On the first day, we evaluated MPS activities, and at the same time on the second day, LPS activities were tested. The root mean square (RMS) of the SEMG was calculated.

Statistical analysis

The differences between the baseline characteristics of the participants including age, height, and body weight were analyzed by ANOVA, followed by multiple comparisons for the three groups. The RMS of EMG activities were compared by the Wilcoxon signed-rank test for each of the three groups. We compared the RMS of EMG activities of the dominant and non-dominant thoracic PSM and lumbar PSM by Friedman two-way analysis to identify the most active muscle group during different exercises in each group. The association between the severity of scoliosis and the RMS of EMG activities while performing isokinetic exercise at different angular velocities was determined by Spearman's correlation test. A p value < 0.05 was considered statistically significant. Statistical analysis was performed with SPSS 12.0 for Windows (SPSS Inc., Chicago IL, U.S.A.).

RESULTS

There were no statistically significant differences in gender, age, or body weight and height in groups A, B and C (Table 1).

The RMS of surface EMG activities of the PSM are shown in Figs. 2 and 3. During back muscle concentric and eccentric isokinetic exercises at different angular velocities, the RMS values of the dominant and nondominant thoracic LPS of groups A, B and C showed no significant differences (Fig. 2).

In contrast to the thoracic LPS, the RMS values of the dominant lumbar LPS of the control group (group A) were significantly higher than the non-dominant lumbar LPS at flexion 30°/s, flexion 90°/s, extension 30°/s and extension 90°/s contractions ($p <$ 0.001, 0.001, 0.001, 0.001, respectively) (Fig. 2A). In group B, the RMS value of the dominant lumbar LPS was significantly higher than that of the non-dominant lumbar LPS, but a significant difference was shown only with extension 30°/s isokinetic exercise ($p = 0.003$) (Fig. 2B). There were no significant differences in RMS values for the dominant and non-dominant lumbar LPS of group C (Fig. 2C). For LPS muscle analysis, the maximal RMS values of EMG were found in the dominant lumbar LPS during flexion 30°/s, flexion 90°/s, extension 30°/s and extension 90°/s contractions ($p <$ 0.001, 0.001, 0.001, 0.001, respectively) in groups A and B (Figs. 2A, 2B). In group C, the maximal RMS values were found in the non-dominant lumbar LPS during flexion 90°/s, extension 30°/s and extension 90°/s contractions ($p =$ 0.034, 0.005, 0.009, respectively) (Fig. 2C).

Table 1. Comparisons of Baseline Data between Groups

	Group A (N = 41)	Group B (N = 23)	Group C (N = 10)	p value
Gender (male/female)*	12/29	7/16	1/9	0.44
Age (years) (Mean (SD))†	14.7 (2.8)	14.6 (3.2)	14.9 (1.7	0.95
Body height (cm)†	158.5 (11.1)	156.3 (9.9)	160.9 (5.8)	0.46
Body weight (kg)†	53.6 (14.8)	49.3 (12.5)	49.4 (10.1)	0.41

Values are expressed as mean ± SD; *: Compared by chi-Square test; †: Compared by ANOVA.

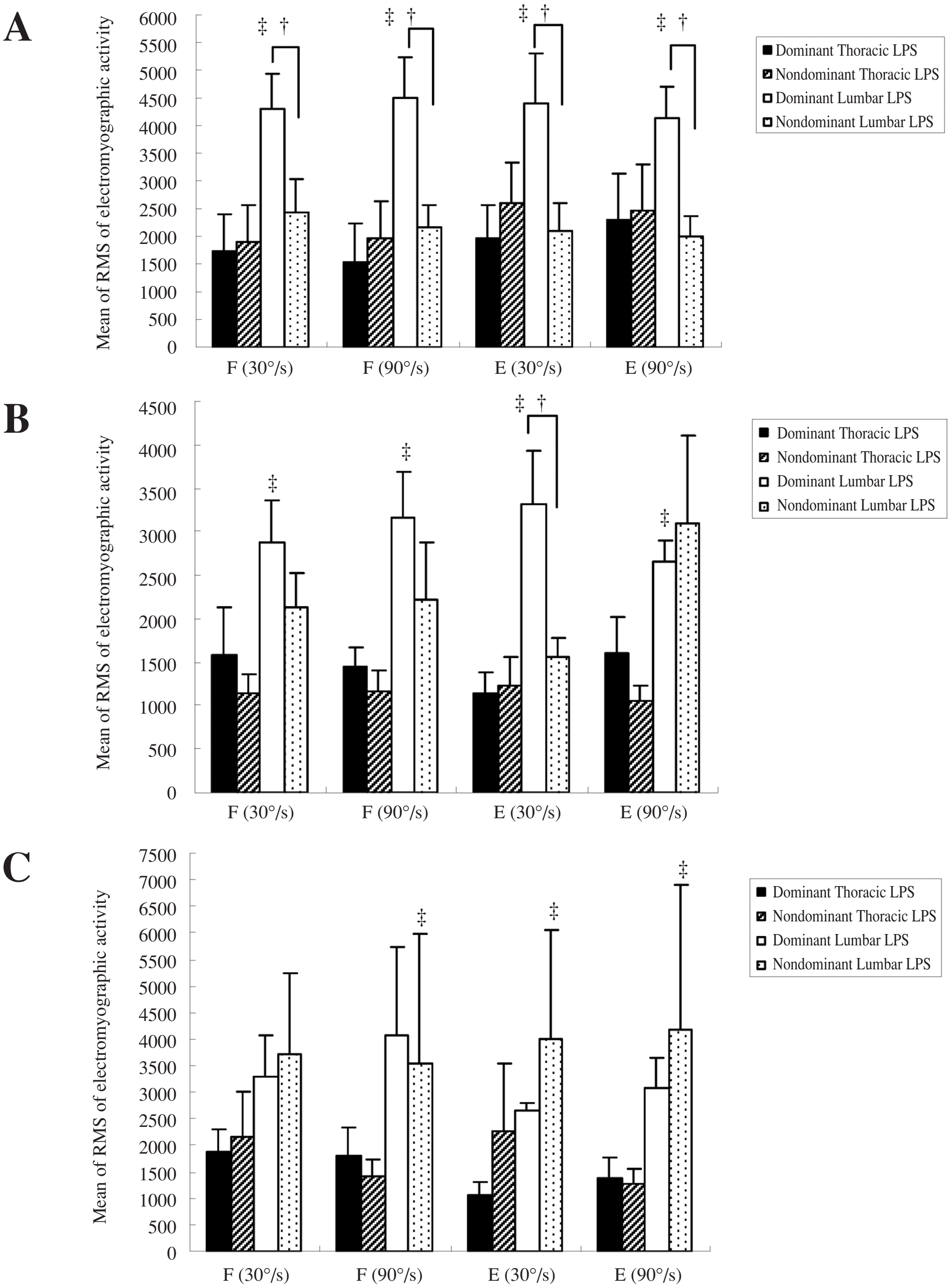

Fig. 2 Comparison of the root mean square of electromyographic activity of the bilateral thoracic and lumbar lateral paraspinal muscles in Group A (A), Group B (B), and Group C (C) for four different isokinetic exercises. Abbreviations used: LPS: lateral paraspinal muscles; F (30°/s): Flexion 30 degrees/second; F (90°/s): Flexion 90 degrees/second; E (30°/s): Extension 30 degrees/second; E (90°/s): Extension 90 degrees/second; Values are expressed as mean ± SEM; *: Compared by Wilcoxon signed-rank test between the bilateral thoracic paraspinal muscles; †: Compared by Wilcoxon signed- rank test between the bilateral lumbar paraspinal muscles; ‡: Compared by Friedman two-way analysis of variance by ranks between the bilateral thoracic and lumbar paraspinal muscles; significance level ($p < 0.05$).

Neither group A nor group B had significantly different RMS values of EMG activities betweem the dominant and non-dominant thoracic MPS during concentric and eccentric isokinetic exercises at 30°/s and 90°/s (Figs. 3A, 3B). In contrast, in group C, the RMS values of the non-dominant MPS were significantly higher than those of the dominant MPS during flexion 90°/s, extension 30°/s and extension 90°/s ($p = 0.047, 0.028, 0.005$, respectively) but no significant differences could be found during flexion 30°/s (Fig. 3C).

The RMS value of the dominant lumbar MPS was significantly higher than the non-dominant lumbar MPS in group A during flexion 30°/s, flexion 90°/s and extension 30°/s ($p < 0.001$, $p = 0.008$, 0.003, respectively) (Fig. 3A). The same significant differences were also found in group B during flexion 90°/s, extension 30°/s and extension 90°/s exercise ($p = 0.004, 0.05, 0.04$, respectively) but not in group C (Figs. 3B, 3C). For MPS muscle analysis, the maximal RMS values of EMG were found in the dominant lumbar MPS during flexion 30°/s, flexion 90°/s, extension 30°/s and extension 90°/s contractions ($p < 0.001, 0.001, 0.001, 0.001$ respectively) in groups A and B (Figs. 3A, 3B). In group C, this was seen in the non-dominant lumbar MPS during flexion 30°/s, flexion 90°/s, extension 30°/s and extension 90°/s contractions ($p = 0.003, 0.022, 0.007, 0.001$, respectively) (Fig. 3C).

The association between the severity of scoliosis and the RMS values in the PSM at different angular velocities of isokinetic exercise were compared with Spearman's correlation test. The severity of scoliosis was position-associated with the RMS value of the non-dominant thoracic paraspinal muscle during flexion 90°/s ($p = 0.04$). No significant association could be found between the dominant thoracic, dominant lumbar and non-dominant lumbar RMS and the severity of scoliosis (Table 2).

DISCUSSION

A review of the literature shows that the cause of idiopathic scoliosis remains unknown, but the majority of cases occur in adolescent populations.(1,2,16,17) EMG studies have determined that muscle imbalance and asymmetry of stretch receptors in the paraspinal muscles of patients with AIS may have an important role in the development and production of the deformity.(13,18) Studies in patients with idiopathic scoliosis showed a shift in fiber distribution from slow to fast exclusively at the concave side of the apex.(19,20) This shift was paralleled by an increased percentage of intermediate type IIC fibers, indicative of fiber transformation, with processes at different levels and different sides along the scoliotic spine related to the severity of the curve of the scoliosis.(18-20)

Many studies have evaluated the PSM activities of scoliosis by surface EMG study.(11,14,15) Most of these studies revealed that EMG activities on the convex side were higher than on the concave side, especially at the apex of the curve and the end-point of the curvature.(13,14) Zoabli et al used magnetic resonance imaging to analyze the volume of the paraspinal muscle and skin fold thickness in patients with AIS.(21) The results of their study showed a large back muscle volume occurred slightly more often on the concave than on the convex side, but there was no significant difference. A larger muscle volume could be present on the convex or concave side. They found the skin fold thickness was always greater on the concave side, especially at the apex region. They suggest that this resulted from compression on the concave side and stretching on the convex side. They postulated that the increased EMG signal on the convex side could have occurred because a shorter distance separated the active muscles from the surface electrodes. Cheung et al suggested that the muscles on the convex side were stronger as an attempt to correct the curvature, and they concluded that this increased the activities of the PSM on the convex side of the scoliotic curvature.(22)

Most previous studies were based on evaluation of the EMG signals of the PSM during isometric exercise, and were unable to represent the condition of the PSM during complex bending activity or heavy weight bearing. Therefore, they cannot reflect the PSM conditions of a scoliosis patient in daily or heavy loading activities. We postulated that in AIS patients, the different muscle fiber compositions of the bilateral PSM, which may be related to different contractility and continuity, lead to the different presentations of surface EMG activities in different kinds of exercise. In our study, we evaluated the EMG signal of the PSM during isokinetic flexion and extension exercises by using a back system with

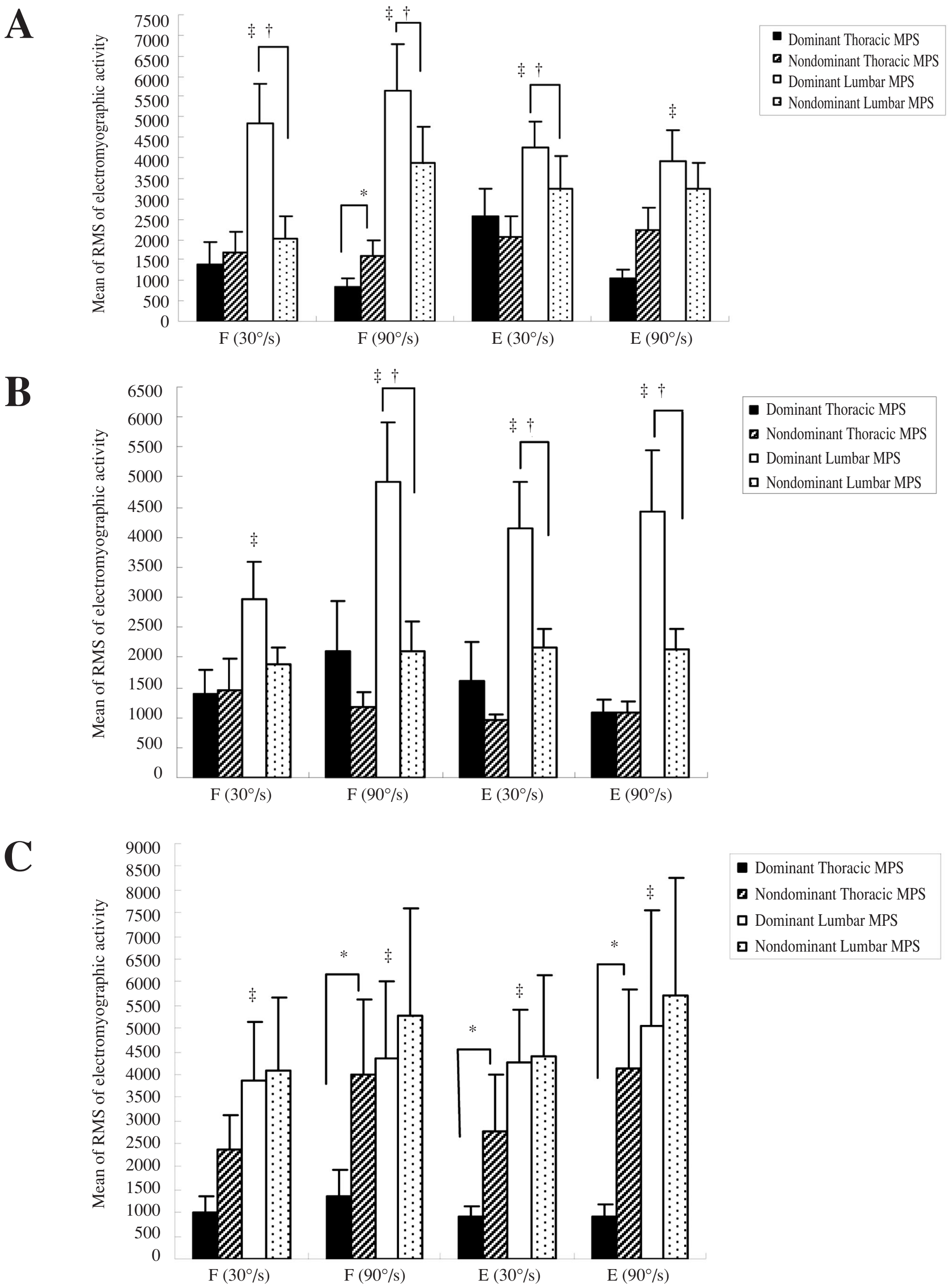

Fig. 3 Comparison of the root mean square of electromyographic activity of the bilateral thoracic and lumbar medial paraspinal muscles in Group A (A), Group B (B), and Group C (C) for four different isokinetic exercises. Abbreviations used: MPS: medial paraspinal muscles; F (30°/s): Flexion 30 degrees/second; F (90°/s): Flexion 90 degrees/second; E (30°/s): Extension 30 degrees/second; E (90°/s): Extension 90 degrees/second; Values are expressed as mean ± SEM; *: Compared by Wilcoxon signed-rank test between the bilateral thoracic paraspinal muscles; †: Compared by Wilcoxon signed- rank test between the bilateral lumbar paraspinal muscles; ‡: Compared by Friedman two-way analysis of variance by ranks between the bilateral thoracic and lumbar paraspinal muscles; significance level ($p < 0.05$).

Table 2. The Association between the Severity of Scoliosis and the Root Mean Square Values of Electromyographic Activity in the Paraspinal Muscles for Four Different Isokinetic Exercises

Angular velocity		Movement direction/Site (n = 33)							
		Dominant				Non-dominant			
		Flexion		Extension		Flexion		Extension	
		T	L	T	L	T	L	T	L
	r	0.06	–0.03	–0.05	–0.14	0.29	0.06	0.34	0.01
30°/Sec	*p* value	0.75	0.87	0.78	0.44	0.11	0.74	0.06	0.97
	95% CI	–0.29~0.40	–0.37~0.32	–0.39~0.30	–0.46~0.21	–0.06~0.58	–0.29~0.40	–0.00~0.61	–0.33~0.35
	r	-0.09	–0.13	–0.14	–0.21	0.36*	-0.15	0.26	–0.05
90°/Sec	*p* value	0.63	0.47	0.45	0.25	0.04	0.42	0.15	0.77
	95% CI	–0.42~0.26	–0.45~0.22	–0.46~0.21	–0.52~0.14	0.02~0.63	–0.47~0.20	–0.09~0.55	–0.39~0.30

Abbreviations: T: Thoracic; L: Lumbar; CI: Confidence Interval; *: $p < 0.05$ by Spearman's correlation test.

isokinetic muscle power evaluation and a trainer system connected to multi-channel quantitative surface electromyography. Isokinetic exercise may trigger more motor units to act together than isometric exercise,(23) so this can create increased EMG signals. This study used two different constant angular velocities as exercise testing tools to observe the different EMG activities with the RMS of the PSM carried from 0- to 90-degrees in trunk flexion and extension exercises. The resistance was higher in 30°/s than in 90°/s, predisposing to different EMG signals.(23,24)

The results of our study revealed that during motion at an angular velocity of 30°/s, the RMS of the EMG signals of the LPS and MPS of the lumbar region were higher on the dominant (concave) side, in both flexion and extension. The same results were obtained during flexion and extension at 90°/s. No statistically significant differences could be found between the dominant (convex) and non-dominant (concave) MPS of the thoracic region during flexion and extension at 30°/s and 90°/s. The results of our study showed that during both fast and slow isokinetic exercise, the muscle activities were not symmetrical in the healthy subjects, and the lumbar PSM the major action occurred on the dominant side. However, there was no significant difference in dominant and non-dominant PSM activities in the thoracic region.

The results of our study revealed that the RMS of the bilateral PSM in patients with AIS with smaller curves (group B) was similar to the results in the control group. The RMS of the MPS in the lumbar region was significantly higher on the dominant (concave) side than the non-dominant (convex) side. Although expected during extension 30°/s exercise, there was no significant difference for both LPS of the lumbar region, but the mean of the RMS of EMG was higher on the dominant (concave) than non-dominant (convex) side. There were no significant differences for the RMS of the dominant (convex) and non-dominant (concave) side MPS and LPS of the thoracic region during flexion or extension exercises at different angular velocities in the small curve scoliotic group (group B) as was seen in the control group (group A). The major muscle action during isokinetic exercise at 30°/s and 90°/s was in the dominant lumbar MPS and LPS. The findings in our study concerning mild scoliosis with small curves (< 20 degrees) are not consistent with previous studies that documented an increase in EMG activities on the convex side of the PSM.(13,15,25) Some authors explained the increased EMG activities as being an effect of increased tension and stress on the convex side during isometric exercise in order to keep the posture in balance.(13,25) Although the age group in our study was similar to those studies, we used a different methodology. Those studies collected adolescents with single right thoracic curves, which may not reflect the problems of muscle activities in double-curve patients. In our study, AIS with small curves had the same PSM contraction pattern as that found in the control group during isokinetic exercise. The dominant lumbar PSM (concave side) had significantly higher EMG activities than the non-dominant (convex side) in both groups (control and small curve scoliosis groups). These results may occur when the deformity is not severe enough to affect trunk balance and the dominant lumbar PSM provides the major action during resistance exercise.

When analyzing data from group C, the RMS of the LPS and MPS in the lumbar region showed no significant differences between the non-dominant and dominant sides, but the mean of the RMS of the non-dominant (convex) side was greater than that of the dominant (concave) side. The RMS of the MPS of the thoracic region was significantly higher on the non-dominant (concave) side than the dominant (convex) side, and it had a significant association with the severity of scoliosis. We determined that the MPS of the lumbar region in scoliosis patients with larger curves still provided the major action, but the dominant effect might be impacted by muscle activities from the convex side and compensated by overaction of the thoracic PSM. Several studies demonstrated that even with symmetrical flexion and extension movements, several back muscles had asymmetrical activities.(9,11,26) In our study of large curve scoliosis, more imbalance in the back muscles with increasing severity of the curvature instigated asymmetric EMG activities in order to keep the center of gravity of the upper part of the body in the midline, thus increasing non-dominant thoracic and lumbar activities. Our findings suggest that the asymmetric PSM activities in AIS may be considered as an imbalance of neural control.

One limitation of this study is that only subjects with scoliosis with a Cobb’s angle less than 50 degrees were enrolled, and we could not analyze the different EMG patterns of the PSM in more severe scoliosis cases. Another limitation is that only slow and medium speed exercises were analyzed in this study, and we did not investigate back muscle activities during fast exercise. Our study only recorded surface EMG activity, and the response of deeper muscles during exercise may have been hidden from detection. Hence, further investigation is necessary to assess PSM activities in severe scoliosis, and the effects on back muscles while exercising at different velocities.

Conclusion

In healthy subjects, the bilateral paraspinal muscles were asymmetrical during isokinetic exercise; the major action was in the muscles on the dominant side. In subjects with small curve scoliosis, the pattern of activities of the back muscles was the same as in healthy subjects.

In subjects with large curve scoliosis, shifting of muscle activities from the lumbar dominant (concave) side to the thoracic side were noted during isokinetic exercises, and the EMG activities of the thoracic muscle were significantly higher on the non-dominant (concave) side than on the dominant (convex) side. This phenomenon suggests that compensated muscle activity may be needed for larger curve scoliosis when doing resistance exercise. We recommend, more midback protection for subjects with scoliosis with large curves when they are doing resistance exercises.

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自發性脊椎側彎角度五十度內之青少年患者於背部等速運動時之脊椎旁肌肌電

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背景： 因爲和靜態運動相比較，動態活動造成更複雜的脊椎負荷，因此分析背肌在動態運動期間的肌電活動是需要的。本篇研究的目的是評估正常受試者及脊椎側彎患者，在執行不同阻力之等速運動時，左右兩側之中背和下背脊椎旁肌的電氣活動。

方法： 本研究收錄 33 位年輕的自發性脊椎側彎患者與 41 位脊椎正常受試者，以聯合多頻道定量表面肌電圖儀及等速肌力評估儀之背肌系統，測量正常受試者與脊椎側彎患者分別於軀幹三十度及九十度之等角速度背肌屈曲及伸展活動時慣用側及非慣用側之脊椎旁肌的肌電活動均方根 (root mean square, RMS) 以進行分析。

結果： 對照組及角度小於二十度之脊椎側彎患者在等角速度屈曲及伸展運動時，其慣用側內側及外側之腰部脊椎旁肌之表面肌電訊號均方根均明顯高於非慣用側。角度於二十至五十度之脊椎側彎患者在進行等角速度伸展及屈曲運動測試時，主要之肌肉活動則自慣用側轉移至非慣用側，且在胸部脊椎旁肌之表面肌電訊號均方根，非慣用側高於慣用側。

結論： 正常人及較小角度彎曲之脊椎側彎患者在等速背肌活動中，左、右脊椎旁肌之肌電活動訊號並不對稱，以慣用側腰部之脊椎旁肌爲主要運動肌群。較大角度彎曲之脊椎側彎患者在進行阻力性活動時，肌肉群活動度則出現了代償性的改變，因此建議較大角度彎曲之脊椎側彎患者於進行阻力性活動時，應使用中背部防護措施。

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關鍵詞： 自發性脊椎側彎，等速運動，量化表面肌電圖

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