EFFECTS OF SMOOTH VS "PRICKLY" SURFACE CONDITIONS ON TILTBOARD PERFORMANCE

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INTRODUCTION

The somatosensory system, along with vestibular, visual, and proprioceptive functions, coordinates with neuromuscular systems to maintain postural stability. Investigations of somatosensory influence have often involved comparisons of diminished and normal function [1-3]. These efforts have demonstrated that compromised somatosensory function is associated with reduced postural stability. Such assessments have commonly involved measurements obtained during static standing, or with imposed perturbations. Neither approach, however, evaluates balance capacity or mechanisms associated with passively unstable surfaces.

The present study investigated the effects of a "prickly" standing surface versus a smooth surface on the performance of a tiltboard balance task. A basic tiltboard is a flat circular standing platform with a solid hemisphere attached to it. The addition of a prickly texture on the surface of a tiltboard was intended to enhance plantar surface sensation. The use of a tiltboard was intended to provide a passively unstable surface.

METHODS

Thirteen healthy subjects (8 males, 5 females), with mean height and weight of 176±8 cm and 71±10 kg, participated in this study, Each individual signed an informed consent form that approved by this institution's IRB. Each subject was provided an opportunity to "warm up" with a tiltboard prior to testing. Three reflective markers were placed at 90° intervals at the edges of the tiltboard. These markers represented right, left, and rear edges. Body markers were placed in a Helen Hayes arrangement, and surface EMG electrodes were also placed bilaterally over the gastroc/soleus, tibialis anterior, quadriceps, and hamstring groups.

For each tiltboard balancing trial, feet were positioned, such that the dorsal crease at the tibial/midfoot junction was aligned along the diameter line between the right and left tiltboard markers. For each trial the subject was instructed to maintain the tiltboard as stable as possible for an extended duration, while marker spatial coordinates were obtained at 100 Hz, with a Hawk Motion Tracking System (Motion Analysis Corp.). This duration was intended to be 35 seconds for all subjects; however, three subjects were tested with 20 second durations, and one individual performed 25 second trials. The 20 second trials were also performed without placement of body reflective markers or surface electrodes. A random draw determined whether the first trial would be performed with a "prickly" or smooth surfaced tiltboard. The second trial was then performed with the remaining surface. Another random draw then determined the order of the third and fourth trials.

Data processing has focused, to this point, on results obtained from the tiltboard reflective markers. These marker coordinate trajectories were used to determine tilt angle magnitude, and tilt direction (relative to an anterior/posterior axis) for each sampling interval. Tilt angle means and standard deviations were determined for each trial, and values from prickly and smooth surface trials were compared, using ANOVAs, to determine effects of tiltboard surface type. Plots of tilt angle magnitude vs. tilt direction were more qualitatively evaluated to assess preferred balancing orientations. EMG evaluation was intended to assess muscle activity durations.

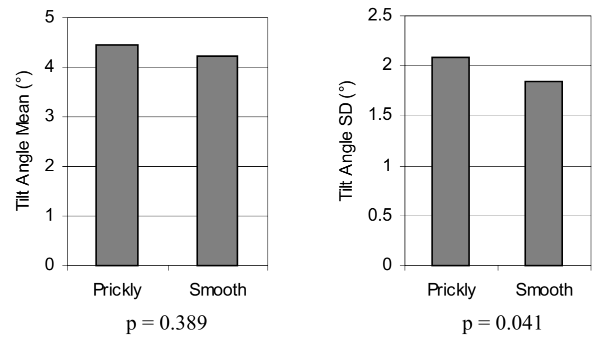

Figure 1: Mean & SD of tilt angle magnitude for prickly and smooth tiltboard surfaces

RESULTS AND DISCUSSION

Tiltboard surface type did not have a statistically significant effect on tilt angle magnitude mean values ($p = 0.389$), while standard deviations of tilt angle magnitudes were found to be significantly larger for the prickly surface ($p=0.041$). This result suggested that balance performance was poorer with the prickly surface, although this surface was intended to intensify plantar surface somatosensory input. This finding seems somewhat contrary to some previous reports that demonstrated improved balance performance with better plantar surface sensation. It was noted, however, that such improved performance was generally associated with more static balance tasks. While Horak [2] reported that healthy vs neuropathic balance differences were mitigated when sway referencing was introduced, neither the effects of an intervention directed towards intensifying somatosensory input, nor the influence of an inherently unstable surface was considered.

Analyses of tilt angle magnitudes vs tilt orientations, and of EMG recordings are more preliminary at this time. Tilt magnitude vs tilt orientation findings, however, suggest that anterior/posterior or medial/lateral tilt orientations are more prevalent during tiltboard balance tasks. EMG results indicate little, if any, periods of inactivity of lower extremity muscles.

REFERENCES

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