THE USE OF AN ACCELEROMETER TO DETERMINE VESTIBULOSPINAL FUNCTION: THE NIH TOOLBOX PROJECT

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INTRODUCTION

The overall goal of this project was to develop a tool to be used by non-specialty trained personnel to quantify standing balance, particularly as it relates to vestibulospinal function. Accelerometers may be able to be used across the life span to record sway under varying sensory conditions [1]. In addition, recent evidence suggests that accelerometers can be used to identify older adults who are at risk for falling [2]. Our goal in this pilot study was to determine if an accelerometer can accurately record postural sway during standing for healthy young adults. This project is part of a larger effort (the NIH Toolbox Project) to develop an inexpensive system that can help investigators determine if the vestibular system is functioning properly.

METHODS

Ten young volunteers (3M, 7F; mean age 26.9 $\pm$ 5.51 years, height 66 $\pm$ 3.20 inch) participated and performed the following 6 standing trials twice: eyes open or closed while standing on a solid surface or on 2 different types of high density foam pads. Subjects stood with feet together and arms crossed in front of the chest. Instructions were standardized and subjects stood in position for 90s. The first 5 seconds and the final 25 seconds of each trial were truncated and not used in this project.

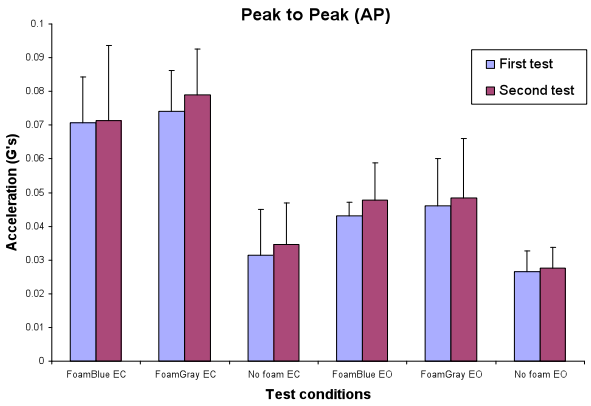
A custom-designed, custom-built accelerometer system was developed using a dual-axis accelerometer (ADXL213AE, ±1.2 g, Analog Devices, Inc.) that was pre-mounted on a breakout board (SparkFun Electronics). Acceleration data was wirelessly transmitted from the sensor to the collection station via Bluetooth®. A custom LabVIEW code (Crossroads Consulting, LLC) imported the acceleration at 100 Hz, and filtered using a 4th order, 5 Hz low-pass filter, sway was quantified using root-mean-square (RMS), peak-to-peak, and path length of the accelerometer data.

The system, composed of battery, sensor, and transmitter modules, was fixed to a belt using Velcro (Figure 1). The Velcro belt was secured around the subjects' pelvis and the sensor module was attached to the belt so that the axes of the accelerometer were approximately aligned with the anteroposterior and mediolateral axes of each subject.

Figure 1: Accelerometer measurement system. Left: transmitter, middle: sensor, right: battery

Statistical analysis: Descriptive statistics (mean, SD) of performance were calculated across two testing sessions for each sway parameter within each test condition (Figure 2). Estimates of reliability across two testing sessions were determined using the Intraclass Correlation Coefficient (ICC) based on a two-way mixed effects model of consistency.

A.



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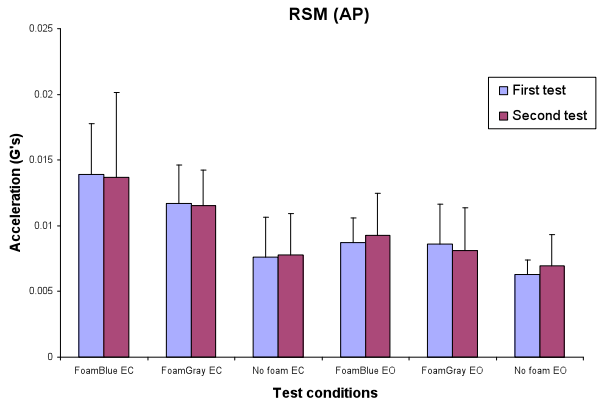

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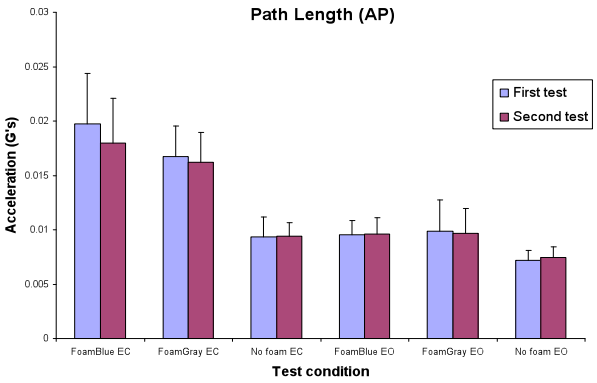

Figure 2: A. Peak to Peak B. RMS C. Path Length. EC: eyes closed; EO: eyes open.

RESULTS AND DISCUSSION

Between-session reliability was good to excellent on a firm surface with eyes closed across all sway parameters (ICC = 0.64-0.83). Across all test conditions, between session reliability appeared higher with the path length parameter (ICC = 0.58-0.82) with the exception of eyes closed on gray foam (ICC = 0.29). Peak to peak and RMS sway parameters demonstrated lower between session reliability estimates except on firm surfaces with eyes closed. There were no differences noted between sessions.

The low variability in the data may have affected the reliability statistic, yet the ICC's were reasonable. It appears that reliability of the 6 tests appear to be moderate to good. Our group will continue to attempt to determine how to make the human performance more repeatable between sessions by attempting to further standardize the verbal instructions to the subject. Advantages of the new use of the off the shelf technology include significant cost savings and the wireless ability to collect the data.

SUMMARY

The new use of the accelerometer appears to be effective as an inexpensive, reliable measure of postural sway.

REFERENCES

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2.O'Sullivan M et al. *Age Ageing* Feb 28, 2009.

ACKNOWLEDGEMENTS

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