TRUNK STIFFNESS IMPROVEMENT BY PHYSICAL THERAPY/EXERCISE DURING UNSTABLE SITTING

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INTRODUCTION

Many studies have examined the role of physical therapy (PT) and/or exercise on prevention, rehabilitation and recurrence rate of low back pain (LBP). One of the aims of PT exercises is to modify the neuromuscular control of spinal stability. However, effect of PT exercises on neuromuscular control of the trunk is still unclear.

Research demonstrates that seated sway can be used to identify differences in neuromuscular control between patients with LBP and asymptomatic controls [1]. Therefore, the purpose of this present study was to test whether PT exercises influences neuromuscular control of stability by assessment of seated sway.

METHOD

A control group of twenty-seven subjects and a PT-exercise group of twenty-eight subjects with no previous history of low back pain were tested. Subjects in the PT-exercise group participated in a program consisting of 8 PT exercises every day for 12 weeks. Both control and PT-exercise subjects performed a seated sway test at baseline (week 0) and once every 4 weeks for an interval for 12 weeks. To measure trunk sway, each subject maintained an upright seated posture on a flat platform. They sat with thighs resting horizontally on the platform and knee flexed 90^0 hanging over the edge of the platform. Leg and foot supports were provided to prevent any lower-limb movement. Subjects were required to sit quietly for 90 seconds with a barbell of 0% and 30% of body weight on their shoulders. Trunk sway was recorded at 1000 Hz from a force plate underneath the seat/platform and filtered at 10 Hz using a fourth order Butterworth digital filter.

The center of pressure trajectories were calculated from the force and moment data. Analysis included mean sway frequency in anterior/posterior and lateral directions, a total CoP path length traveled per second, and 95% confidence ellipse area of COP.

RESULTS AND DISCUSSION

There was no significant difference in performance between the groups at initial assessment. After 12 weeks of PT the PT-exercise group had smaller ellipse area but longer path length (Table 1). This indicates that the PT-exercise group moved more but constrained the movement within a smaller area. This suggests possible differences in effective trunk stiffness between groups. To verify this, we created a mechanical inverted pendulum held upright by steel springs stretched from the pendulum to its base. When disturbed the pendulum-spring system would oscillate and COP was recorded. Using a stiff spring the ellipse area was smaller but path length was longer than when using a more compliant spring. This was because the system with greater stiffness oscillated at a higher frequency than a system of less stiffness (Figure 1). Similarly, mean sway frequency of the PT-exercise group was greater than in the control group ($p < 0.0001$ anterior/posterior only).

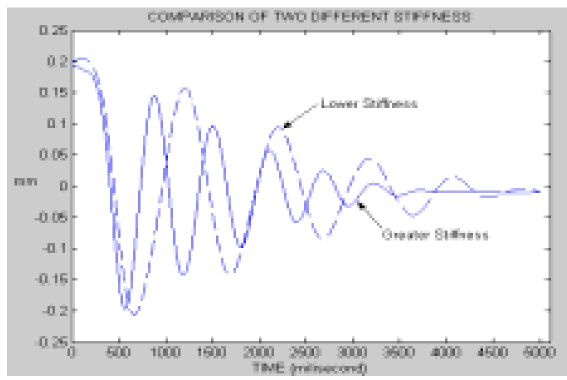

Figure 1: CoP displacements from inverted pendulum with springs of two different stiffness.

CONCLUSION

Following a 12 week program of PT exercise the postural control of the trunk demonstrated characteristics consisted with increased trunk stiffness. Results suggest PT-exercises contribute to improved neuromuscular control of stability. Further research is necessary to identify specific neuromuscular contributions to spinal stability and the factors that influence them.

REFERENCES

1. Radebold, et al.. *Spine* **26**, 724-730, 2001.

Research Support: CDC NIOSH R01 OH07352-01

Table 1, Mean (standard deviation) ellipse area and path length of the seated sway center of pressure (COP) movement while holding a barbell on the shoulders with 0% and 30% of body weight.

VARIABLE	GROUP	LOAD^A		GENDER^B		TOTAL^C
		0 %	30 %	MALE	FEMALE	
Ellipse Area (mm^2)	CONTROL	20.08 (14.68)	48.39 (29.69)	30.05 (23.72)	39.35 (30.57)	34.23 (27.32)
	EXERCISE	13.23 (7.19)	23.02 (11.06)	17.92 (9.89)	18.39 (11.37)	18.12 (10.52)
Path Length (mm/s)	CONTROL	9.58 (2.33)	10.42 (2.56)	9.50 (2.53)	10.55 (2.32)	1.00 (2.48)
	EXERCISE	13.02 (3.57)	13.84 (4.27)	11.95 (3.31)	14.90 (3.99)	13.43 (3.94)

A: Load was significant at $p < 0.0001$ for EA and $p < 0.006$ for PATH.
B: Gender was significant at $p < 0.005$ only for PATH.
C: Total EA and PATH between groups were significant at $p < 0.001$ and $p < 0.001$, respectively.