TRUNK MUSCLES ACTIVITY OF BRACED SCOLIOSIS PATIENTS

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ABSTRACT

A multi-electrodes electromyographic (EMG) technique was used to investigate the action mechanisms of the Boston brace (BB) system on the scoliotic spine. EMG activity was measured from the trunk muscles of scoliosis patients during four controlled isometric tasks. Measurements were made with and without the brace. Results showed a brace-induced increase of specific trunk muscle groups. The increase activity of these specific muscles can be beneficial for the correction of scoliosis as predicted by simulations of the trunk biomechanics. It thus seems that EMG can be used to acquire knowledge on how scoliosis brace treatment can be clinically effective.

INTRODUCTION

Scoliosis is a three-dimensional deformity of the spine and rib cage which requires surgical correction when the deformity is important. For less severe cases, use of an orthosis such as the BB is prescribed. While the clinical outcomes of the BB treatment are quite known [2], there is a lack of understanding concerning the brace action mechanisms. Since muscles play an important role in the biomechanics of the trunk, EMG could be a useful tool to help understand how the brace can be beneficial to the scoliosis patients. For instance, it is believed that the BB engenders the recruitment of specific muscle groups capable of reducing the magnitude of the scoliosis [1]. Although these muscles have been identified by model simulation studies, there is practically no clinical data supporting the validity of these findings [3,4].

To obtain further insight on this subject, we used a multi-electrodes EMG system to investigate the immediate muscular reaction in response to bracing in scoliosis patients.

MATERIALS AND METHODS

Eleven female adolescent idiopathic scoliosis patients treated with the BB system were studied. The hospital ethics committee approved the protocol and all participants gave their informed consent. EMG signals of trunk muscles were obtained with and without the brace (gain: 5000, bandpass filter: 3-1000 Hz (–6 dB), A/D: 2000 Hz) under 4 controlled tasks. Due to the limited mobility permitted by the brace, isometric tasks were executed using an experimental apparatus allowing the loading of trunk muscles.

As shown in Fig.1, the load was applied horizo n-tally to the ground at the level of the shoulders. This load (12% of body weight) was subsequently applied in the front, left and right side of the patient. The isometric tasks were to: 1) maintain an upright posture, 2) resist a trunk flexion moment, 3) resist a right lateral bending moment and 4) resist a left lateral bending moment. This allowed for different trunk muscle groups to be recruited. To stabilize the lower body and isolate the muscle activities in the area of the trunk, position of the feet and pelvis of the patient was restrained. Data were recorded with and without the BB.

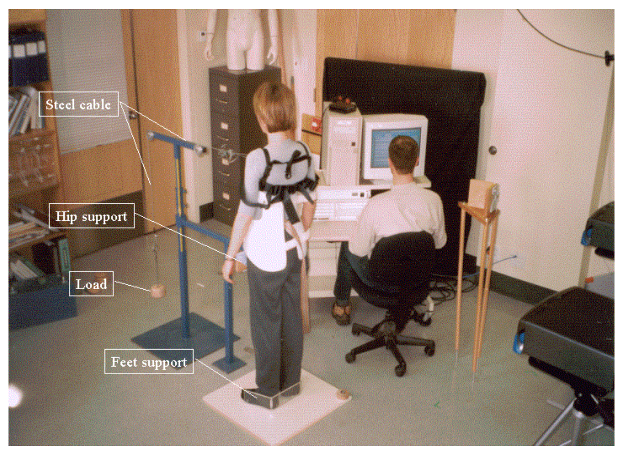

Figure 1: Experimental apparatus for application of isometric load on the trunk muscles.

EMG signals were picked up from 20 different sites of the trunk (Fig.2) with paper thin bipolar surface electrode (NuTab^{TM} Ag/AgCl 10 mm diameter, 20 mm center-to-center). A motion analysis system (Optotrak^{TM}, 3 cameras, 60 Hz sampling) with 3 infrared markers was used to evaluate the magnitude of trunk movements that could have been induced during the execution of the tasks. A thermistor was placed between the skin and the brace to measure temperature around the EMG recording sites. ANOVA tests were conducted with $p<0.05$.

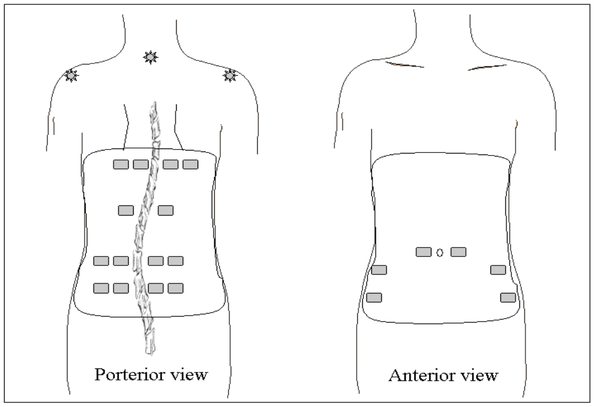

Figure 2: In the frontal plane, a scoliotic spine is usually characterized by two curves: one at the thoracic and the other at the lumbar level. Electrodes (rectangles) are placed near the apices of these deviations. Infrared markers (stars) at the shoulder levels are used to measure trunk motions during the tasks. An outline of the brace is presented.

RESULTS

In all tasks, the 11 subjects maintained their trunk in the initial position as all trunk movements were within 13 mm. At the individual level, a significant brace-induced increase in back muscles EMG activity was observed in 93% of the observations (43% significant). Significant EMG ratios for similar braced/unbraced conditions ranged from 1.28 to 2.34 for back muscles.

At the group level, a significant augmentation of the back muscles EMG activity was measured for 3 of the 4 tasks (upright posture, right and left lateral bending moment). Significant mean EMG ratios for braced/unbraced conditions ranged from 1.49 to 1.61 for back muscles among the tasks (Table 1). In none of these analysis (group and individual), a significant effect of the BB on abdominal muscles was observed.

When specific muscular regions were analyzed, stronger increases were measured from muscles spanning the convex side of the lumbar curve. With a room temperature of 24.5±1.3 °C, mean temperature measured between the brace and the skin was 33.6±1.3 °C.

DISCUSSION

Our results suggest that the BB can stimulates the activity of back muscles. Such action is more important for the muscular region on the convex side of the lumbar curve. This is a region of the trunk that has been proposed by a computer simulated model study as the most likely to have a corrective effect on the scoliosis. RMS values of our EMG signals are however generally small. This may be due to a too small charge (12% of bodyweight). Also, the mean temperature increase of 9°C when the subjects wore their BB also contributed to lower the amplitude signal. Additional studies should then be conducted to support the validity of these preliminary findings.

Table 1: Group EMG root mean square (RMS) values for each task. Ratio with a * is statistically significant.

	EMG RMS (□V)		
Task	Unbraced	Braced	Braced/ Unbraced
Upright posture	1.41±0.17	2.26±0.40	1.60*
Flexion bend	3.54±0.80	4.40±1.30	1.24
Right lateral bend	1.67±0.31	2.49±0.72	1.49*
Left lateral bend	1.83±0.26	2.94±0.66	1.61*

CONCLUSION

EMG appears to be a useful tool to investigate the action mechanisms of non-operative treatment of scoliosis. For instance, the use of the BB seems to induce a muscular activity which could be beneficial for the correction of scoliosis.

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