A PARADIGM TO ASSESS ELECTROMYOGRAPHIC AND KINEMATIC RESPONSES DURING ANTEROPOSTERIOR SURFACE TRANSLATIONS IN SITTING FOLLOWING WHIPLASH INJURIES

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INTRODUCTION

Support surface perturbations are used in research to study the postural control system in humans. In standing healthy subjects, appropriate movement patterns and muscle actions are generated by the central nervous system to restore the projection of the body's center of mass (COM) within the base of support following multidirectional surface translations [1]. Similar studies have been done in sitting [2]. Persons with whiplash associated disorders (WAD) display clinical manifestations resulting from neck trauma. A protocol using low-intensity support surface translations could also be used to evaluate the integrity of the postural control system of WAD individuals [3]. The goal of this study was to identify a low-intensity surface translation characterized by stereotypical postural responses in healthy sitting subjects, with a long-term goal of administrating this protocol to WAD individuals.

METHODS

Healthy subjects (N = 3) sat on a chair fixed on a moveable support surface which was servo-controlled by electro-hydraulic actuators. Pilot tests were initially performed to identify the weakest translational perturbation that provoked stereotypical postural responses. Subjects were then submitted to a randomized sequence of 15 perturbation trials at the identified threshold intensity, with 5 forward translations, 5 backward translations and 5 unperturbed trials. Electromyography (EMG) of eight trunk and neck muscles was recorded bilaterally using a system of bipolar surface electrodes (Noraxon©). Reflective markers were fixed on the subject's head, trunk and arms and their position was recorded using a 6-camera high-resolution passive motion capture system (VICON©). EMG onset was identified when the signal surpassed two standard deviations above the mean of the baseline signal. EMG amplitude was determined by calculating the root mean square (RMS) values over 50 ms intervals. The position of the head, arms and trunk center of mass (HATCOM) was determined using marker coordinates and anthropometric data. The onsets of platform, head and trunk, and HATCOM displacements were identified when their velocities surpassed 5 % of maximum value.

RESULTS AND DISCUSSION

The weakest perturbation that elicited stereotypical muscle and kinematic responses was a support surface translation of 15 cm in 500 ms. For forward perturbations, neck and trunk flexors were activated first (150-250 ms after platform onset), followed by the extensors (600-650 ms). For backward perturbations, extensors were activated first (100-250 ms after platform onset), followed by flexors (450-600 ms). In both directions, flexors were activated for a shorter period as compared to extensors. Trunk and head segment onsets occurred 0-220 ms and 100-500 ms after platform onset, respectively. Trunk and head angular displacements ranged from 2 to 12 degrees, with head movement about 3 degrees smaller than trunk movement. HATCOM began moving 0-100 ms after platform onset. HATCOM stabilised within 2 seconds after overshooting its final position.

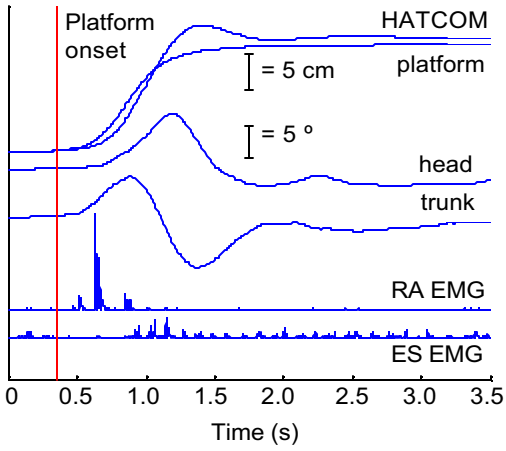

Figure 1: Kinematic and muscle responses to a forward support surface perturbation in a typical subject. RA EMG: left rectus abdominis; ES EMG: left erector spinae.

Our results show that in healthy subjects, the selected translations elicited stereotypical muscular and kinematic responses. At this threshold perturbation, the muscular response pattern is such that muscles stretched due to segmental displacement are activated first, as was shown in other studies using higher intensity perturbations [1-2]. We predict that when submitted to this protocol, WAD individuals will display a variety of inappropriate postural responses which may be caused by deficits at the musculoskeletal or proprioceptive receptor levels associated with their WAD [3].

CONCLUSIONS

Pilot studies were done to identify a low-intensity perturbation that provoked stereotypical postural responses in healthy subjects. This protocol could be used to assess the integrity of the postural control system in WAD individuals.

REFERENCES

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