FALLS RISK EVALUATION: CENTRE OF PRESSURE COMPLEXITY VS CLINICAL ASSESSMENT

[1]Fiona Higgs B.Sc, [1,2]Hugh Chadderton Ph. D and [1]Samantha L. Winter Ph. D
[1]Department of Sport and Exercise Science, Aberystwyth University, Aberystwyth, SY23 3FD United Kingdom, [2]Hywel Dda Local Health Board, UK.
email: fhh09@aber.ac.uk, web: http://www.aber.ac.uk/en/sport-exercise/

Introduction:
Simple measures of centre of pressure (COP) motion can be used to predict for falls risk in older adults, e.g.: spontaneous medio-lateral (M-L) sway [1]. Reductions in complexity of COP signals have been found in older adults [4], as well as high intraclass correlation coefficients for within- and between-days across age ranges [5]. Complexity and fractility of COP signal can be quantified using specific signal processing analyses [2-4]. Comparisons between use of objective COP signal complexity and more subjective clinical measures (e.g.: multifactorial falls risk assessments) to identify falls risk have not been made.

Objective
To investigate whether measures of COP signal complexity correlate with outcome measures from clinical tests used to categorize falls patients as being at a higher or lower risk of falling. Evidencing that COP complexity, an objective measure postural stability, correlates with clinical outcomes (without requiring the administration of a battery of tests) would support the use of force plates in falls risk assessment. It is predicted that subjects categorized high risk by clinical assessment will also have reduced COP signal complexity and fractility when compared with low risk

Method – participants
A volunteer sample of twenty healthy older adults with a mean age of 78 (SD) years, height of 1.608 (SD) m, and mass of 73.46 (SD) kg. Community-dwellers attending a UK National Health Service hospital-based Falls Clinic following >1 injurious falls. The subjects were classified by a hospital doctor into a high risk group (HR) and a low risk group (LR) according scores in five keys tests (see ***Table 2***). Subjects were referred to one of two strength and balance training programmes according to the criteria listed in ***Table 1***.

Five Key Tests	Scores
Timed Up-and-Go-Test (TUG-T)	>.20 seconds
Romberg Test (RBT)	
Hand grip dynamometry (HGD)	Comparison to age mean
Timed sit-to-stand (TSTS)	
Falls Efficacy Scale (FES-I)	

Table 2
Five key tests administered by Falls Clinic to categorise patients into higher and lower falls risk groups for referral to appropriate exercise intervention group

Inclusion Criteria	Exclusion Criteria
1. Strength and balance deficits identified through scores in Five Key Tests (see Table 2) 2. Subject willing to undergo postural stability instruction in strength and balance exercise class programme	1. Acute illness 2. Deteriorating neurological condition 3. MMSE <24 4. Behaviour that creates risk to themselves or others 5. Unassessed syncope 6. Unassessed low BMI 7. Uncontrolled tachycardia, hypertension or heart failure 8. Uncontrolled diabetes or respiratory problems 9. Uncontrolled pain 10. Untreated severe osteoporosis – T score > -2.5

Table 1: Exclusion and Inclusion Criteria for patients entering strength and balance exercise programme

Method – assessment
Subjects completed balance trials in gait laboratory before and after six week training programme. Test conditions for balance trials were based on the Romberg Balance Test used in the falls clinic (see ***Fig. 1***). Each trial lasted 20 seconds. Subjects wore their own shoes. Ground reaction force data was collected using an AMTI force plate at a sample rate of 1,000 Hz. A 4th order Butterworth filter with a low pass cut off frequency of 40Hz was applied in both directions to give zero-phase distortion. All protocols had been approved by the Dyfed-Powys National Health Service and Aberystwyth University research ethics committees. All subjects signed an informed consent document prior to participating in any testing protocols.

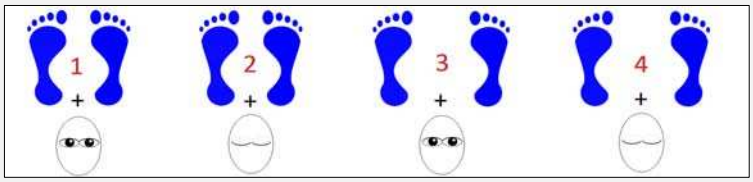
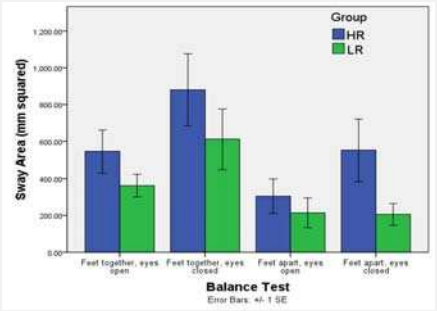


Fig.1
The four trial conditions were administered in order: 1 - narrow base eyes open (NBEO); 2 - narrow base eyes closed (NBEC); 3 - wide base eyes open (WBEO); 4 - wide base eyes closed (WBEC).

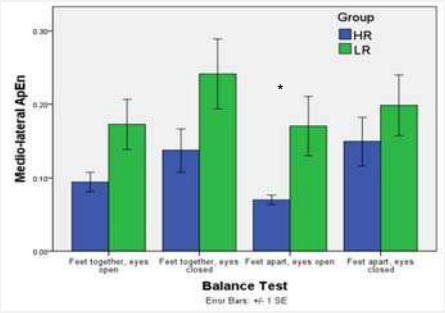
Method – data processing
Data imported into MATLAB 2009b (The Mathworks Inc., MA, USA) to compute: path length of COP; COP mean velocity, the area of the 95% best fitting ellipse, the standard deviation of the COP in the medio-lateral (ML) and anterior-posterior (AP) directions, and the median frequency and fractal dimension of the COP data in the ML and AP directions. In addition, the time dependent structure of the COP data was analysed using Approximate Entropy (ApEn) [3].

Outcome measures
A surrogate analysis of the data determined that the ApEn were due to signal properties and not measurement system noise. Statistical comparisons between types of balance trial were performed using an ANOVA, and between subject groups were performed using independent t-tests in Minitab 15 (Mintab Inc., PA, USA).

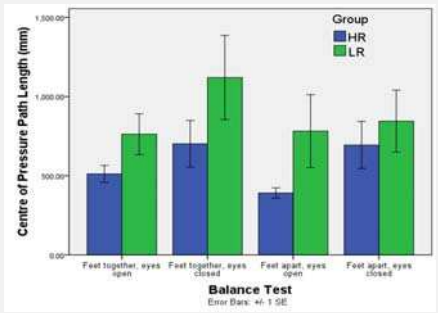
Preliminary Results



Graph 1: Sway area generally greater in HR group, but increases in both groups under eyes closed conditions except in LR group when standing on a wide BOS



Graph 2: COP complexity (ApEn) appears greater in LR group. COP complexity increases in both groups under eyes closed conditions



Graph 3: COP path length is shorter in the HR group and longest under eyes closed conditions in both groups

Conclusions

Taken together, these early results suggest it may be possible to use certain COP measures to objectively differentiate between fallers identified using a clinical tool as high and low risk. It is also possible to differentiate between the type of balance task undertaken by both groups of older adults. While the 'Five Key Test' tool in this particular setting used to distinguish between high and low risk fallers has not been validated, individual elements of the five tests have previously been used to distinguish between high and low risk fallers, and these cut off points informed development of the tool. Anecdotal evidence from the particular hospital involved in this study suggests that the 'Five Key Tests' tool was useful for specialist physical therapists and exercise professionals, however it was less successfully used by 'doorkeeper' or triage clinicians involved in referrals to these specialists. It may be at this earlier stage that simple objective tests using COP motion may be useful.

References
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