Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Multiple modes of assessment of gait are better than one to predict incident falls

Gilles Allali [a,b,*], Emmeline I. Ayers [a], Joe Verghese [a]

[a] Department of Neurology, Division of Cognitive & Motor Aging, Albert Einstein College of Medicine, Yeshiva University, Bronx, NY, USA
[b] Department of Clinical Neurosciences, Geneva University Hospitals and University of Geneva, Geneva, Switzerland

ABSTRACT

Background: Though gait evaluation is recommended as a core component of fall risk assessments, a systematic examination of the predictive validity of different modes of gait assessments for falls is lacking.
Objective: To compare three commonly employed gait assessments – self-reported walking difficulties, clinical evaluation, and quantitative gait – to predict incident falls.
Materials and methods: 380 community-dwelling older adults (mean age 76.5 ± 6.8 y, 55.8% female) were evaluated with three independent gait assessment modes: patient-centered, quantitative, and clinician-diagnosed. The association of these three gait assessment modes with incident falls was examined using Cox proportional hazards models.
Results: 23.2% of participants self-reported walking difficulties, 15.5% had slow gait, and 48.4% clinical gait abnormalities. 30.3% had abnormalities on only one assessment, whereas only 6.3% had abnormalities on all three. Over a mean follow-up of 24.2 months, 137 participants (36.1%) fell. Those with at least two abnormal gait assessments presented an increased risk of incident falls (hazard ratio (HR): 1.61, 95% confidence interval (CI): 1.04–2.49) in comparison to the 169 participants without any abnormalities on any of the three assessments.
Conclusions: Multiple modes of gait evaluation provide a more comprehensive mobility assessment than only one assessment alone, and better identify incident falls in older adults.

© 2015 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

The clinical examination has evolved over time building on collective clinical experience in disease and risk assessments, but a systematic assessment of its elements is lacking. Gait assessment is a core element of the clinical examination (Snijders, van de Warrenburg, Giladi, & Bloem, 2007), assisting diagnosis as well as predicting major adverse outcomes such as falls and disability (Verghese, Ambrose, Lipton, & Wang, 2010). Clinical guidelines to prevent falls in older adults from various national organizations and expert committees recommend gait assessment as a core element of fall risk screening in older adults, but do not provide guidance on which modes of assessment are optimal (ACSQH; Lamb, Jorstad-Stein, Hauer, & Becker, 2005; National Institute for Clinical Excellence; Panel, 2011). Methods employed in clinical practice and in research settings to identify gait disorders include eliciting self-report of mobility difficulties from patients, observation of walking patterns by clinicians, and quantitative gait assessments using instrumented methods.

Self-reported mobility difficulties are an independent predictor of functional impairment (Leskinen, Laatikainen, Peltonen, Leva-lahti, & Antikainen, 2013), but accuracy depends on intrinsic factors such as visual impairment (Swenor, Bandeen-Roche, Munoz, & West, 2014). Furthermore, aging affects the accuracy of self-reported mobility difficulties in older adults due to cognitive impairment (Abraham et al., 2012). Clinical gait abnormalities identified by clinicians have been reported to be good predictors of adverse outcomes such as dementia (Verghese, Derby, Katz, & Lipton, 2007; Verghese, Lipton, et al., 2002), institutionalization (Verghese et al., 2006), or mortality (Verghese et al., 2006). However, the clinical gait assessment is less reliable than quantitative gait evaluation (Mera et al., 2013). Quantitative

* Corresponding author at: Albert Einstein College of Medicine, Yeshiva, University, 1165 Morris Park Avenue, Room 420, Bronx, NY 10461, USA.
Tel.: +1 718 430 3991; fax: +1 718 430 3829.
E-mail address: gilles.allali@einstein.yu.edu (G. Allali).

assessment of gait is a strong predictor of cognitive decline (Verghese, Wang, Lipton, Holtzer, & Xue, 2007), disability (Cesari et al., 2005) and mortality (Studenski et al., 2011) in aging, and is recommended by experts and national organizations as a valid screening measure (ACSQH; Guideline, 2001; National Institute for Clinical Excellence). Clinical gait evaluations may be combined with quantitative assessments in order to take into account the intra-individual variability in gait performance (van Iersel, Munneke, Esselink, Benraad, & Olde Rikkert, 2008). In the specific context of falls, inclusion of self-reported mobility difficulties was reported to improve fall risk assessments. However, independent of abnormal results on other clinical assessments, such as quantitative assessments, self-reported mobility difficulties had a weaker association with falls (Simonsick et al., 2008). Clinicians diagnosed neurologic gait abnormalities and slow gait were also reported to predict falls in older adults (Verghese, Holtzer, Lipton, & Wang, 2009; Verghese et al., 2010). Given the variability in methods used to assess gait in clinical practice, it would be helpful to know the individual and combined predictive validity of different modes of gait assessment for identifying fall risk.

To address these knowledge gaps, we conducted a prospective study in a community residing cohort of non-demented older adults to compare the predictive validity for falls of three commonly employed, independent gait assessments: self-reported walking difficulties, clinical gait evaluation, and quantitative gait assessment. Identifying efficient methods of using single or combined gait assessment modes can help optimize current fall prediction and refine current clinical guidelines for fall risk assessment.

2. Material and methods

2.1. Participants

Participants were recruited from the "Central Control of Mobility in Aging" study. The primary goal of the study is to determine clinical predictors of mobility decline and disability in aging (Holtzer, Mahoney, & Verghese, 2014; Holtzer, Wang, & Verghese, 2014). Participants seen in our research center between June 2011 and May 2014 were included in this analysis. Following a screening interview to rule out presence of dementia using two validated cognitive screeners (Galvin et al., 2005; Lipton et al., 2003), eligible individuals age 65 and older were scheduled for in-person visits at our research center. Participants received comprehensive neuropsychological, cognitive, psychological, and mobility assessments as well as a neurological examination including gait assessment. Exclusion criteria were: inability to speak English, unable to ambulate independently, dementia, significant loss of vision and/or hearing, and major psychiatric disorders. Informed consents were obtained and study protocols were approved by the local Institutional Review Board.

2.2. Gait assessment modalities

Gait was evaluated by three independent modes of assessments with previously described clinical utility for diagnosis of gait deficits and predicting various adverse outcomes in older patients (Simonsick et al., 2008; Verghese et al., 2009, 2010). Gait assessments included: self-report, clinical evaluation, and quantitative. Each gait assessment was conducted by independent clinicians, blinded to the results of the other two gait assessment methods. Patient centered assessment was based on response to: "Do you have any difficulty walking?" We have reported that this question has moderate reliability in identifying clinical and quantitative gait deficits in older adults (Verghese et al., 2004). Gait speed (cm/s) was measured while participants walked at

their normal pace on an instrumented walkway (180 in. × 35.5 in. × 0.25 in.) without any attached devices (GAITRite, CIR systems, Havertown, PA). Excellent test–retest reliability has been reported for quantitative gait assessments at our center (Verghese, Wang, et al., 2007). Slow gait was defined as one or more standard deviations (SD) below previously defined age and sex-appropriate mean values (Verghese et al., 2014). We have reported that slow gait predicted incident falls in another aging cohort (Verghese et al., 2009). While GAITRite provides information on several other gait variables that have been linked to fall risk (Verghese et al., 2009), we focused on speed for this report, as it is the most widely used gait metric and can be derived without the use of instrumented methods, increasing generalizability of our findings. Participants' gaits were rated as normal or abnormal (due to neurological or non-neurological diseases) by study clinicians following visual inspection of gait patterns while they walked down a well-lit hallway, as previously described (Verghese, Lipton, et al., 2002). Our clinical gait classification has been reported to have good inter-rater reliability (kappa 0.8) (Verghese et al., 2006), and neurological gait abnormalities identified by this method has been reported to predict falls in our previous study (Verghese et al., 2010).

2.3. Falls

Falls were defined as unintentionally coming down to the floor or lower level not due to a major intrinsic or extrinsic event. Subjects were interviewed at baseline and during their annual in-house visit about falls in the previous 12 months. Furthermore, every 2–3 months, the participants were contacted by telephone and asked if they had any falls since their last interview. The consistency between our telephone and in-house interview methods has been reported as highly reliable in the previous study (Verghese, Buschke, et al., 2002). To improve reliability, three participants diagnosed with dementia following their in-house assessment were excluded from this analysis.

2.4. Statistics

Participants were grouped based on the presence of abnormalities on each assessments (Fig. 1). Participant characteristics are described using mean and SD or otherwise appropriate values (Table 1). We used Cohen's kappa coefficient to describe the overall agreement between the three classification methods. Cox proportional hazards models were used to compute HRs with 95% CIs to predict incident falls based on baseline groups, where we compared participants presenting only one abnormal gait assessment out of the three modes of assessment with those presenting two and three abnormal gait assessments. The 169 participants without abnormality on any of the three modes of gait assessment was the reference group. The models were adjusted for age, gender, education and presence of falls in the year prior to enrollment. Finally, we conducted sensitivity and specificity analyses of the various diagnostic groups for the identification of incident falls. All analyses were performed using SPSS version 20.

3. Results

Clinical characteristics of the 380 non-demented older adults (mean age 76.5 ± 6.8 y, 55.8% female) are summarized in Table 1.

The distribution of diagnostic groupings is illustrated in a Venn diagram (Fig. 1). The largest group was the 91 participants that had only gait abnormalities on clinical examination (group b). The smallest group was the three participants with the combination of self-reported and quantitative abnormalities (group e).