The Effect of Trunk Muscle Fatigue on Posturography Limits of Stability Measures

D. Scott Davis, PT, MsPT, EdD, Carlin Biederbeck, PT, DPT, Kathryn Clarke, DPT, Samuel Smith, DPT

Marshall University School of Physical Therapy

Introduction

- LBP second most common cause of disability in the US among adults[1]
- CLBP = pain >3 months
- Estimated 149 million workdays lost per year to LBP[1] , increasing prevalence over 14 years
- Higher utilization of health care services[1]
- Opioids commonly prescribed[3]
- Optimal integration of postural control, motor planning, and activation of local muscle stability and intrinsic control needed for effective performance of ADLs
- Previous studies suggest muscle fatigue alters proprioceptive input, thus altering muscle and strategy recruitment to control posture and optimize motor control[4]
- Impairments in proprioception may be one cause for balance impairments in patients with CLBP[5]

- Optimal integration of postural control, motor planning, and activation of local muscle stability and intrinsic control needed for effective performance of ADLs
- Previous studies suggest muscle fatigue alters proprioceptive input, thus altering muscle and strategy recruitment to control posture and optimize motor control[4]
- Impairments in proprioception may be one cause for balance impairments in patients with CLBP[5]
- Optimal integration of postural control, motor planning, and activation of local muscle stability and intrinsic control needed for effective performance of ADLs
- Previous studies suggest muscle fatigue alters proprioceptive input, thus altering muscle and strategy recruitment to control posture and optimize motor control[4]
- Impairments in proprioception may be one cause for balance impairments in patients with CLBP[5]

Materials and Methods

29 participants (16 M; 13 F) with a mean age 24.7 ±1.5 years.
Practice and pre/post computerized dynamic posturography (Bertec, Columbus, Ohio)
Performed 3 exercises/maneuvers in randomized order x 5 reps or until fatigue

- Side-bridge- 60 sec
- Sorenson- 90 sec
- Abdominal curl up- 120 sec

Paired t-tests were performed to analyze pre- and post-test differences in RT, MVL, MXE, and DCL in all eight directions

Biering-Sorenson

Posturography

Results

Direction and movement element that was statistically significant from pre-test to post-test following trunk muscle fatigue exercises.

We can conclude that movement velocity was highly affected; being significant in 6 out of 8 directions.

Test	Pre-test Mean	Post-test Mean	P value
F-RT	0.83655	0.90345	0.0457
F-MVL	9.22931	7.71448	0.0072
RF-MVL	13.379	11.7062	0.016
R-MVL	13.0217	11.5976	0.0043
R-DCL	86.0397	88.07614	0.018
RB-MVL	8.92759	7.79414	0.0421
LB-MVL	10.0755	9.14276	0.0404
LF-RT	0.80172	0.8869	0.0072
LF-MVL	13.1572	11.4686	0.0023

Test	Pre-test Mean	Post-test Mean	P value
RF-MXE	111.604	104.267	0.0573
R-RT	0.78345	0.8369	0.0582
RB-DCL	65.9007	71.04138	0.0506

This set of data collection was very close to reaching statistical significance between pre-test and post-test measures; it is very possible these measures would reach statistical significance with a larger sample size.

Conclusion

- Posturography LoS, especially reaction time and movement velocity can be negatively affected via trunk muscle fatigue.
- Future research: examine the effects of trunk muscle endurance training on posturography LoS in those with LBP.

Clinical Relevance

- Better understanding of the role that trunk muscle fatigue can have on human movement can aide PTs in both assessment of movement in those with CLBP, and intervention selection to mitigate fatigue, reduce pain, restore purposeful functional movement, and enhance activity participation.
- Further research may help PTs understand and quantify the human movement system better, thus decreasing dependence on alternative treatments like opioid medications.

References

1. Freburger JK, Holmes GM, Agans RP, et al. The rising prevalence of chronic low back pain. *Arch of Intern Med.* 2009;169(3):251-258.
2. Andersson GBJ. Epidemiological features of chronic low-back pain. *The Lancet.* 1999;354(9178):581-585.
3. Deyo RA, Von Korff M, Duhrkoop D. Opioids for low back pain. *BMJ : Br Med J.* 2015;350.
4. Allen TJ, Proske U. Effect of muscle fatigue on the sense of limb position and movement. *Exper Brain Res.* 2006;170(1):30-38.
5. della Volpe R, Popa T, Ginanneschi F, Spidalieri R, Mazzocchio R, Rossi A. Changes in coordination of postural control during dynamic stance in chronic low back pain patients. *Gait Posture.* 2006;24(3):349-355.
6. Mientjes MIV, Frank JS. Balance in chronic low back pain patients compared to healthy people under various conditions in upright standing. *Clin Biomech.* 1999;14(10):710-716.
7. Johanson E, Brumagne S, Janssens L, Pijnenburg M, Claeys K, Pääsuke M. The effect of acute back muscle fatigue on postural control strategy in people with and without recurrent low back pain. *Eur Spine J.* 2011;20(12):2152-2159.
8. Brumagne S, Cordo P, Lysens R, Verschueren S, Swinnen S. The Role of Paraspinal Muscle Spindles in Lumbosacral Position Sense in Individuals With and Without Low Back Pain. *Spine.* 2000;25(8):989-994.
9. McGill S, Childs A, Liebenson C. Endurance times for low back stabilization exercises*:* Clinical targets for testing and training from a normal database. *Arch Phys Med Rehabil.* Vol 801999.
10. Youdas JW, Guck BR, Hebrink RC, Rugotzke JD, Madson TJ, Hollman JH. An Electromyographic Analysis of the Ab-Slide Exercise, Abdominal Crunch, Supine Double Leg Thrust, and Side Bridge in Healthy Young Adults: Implications for Rehabilitation Professionals. *J Strength Cond Res.* 2008;22(6):1939-1946.
11. Electromyographic Analysis of Core Trunk, Hip, and Thigh Muscles During 9 Rehabilitation Exercises. *J Orthop Sports Phys Ther.* 2007;37(12):754-762.
12. McGill SM. Low back exercises: evidence for improving exercise regimens. *Phys Ther.* 1998;78(7):754-765.
13. Interrater Reliability of Six Tests of Trunk Muscle Function and Endurance. *J Orthop Sports Phys Ther.* 1997;26(4):200-208.
14. Shirado O, Ito T, Kaneda K, Strax TE. Electromyographic analysis of four techniques for isometric trunk muscle exercises. *Arch Phys Med Rehabil.* 1995;76(3):225-229.
15. Miller MI, Medeiros JM. Recruitment of Internal Oblique and Transversus Abdominis Muscles During the Eccentric Phase of the Curl-up Exercise. *Phys Ther.* 1987;67(8):1213-1217.
16. Demoulin C, Boyer M, Duchateau J, et al. Is the Sørensen test valid to assess muscle fatigue of the trunk extensor muscles? *J Back Musculoskelet Rehabil.* Vol 292015.
17. Champagne A, Descarreaux M, Lafond D. Comparison Between Elderly and Young Males' Lumbopelvic Extensor Muscle Endurance Assessed During a Clinical Isometric Back Extension Test. *J Manip Physiol Ther.* 2009;32(7):521-526.