Predicting falls with the cognitive timed up-and-go dual task in frail older patients

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1. Introduction

Falls are a major health problem in older people. More than 30% of people older than 65 and 50% older than 80 fall at least once a year [1]. Falls are the most common cause of injury in old age and lead to distress, pain, fractures, loss of confidence and loss of independence [1,2].

The cause of falling can be multifactorial, but gait disorders are often the main cause in older people [1]. Several walking and balance tests have been proposed to assess the risk of falls, but their predictive validity in older people is still controversial [3–5]. Among these tests, the timed up-and-go (TUG) test is often routinely used [5–8].

The relationship between gait and cognitive function has been well established in healthy older people and those with cognitive impairment [9–11]. Executive and attentional functions are essential for normal walking [12,13]. A decrease in gait speed while talking was proposed to indicate mild cognitive impairment [11,13]. Dual-task paradigms were then proposed for predicting falls in older people, but showed conflicting results [14]. Although very mild impairment in attention and executive functions are independently associated with risk of postural instability and falls [12–14], the added value of dual-balance tasks for assessing fall intervention remains controversial [15].

Frailty [16] is associated with a high risk of falls. Low gait speed is one of the criteria proposed in the Fried et al. definition of frailty [17], and the TUG score was suggested to be a proxy for frailty in older people [18]. An added dual task could improve the validity of the TUG score as a screening tool for detecting pre-frailty [19]. A recent review [20] recommended adding a cognitive task to improve the sensitivity and specificity of the frailty risk.

Keywords:
TUG 
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Handgrip strength 
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We hypothesized that the TUG score associated with a cognitive dual task (CogTUG) score could differentiate older frail people who would fall and not fall better than the TUG score alone. We designed this retrospective study to determine whether the CogTUG score was associated with a history of falls in frail older hospital outpatients with gait disorders.

2. Methods

2.1. Population

This study took place in a geriatric day hospital specializing in evaluating gait disorders and falls (Bretonneau Hospital, Paris). We retrospectively included all patients >75 years old who were admitted from January 2012 to January 2014 for gait or balance disorders with or without a history of falls. We did not include patients who could not perform walk tests or presented an acute disease; major visual loss; serious neurological, articulation or motor handicap; or falls related to loss of consciousness. The data were declared to the French National Computing and Freedom Commission (CNIL) (No. 1858079).

2.2. Comprehensive geriatric assessment

All patients underwent a comprehensive geriatric assessment [21] including number of comorbidities, number of drugs taken per day, activities of daily living (score 0–6), instrumental activities of daily living (score 0–4), mini-mental state examination (MMSE) (score 0–30), albumin level and the first part of the Tinetti scale (balance section, score 0–16) [1,3].

Frailty indicators were operationalized as closely as possible to the phenotypic definition of Fried et al. [17]. Only 3 criteria were used: (1) weight loss (yes/no), (2) gait speed < 1 m/s as measured in a 10-m walk at preferred velocity [22], and (3) low handgrip strength. The handgrip strength of the dominant hand was measured by using a hydraulic dynamometer (Sissel, Sweden). Handgrip strength was considered low at <30 kg for men and <20 kg for women [23]. Patients were considered pre-fragile with 1 or 2 of these criteria and frail with 3.

A fall was defined as the person unintentionally coming to rest on the ground. History of falls over the previous year was recorded by use of a standardized questionnaire [1,6].

2.3. TUG and CogTUG

Patients were first asked to stand from a seated position, walk 3 m at their usual pace, turn around, walk back to the chair, and sit down (the TUG test). Walking aids were allowed. After a recovery phase, patients were asked to perform the same exercise while performing a cognitive dual task (continuously subtracting 2, starting from 100; the CogTUG test) [24,25]. Both tests were timed in seconds. We also calculated the difference between the time to perform the CogTUG and TUG tests (CogTUG − TUG = ΔTUG).

2.4. Statistical analysis

Quantitative data are reported as mean ± SD and categorical data as frequency (%). Missing values were studied, but we did not impute missing values. The differences between groups (fallers and non-fallers) were examined by independent Student t test for continuous variables and chi-square test for categorial variables. The validity conditions of these tests were checked. Logistic regression analysis was used to model the factors associated with a history of falls. The covariables were selected by their clinical relevance, their association with falls on bivariate analysis at a 20% threshold and a correlation matrix. Regression diagnosis was used to assess the conduct of the convergence process and check the robustness of the model. Data were analyzed by using R v3.1.1 (http://www.r-project.org). All tests were two-tailed, and P < 0.05 was considered statistically significant.

3. Results

We included 161 patients. We excluded the 4 patients who were neither frail nor pre-frail or had incomplete data, so the analysis included 157 patients (mean age 84.2 ± 6.2; 72% women). The sample characteristics and test results are in the Table. The patients walked slowly (0.62 ± 0.30 m/s) and had low handgrip velocity.

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<tr>
<th>Table 1</th>
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<tr>
<td>Characteristics and test results of older patients with and without a history of falls.</td>
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<tr>
<td>Total (n=157)</td>
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<tr>
<td>Age (years)</td>
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<tr>
<td>Female, no. (%)</td>
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<tr>
<td>No. of comorbidities</td>
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<td>No. of drugs per day</td>
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<td>Activities of daily living (0–6)</td>
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<td>Mini-mental state examination score (0–30)</td>
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<td>Weight (kg)</td>
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<td>Weight loss: no. of patients (%)</td>
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<td>Albumin level (g/l)</td>
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<td>Handgrip strength (kg)</td>
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<td>Gait speed (m/s)</td>
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<td>Tinetti balance score/16</td>
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<td>TUG (s)</td>
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<td>CogTUG (s)</td>
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<td>ΔTUG (s)</td>
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<td>Frailty status, no. (%)</td>
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<td>Pre-fragile</td>
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</table>

Data are mean ± SD unless indicated.

*P < 0.05 by Student t test or chi-square test.

TUG, timed up-and-go task; CogTUG, cognitive timed up-and-go dual task.
was associated with increased risk of falling in residential long-term-care patients. However, 3 studies that assessed the efficacy of protein and energy supplementation for falls, as a secondary endpoint, obtained negative results [31–33]. Building muscle again after weight loss likely needs physical exercise [34]. In our study, malnutrition, as assessed by weight loss, was associated with falls, but we found no evidence of a causal relationship. Malnutrition may favor falls in terms of muscle weakness, but falls may limit mobility and thereby favor malnutrition. Our results suggest that screening for weight loss may be more effective than the TUG score for identifying fallers.

Low handgrip strength was associated with a history of falls. In another frail and pre-frail older population, handgrip strength was correlated with leg strength [35], which may explain the association between handgrip strength and falls. In a meta-analysis [36], weakness was not identified as a risk factor of falls, but physical exercise improved strength and reduced the rate of falls and risk of falling. The type of exercise performed probably has a strong effect on strength and balance: combining resistance training, aerobic exercises, balance and flexibility is recommended to prevent falls in older people [37,38].

Finally, TUG score, weight loss and muscle strength (ability to rise from a chair and handgrip strength) are closely linked to frailty and risk to falls. The TUG score could be useful to identify frailty, because it often identifies fallers.

Our work presents limitations with the patient enrolment in a single center and the specialization of the day hospital in gait disorders and screening for fragility. Therefore, our results cannot be generalized to a larger population. Secondly, the retrospective nature of our study is a bias in the collection of data on falls. Finally, we did not collect data on other intrinsic risk factors associated with falls, such as vision impairment or psychotropic drug use, or extrinsic risk factors, such as the need for a walking aid or non-adapted shoes.

In conclusion, our study suggests that unlike the TUG score, CogTUG and ΔTUG scores are not associated with a history of falls in community-dwelling frail older people with gait disorders.

Disclosure of interest

The authors declare that they have no competing interest.

References


4. Discussion

Our study shows that unlike the TUG score alone, the CogTUG score was not associated with a history of falls in this population of frail older outpatients with gait disorders.

The utility of dual tasks for predicting falls in various balance tests has been explored by a number of clinical studies, but they varied in characteristics of participants (gait disorders, Alzheimer’s disease, Parkinson’s disease, stroke or brain injury, multiple sclerosis, etc.), the single and dual task tests performed (standing on a force platform, walking, TUG, etc.) or the retrospective or prospective design and are thus difficult to compare. Furthermore, the number of participants included was often small, <60. Some studies [18,19] emphasize the importance of the dual TUG task, but a recent meta-analysis [26] concluded that single and dual task tests for gait speed are equivalent in predicting falls in older people.

Our study included a relatively large number of participants (n = 161). Our results are similar to those of Vaillant et al. [25], who found that the time to perform the cognitive dual task TUG (subtractions and additions) did not differ in 95 older women with or without a history of falls. We studied a specific population, very old patients admitted for a comprehensive geriatric assessment of gait disorders and falls. The patients were frail, with low gait speed and handgrip strength, and the MMSE suggested light to moderate cognitive impairment. The high frequency of light cognitive impairment and gait disorders could explain the lack of effect of adding an attentional burden to the TUG to predict falls. In a recent review [15], the authors underlined the low sensitivity of the dual task for predicting falls, except for identifying fallers with attention or executive deficit [27]. Our results do not support this finding: neither the CogTUG score nor the difference in time taken to perform the CogTUG and TUG tests (ΔTUG) was associated with a history of falls.

The TUG and dual task TUG tests have been proposed for screening frailty in community-dwelling people [18–20]. In our population, both the TUG and CogTUG scores were significantly associated with grip strength and gait speed, as was expected, but not weight loss (data not shown). However, weight loss and low muscle strength were strongly and independently associated with a history of falls. On multivariate analysis, the risk of a history of falls was increased threefold with weight loss. In sedentary older people, weight loss mostly affects muscle mass and leads to muscle weakness and balance disorders that favor falls. However, we lack data on the specific association of malnutrition with falls. Hirose et al. [28] showed no increase in rate of falls in malnourished versus non-malnourished patients. By contrast, Meijers [29] suggested that malnutrition was a potential reversible factor related to falls, and Neyens et al. [30] showed that malnutrition

strength (men: 25.5 ± 7.4 kg, female: 14.7 ± 4.6 kg) and 53 (33.8%) had lost weight. Only 3 patients presented none of the 3 frailty criteria, 105 patients (65.6%) had 1 or 2 criteria and were considered pre-frail, and 52 (32.5%) had 3 criteria and were considered frail.

Overall, 84 patients (53.5%) had fallen in the previous year (Table 1). As compared with non-fallers, fallers were significantly older (P = 0.03), had more often lost weight (P = 0.04), had lower handgrip strength (P = 0.03) and Tinnetti balance score (P = 0.0004), and took longer to perform the TUG test (P = 0.04). The groups did not differ in CogTUG or ΔTUG scores.

On multivariate analysis (including age, sex, number of comorbidities, weight loss, albuminaemia, handgrip strength, Tinetti score, TUG and CogTUG scores), falling was associated with only weight loss (odds ratio 3.43, 95% CI 1.13–11.30, P = 0.03) and reduced handgrip strength (0.88; 0.78–0.97, P = 0.02).
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