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Application of the clinical version of the narrow path walking test to identify elderly fallers

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ABSTRACT

Introduction: Falling during walking is a common problem among the older population. Hence, the challenge facing clinicians is identifying who is at risk of falling during walking, for providing an effective intervention to reduce that risk. We aimed to assess whether the clinical version of the narrow path walking test (NPWT) could identify older adults who are reported falls.
Materials and methods: A total of 160 older adults were recruited and asked to recall fall events during the past year. Subjects were instructed to walk in the laboratory at a comfortable pace within a 6 meter long narrow path, 3 trials under single task (ST) and 3 trials dual task (DT) conditions without stepping outside the path (i.e., step errors). The average trial time, number of steps, trial velocity, number of step errors, and number of cognitive task errors were calculated for ST and DT. Fear of falling, performance oriented mobility assessment (POMA) and mini-metal state examination (MMSE) were measured as well.
Results: Sixty-one subjects reported that they had fallen during the past year and 99 did not. Fallers performed more steps, and were slower than non-fallers. There were no significant differences, however, in the number of steps errors, the cognitive task errors in ST and DT in POMA and MMSE.
Conclusion: Our data demonstrates slower gait speed and more steps during the NPWT in ST and DT in fallers. There is no added value of DT over the ST for identification of faller's older adults.

1. Introduction

Falls in older adults, especially lateral falls, are the leading cause of hip fractures (Lofthus et al., 2001), injury-related visits to emergency departments (Tinetti, Speechley, & Ginter, 1988), and the leading cause of accidental death (Centers for Disease Control and Prevention (CDC), 2006). Age-related deterioration in medio-lateral balance control during up right standing (Lord, Rogers, Howland, & Fitzpatrick, 1999; Maki, Holliday, & Topper, 1994; Melzer, Benjuya, & Kaplanski, 2004; Melzer, Kurz, & Oddsson, 2010; Stel, Smit, Pluijm, & Lips, 2003) as well as during compensatory stepping following unexpected loss of balance (Maki, Edmondstone, & McIlroy, 2000; McIlroy & Maki, 1996) is a major contributor to falls in older adults. Most falls occurs during locomotion (Berg, Alessio, Mills, & Tong, 1997; Overstall, Exton-Smith, Imms, & Johnson, 1977; Prudham & Evans, 1981), due to impaired gait i.e., decreased gait velocity, high stride time variability, and Medio-lateral asymmetry (Hausdorff, Rios, & Edelberg, 2001; Mignardot et al., 2014; Toebes et al., 2012; Verghese, Holtzer, Lipton, & Wang, 2009). We recently found that the clinical version of the Narrow Path Walking Test (NPWT) during single and dual task conditions is a reliable and valid testing procedure (Gimmon, Jacob, Lenoble-Hoskovec, Bule, & Melzer, 2013). A laboratory version of NPWT was developed previously by Kelly, Schrager, Price, Ferrucci, and Shumway-Cook (2008) to challenge medio-lateral balance control during walking in a narrowed pathway in both single and dual tasks. It was developed because mobility during daily life requires navigating in narrow pathways often when cognitive attention allocated elsewhere. Studies suggest that attentional resources are limited (Shumway-Cook & Woollacott, 2000), thus shifting attention away from gait

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(i.e., dual task condition) may cause interference effects. In a review Zijlstra, Ufkes, Skelton, Lundin-Olsson, and Zijlstra (2008) could not reach a conclusive statement whether dual task (DT) has an added value over single task (ST) in fall risk assessment. However, there are studies indicating that a DT may have an added value over a ST for identification of older adults who fell (Condron & Hill, 2002; Al-Yahyaa et al., 2011). A prospective study reported higher odds ratios (13.7) for walking while talking for DT performance compared to ST walking as a test to identify older individuals at high risk for falls (Verghese et al., 2002). Other studies (Lundin-Olsson, Nyberg, & Gustafson, 1997; Shumway-Cook, Woollacott, Kerns, & Baldwin, 1997) showed that elderly people prone to fall are more affected by a cognitive task while walking than non-falling older adults. These results suggest that assessing balance under DT may better identify fallers (Mirelman et al., 2012). In a systematic review, Beauchet et al. (2009) examined the relationship between fall incidences and DT amongst elderlies. There were conflicting reports but they concluded that changes in performance whilst DT was significantly associated with an increased risk of falling amongst older adults and frail older adults in particular. Therefore assessing medio-lateral instability during DT walking amongst older adults may be a useful tool in identifying older adults with an increased risk of falls.

The NPWT may be a simple functional assessment procedure that specifically designed to challenge balance during walking, easy to use, highly reliable, do not require expensive equipment, and quick to administer (Gimmon et al., 2013). Among the most commonly used clinical instruments to assess fall risk, the Timed Up and Go (Weiss et al., 2010) the performance oriented mobility assessment (POMA) (Tinetti, 1986) and the Berg Balance Test (Conradsson et al., 2007) have limitations in their usage especially for higher level functioning older adults who are capable of independent walking, but still have a substantial decline in the ability to control equilibrium, which does not become evident until fall happens. Results obtained may be subjective, show ceiling effects, and are usually not responsive enough to measure small progress or deterioration in a subject's ability to balance (Blum & Korner-Bitensky, 2008).

In this study, we aimed to assess whether the NPWT could identify older adults who reported falls and whether the NPWT was better than the performance oriented mobility assessment (POMA) (Tinetti, 1986) and the short version, FES-I (Yardley et al., 2005). Also we aimed to explore which of the NPWT parameters that identifies past falls. We also aimed to assess whether NPWT under DT conditions have an added value for fall prediction compare with ST condition. We hypothesized that NPWT will be able to identify fallers and that NPWT will better identify older adults who are prone to falling than POMA especially gait velocity. Gait velocity has been shown to reflect health and functional status (Abellan van Kan et al., 2009). Gait speed has also been recommended as a potentially useful clinical indicator of well-being among the older adults (Hall, 2006), frailty and even survival of older adults (Studenski et al., 2011). Our second hypothesis was that the NPWT under DT conditions would be able to better identify fallers than ST, with a gait velocity in DT as the best predictor of falls.

2. Materials and methods

A total of 160 independent older adults, 65–91 years, were recruited from senior living facilities. Of 160 older adults, 99 subjects (mean age 81.50 ± 5) reported that they had not fallen (NF), and 61 subjects (79.40 ± 5.7) reported that they had fallen at least once during the past year (F). The inclusion criteria were: (a) 65 years old and older; (b) able to walk independently; (c) score greater than 24 in the mini mental state examination. The exclusion criteria were: serious visual impairment, severe cardio-vascular disease, terminal diseases, Menier and substantial pain, and severe gait impairment due to focal lower limb muscle weakness or palsy; lower limb amputation or joint arthrodesis; neurological diseases, including diseases such as Parkinson's disease, multiple sclerosis, status post stroke with hemi-syndroma, cervical or lumbar stenosis with compression myelopathy, and polyneuropathy with severe proprioceptive impairment.

Our sample size estimation was based on previous work (Gimmon et al., 2013) showing that the smallest detectable change of trial time during the NPWT for old adults was 2.05 s with a standard deviation of 4.10. It was estimated that at least 42 fallers must be studied to be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.80. The type I error probability associated with this test of this null hypothesis is 0.05. Thus we recruited 160 elderly people assuming that at least one-third of elderly people will be fallers (about 50 subjects).

Participants provided informed consent, in accordance with approved procedures by the Helsinki ethics committee. After eligibility was determined subjects were instructed to walk at a preferred walking speed within a 6 meter long narrow path under ST and DT conditions. To produce a similar challenge for individuals with different body morphologies, the width of the narrow path was normalized to 50% of the distance between the participant's anterior superior iliac spines plus the width of the subject's shoe. A total of 3 trials were conducted for ST condition and 3 trials were conducted for DT condition for a total of 6 trials. For the ST, subjects were instructed to walk at their comfortable pace without stepping outside the narrow path. During the 3 dual task trials they performed 3 different cognitive tasks: (1) reciting the days of the week backwards; (2) reciting the months of the year backwards; and (3) count down in increments of 5 from 100 to 50. During the DT participants were asked to perform both tasks as best as they can. All 6 trials were videotaped using a video-camera and stored on a hard disk for later analysis, the procedures have previously been described in detail (Gimmon et al., 2013).

The parameters extracted during the analysis were: (1) number of steps during each trial; (2) trial time; (3) trial velocity (calculated as 6 meter/trial time): (4) mediolateral instability was measured by the number of step errors i.e., defined as every step where the participant's shoe touched the carpet outline on the sides of the narrow path walkway; and (5) the number of cognitive task errors during ST (sitting) and DT. Before embarking on the NPWT, subjects were asked to perform the performance oriented mobility assessment (POMA) (Tinetti, 1986). POMA is a task-oriented test that assesses an older adult's gait and balance abilities the higher the scores are the higher their balance function. In addition we measure fear of falling using the short version, FES-I (Yardley et al., 2005). Subjects were also asked to retrospectively recall fall events during the past year. A fall was defined as "an event which results in a person coming to rest inadvertently on the ground or other lower level, regardless of whether an injury was sustained" (Tinetti et al., 1988).

2.1. Statistical analysis

For statistical calculations PASW Statistics version 18.0 was used (Somers, NY, USA, version 18). Baseline characteristics of F vs. NF were compared using independent *t*-test. To test our first and the second hypothesis we performed two-way analysis of variance (ANOVA) that included 2 groups (NF vs. F) as the between subjects factor, with repeated measures on the within subjects factors of task (ST vs. DT). The dependent variables were: number of steps, trial time and velocity, number of step errors, and cognitive task errors in ST and DT conditions. A significance level of 0.05 was used.