CENTER OF PRESSURE SWAY PARAMETERS CONSIDERED JOINTLY BETTER DIFFERENTIATE OLDER ADULT FALLERS FROM NON-FALLERS

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INTRODUCTION

Posturography has the potential to help identify older adults at high-risk of falling due to balance deficits, but this potential is limited by lack of standardization in testing methodology [1]. With over 35% of older adults falling each year, it is imperative that fall-risk screening become clinically routine so that proactive fall prevention strategies can be employed for those who would benefit the most [2].

The use of a force-measuring platform to quantitatively measure information about an individual's sway has the promise to offer a quick clinical screen that overcomes limitations of subjectivity, space and time requirements of common functional balance tests. This use of posturography has currently been hindered because of the large number of possible sway parameters, both traditional and non-traditional, that can be reported [1]. It is currently unknown what parameters best differentiate fallers and non-fallers and whether a group of parameters might reveal more than a single sway measure [1].

The aim of this study was to determine what postural sway parameter(s) best differentiated older adults who had fallen from those who had not, allowing for the development of a posturography protocol that could be used clinically.

METHODS

One hundred and fifty older adults self-reported their fall history for the past year. Those who reported at least two falls in the past year were classified as fallers. There were 21 fallers (13 females, 8 males; mean age: 83.6 ± 7.6; mean height: 164.3 ± 9.3 cm; mean weight: 72.5 ± 17.5 kg). The remaining 129 subjects were classified as non-fallers (97 females, 32 males; mean age: 81.1 ± 7.9; mean height: 163.2 ± 10.5 cm; mean weight: 72.4 ± 17.4 kg).

Subjects performed four quiet-standing tasks in a randomized order on a force-measuring platform (Model BP5050, Bertec Corporation, Columbus, Ohio): eyes open with feet comfortable, eyes closed with feet comfortable, eyes open with feet together, and eyes closed with feet together. All trials were 60 seconds long and data was collected at 1000 Hz.

From the center of pressure data the following traditional sway measures were calculated: A/P Sway Range, M/L Sway Range, Mean Sway Velocity, RMS, 95% Confidence Ellipse Area, Angular Deviation from A/P, Mean Frequency, and M/L Sway Velocity. Additionally, Detrended Fluctuation Analysis was performed to calculate the fractal measures. DFA plots revealed novel two-region findings, as shown in Figure 1. A/P and M/L Short-Term and Long-Term Scaling Exponents, as well as Crossover Point were thus found.

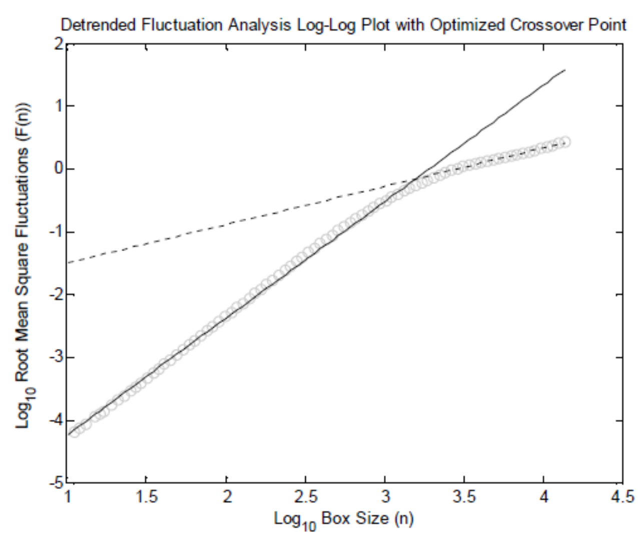

Figure 1. Representative DFA plot of 60 second COP data, revealing novel multiple scaling regions (short-term region, solid line; long-term, dashed).

Stepwise logistic binary regression with forward selection (α=0.15) was used for each testing condition, using all postural sway parameters above, as well as several personal demographics. Fall status was defined as the response variable. For each resulting logistic regression model, the Somers' D value was calculated, a statistical measure of goodness-of-fit of the model, with a value of 1 representing the best fit.

RESULTS AND DISCUSSION

The logistic regression model associated with the eyes closed, feet comfortable condition yielded the highest Somer's D value, 0.715. The resulting parameters included in the model for this testing condition are shown in Table 1.

Table 1. Parameters, in order of significance, to best differentiate fallers from non-fallers in the eyes closed, feet comfortable condition.

Logistic Regression Model Parameters
M/L Velocity
A/P Short Term Scaling Exponent
M/L Short Term Scaling Exponent
Mean Frequency
BMI
Age

Medial-lateral center of pressure velocity was identified as the most significant parameter to differentiate fallers from non-fallers in the eyes closed, feet comfortable condition. It was found that individuals who swayed faster were more likely to fall. This sway parameter also showed strong significance in the differentiation of individuals based on fall risk for the other testing conditions that had models of lower Somers' D values. This finding is in agreement with Maki and others who identified M/L stability as important in the prevention of falls [3,4]. It has been suggested that inability to control M/L stability may indicate loss of cutaneous sensation in the feet [3,4]. This was not tested in the current study.

As shown in Table 1, differentiation ability was best when multiple parameters were considered jointly. Fractal measures were found to be important to include in this group. This suggests that there is a need to jointly consider both traditional and non-traditional measures in differentiating individuals based on fall risk. This finding is significant, especially as groups strive to show that non-linear analyses reveal more than traditional analyses, but do not attempt to describe how these measures might work in combination [5]. It may be true that non-linear analyses reveal certain characteristics about an individual's sway that traditional analyses do not, but this alone is not sufficient.

The resulting logistic regression model was used to calculate probability that each individual had fallen at least twice in the past year. Past fall history has been found to correlate well to future fall-risk [1]. Older adults often report fall history incorrectly, though, making the use of the described protocol an important clinical tool. Results demonstrated that non-fallers were correctly identified as having low likelihood of falls (7.3% $\pm$ 10.8%), whereas most fallers were identified as having a relatively high likelihood of falling (40.0% $\pm$ 33.9%). Those fallers with low calculated likelihood of falling were most commonly those who had fallen due to problems not related with balance (i.e. falls caused by foot drop while walking). From a clinical perspective, this suggests that a simple fall risk screening of only 60 seconds could allow physicians to identify many patients at risk of falling due to balance deficits.

CONCLUSION

To enhance clinical usage of posturography, it is recommended that the eyes closed, comfortable stance condition be performed and the measures listed in Table 1 be examined. Future work is needed to further develop and validate the logistic regression model so that it may be more usable for predicting falls in the clinical environment.

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