INTRODUCTION

Falls are a risk factor for both low back injury in working aged adults and vertebral fractures in the elderly. Slips and falls have been found to be associated with low back injuries in studies of injury rates in industry (Bigos, 1986, Manning, 1984, Manning, 1981). Studies have also shown that falls play a role in the etiology of age-related vertebral fractures (Myers, 1997, Cooper, 1992).

Trunk muscle activation during a fall is not well understood. In particular, there has been little research on how falls in different directions may influence trunk muscle activation. Principal component analysis facilitates examination of overall patterns in data such as electromyographic data. In this study, principal component analysis was used to examine the influence of fall direction on lumbar erector spinae (ES) muscle activation in order to be able to understand some of the factors that influence trunk muscle activation during descent.

METHODS

18 subjects (9 male and 9 female) between 19 and 34 yrs old were tested with the approval of the human subjects committee at the University of Kansas. 8 surface electromyographic (EMG) sensors (Delsys, Boston, MA) were used to assess the trunk muscle groups (ES/RA/IO/EO). Data from these sensors was collected at 1500 Hz, filtered to remove electrical noise, rectified and integrated with a Hanning, 100 point, window filter. Pelvis motion was also collected at 100Hz with 4 electromagnetic sensors located around the subject’s pelvis (Ascension, Burlington, VT).

To analyze the muscle activation in the trunk due to falls, a slipping fall was created. A subject stood on a platform as it moved out from under the subject causing the subject to fall onto a soft padded mat. Although falls are commonly associated with gait, this approach removes influences of gait and allows direction to be controlled. Subjects were instructed to remain motionless on the platform and avoid attempting to maintain balance once the slider began moving. Subjects completed 4 block-randomized trials facing 8 directions on the slider representing falls in every 45° orientation from the anterior direction.

The data was examined between platform release and impact on level ground. Trials were removed if the power spectrum and the
raw EMG signal indicated a loss of the sensor during collection. Principal component analysis (PCA) was used to examine the integrated EMG data. The data was rotated from the parameter space to orthogonal planes through the use of eigenvectors of the covariance matrix. This allowed reduction while maintaining account for a high percent of the within data variability.

RESULTS AND DISCUSSION

The 958 PCA modes for the erector spinae muscle groups could be reduced while still explaining a high percentage of the within data variance. Examining the first 5 and 10 PCA modes explained 80% and 95% of the variability. PCA 1 described 29.7% of the variance with a distinct activation at 550ms. PCA 2 described 20.5% of the variance with a peak at 350-400ms. PCA 3 described 16.7% of the variance with a distinct activation peak at 190ms.

Examination of PCA 3 demonstrated the earliest, reflex-like response followed by a preparatory response for impact. This mode was influenced by fall direction (Figure 3) with increased activation of the response in the right ES with left lateral falls and in the left ES with right lateral falls.

REFERENCES


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