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Short communication

Identification of factors associated with risk of fall using a force platform and power spectrum analysis technique

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ABSTRACT

The purpose of this retrospective study was to investigate some parameters of neuromuscular performance of the lower limbs in a population cross-section and their relationship to the risk of falls, using a force platform (FP). Individuals from the Lower Franconia population were invited by public advertisement. Out of a total of 1720 invited subjects 50–90 years of age, the successful completion of all tests were achieved by 807 women, age 66.4 ± 9.3, and 442 men, age 64.0 ± 9.2. A novel FP measured the time series of vertical forces over 10 s during 3 kinds of tests: tandem stand with eyes closed, knee bends, and chair rise. Proprietary software captured the peak force and calculated the power density distribution (PSD), intended to characterize balance and power through the FP. Grip strength as a common geriatric force test was dynamometrically measured for comparison. The parameters were related to the number of falls in the past 12 months in both genders. Mean PSD showed little age dependency and was not related to falls in tandem stance. Peak forces and power over 10 s knee bends showed a larger age-related decrease in men than in women and these parameters were related to falls ($p < 0.001$), whereas they were not related to falls in the chair rise test. Chair rise time and grip strength was related to falls in women ($p < 0.01$). The PSD obtained from the tandem test with eyes closed did not provide a sensitive parameter associated with falls. Knee bends may be a meaningful FP screening test that justifies further studies of physical performance related to the risk of falls, whereas chair rise and grip measurements provided inferior information in this study.

1. Introduction

Decrease in motor performance and the risk of falling are a hallmark of ageing and can be regarded as precursors of death (Fried et al., 2000). Among multi-factorial causes of age-related immobility (Ferrucci et al., 2000), declining muscle function seems to be one of the key factors (Grassi et al., 1991; Perkowski et al., 1998; Runge et al., 2004). Among other factors, deteriorated balance seemed to independently compromise mobility (Runge et al., 2000; Tinetti et al., 1988). Locomotor capability (muscle power) and balance were predictive of falls, immobilization, hospitalization, and death (Guralnik et al., 1995).

A safe, easy, and quick to use methodology for the non-invasive assessment of neuromuscular function through its resulting ground forces may be helpful (Fricke et al., 2006; Kemmler et al., 2004; Schneider et al., 2009). If so it would be useful to monitor training programs to increase limb forces, in order to reduce the risk of falls (Ciose et al., 1999). Force and power of the lower limbs were highly associated with functional performance (Cuoco et al., 2004).

The tandem stance and high force tests of the lower limbs, such as chair rises or knee bends as well as grip strength were considered to be risk predictors for falls (Ensrud et al., 2009; Sherrington et al., 2010). We assumed deployment of force in a shorter time (higher power) to better help avert falling after stumbling. In these tests, the energetic cost (=force and power) of raising the body's center of mass was significant (Neptune et al., 2004).

We also assumed that those dedicated force platform (FP) exercises may provide relevant parameters for motor performance in safe and easy-to-use screening. We hypothesized that these parameters, including the dynamometrically measured grip strength (Thomas et al., 2010), would be related to the number of falls in a cross-sectional study population. External ground reaction forces were found to be the dominant components to reflect net effect during stance (Schache et al., 2007). Our aim was to investigate whether or not some FP-derived parameters related to stance, high force, and power can provide significant information about their association with the number of falls. These parameters involve power spectral density analysis and its power density distribution

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