POSTURAL CONTROL STRATEGIES DURING PROLONGED STANDING: IS THERE A RELATIONSHIP WITH LOW BACK DISCOMFORT?

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INTRODUCTION

Static postures such as prolonged standing have been associated with development of low back discomfort in the workplace (MacFarlane et al. 1997). Factors such as the number of shifts in the antero-posterior centre of pressure (CoP), and gluteus medius (GM) muscle activity, have shown promise in predicting development of low back discomfort in individuals during prolonged standing (Gregory & Callaghan 2007).

Differences in postural responses to a balance challenge have also been observed in people with and without low back pain. People with low back pain were found to have a decreased use of hip strategy for balance recovery in response to an anterior-posterior balance challenge (Mok et al. 2004). Winter has proposed a load-unload mechanism at the hip abductors as a 'hip strategy' for control of medio-lateral CoP (CoP_{M-L}) in normal individuals during unperturbed, quiet standing (Winter DA 1996). Use of this 'hip strategy' mechanism for CoP_{M-L} control has not been investigated during occupational standing or in those with low back discomfort exacerbated by prolonged standing.

The purpose of this work was to investigate differences in motor control strategies between groups with and without low back discomfort during prolonged standing while performing simulated occupational tasks. A second purpose was to determine whether identification of individuals who would develop low back discomfort during prolonged standing could be accomplished based upon their muscle coordination patterns.

It was expected that use of a load-unload 'hip strategy' would be seen in all participants for CoP_{M-L} control during prolonged standing. A second hypothesis was that there would be differences in trunk and hip muscle coordination patterns between groups. It was expected that these differences would be sufficient to enable separation of subjects into discomfort and non-discomfort groups prior to viewing their discomfort ratings.

METHODS

Fifteen participants stood for two hours in a constrained area while performing four different occupational tasks. Participants were required to have no history of low back pain during the previous 12 months. Participants rated their level of low back discomfort on a visual analog scale (VAS) every fifteen minutes. Ten channels of continuous electromyography (EMG) were collected from bilateral trunk and GM muscles. Force plate measurements were used to determine CoP_{M-L}.

Cross-correlation analyses were used to quantify the common signal and phase relationship between EMG signals to provide muscle coordination information. Cross-correlations between muscle activation and CoP_{M-L} migration were also used as a measure of CoP_{M-L} control.

RESULTS AND DISCUSSION

Eight of the fifteen participants reported low back discomfort with prolonged standing during the study protocol. Participants were clearly separated (one-tailed t-test p = 0.00001) based upon their VAS scores; low back discomfort (41.4 ± 5.16) and non-low back discomfort (7.0 ± 2.39).

All participants demonstrated the load-unload mechanism at the hip for CoP_{M-L} control as shown by strong cross correlations of GM activation and CoP_{M-L} movement to the ipsilateral side. There was also some evidence of a similar mechanism at the trunk, shown by correlations of left and right lumbar erector spinae (LLES, RLES) muscle activation with contralateral CoP_{M-L} movement (Figure 1).

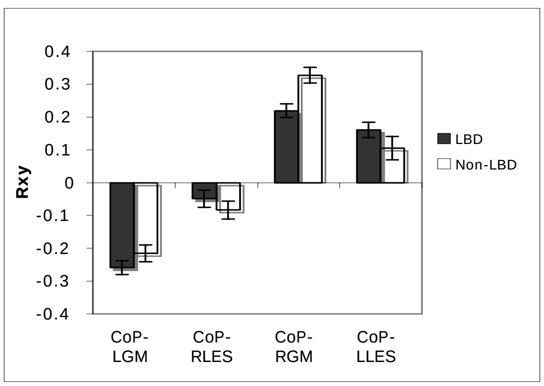

Figure 1: Both groups demonstrated load-unload mechanism for CoP_{M-L} control (CoP + Right)

Participants with low back discomfort had stronger co-activation of bilateral GM muscles than the non-low back discomfort group (one-tailed t-test, p = 0.047). Both groups had similar co-activation of LLES and RLES muscles (Figure 2).

Separation of participants into groups prior to viewing VAS scores was successfully done in 12 of the 15 cases based on the single factor of presence of co-contraction of left and right GM muscles. All of the participants in the low back discomfort group (n=8) were correctly predicted based on this factor.

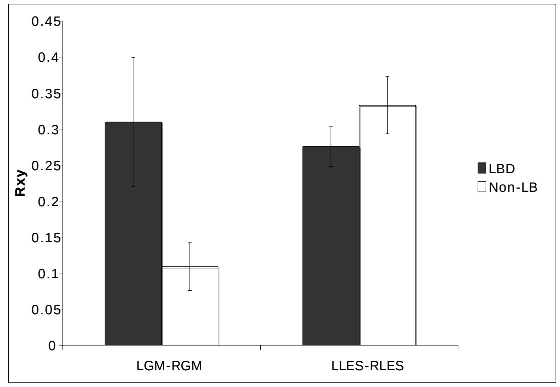

Figure 2: Co-activation of bilateral GM muscles was greater in the LBD group (p=0.047).

SUMMARY/CONCLUSIONS

The findings suggest an apparent increase in co-activation at the hip in individuals with increased low back discomfort when exposed to a prolonged standing task. This factor appears to be a useful predictive variable in identifying which individuals will develop low back discomfort with standing.

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