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Functional assessment in older adults: Should we use timed up and go or gait speed test?

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HIGHLIGHTS

- We tested the link between locomotors tests and arm reaching velocity in frail subjects.
- The Pearson correlation between GS and hand velocity was significant ($r = 0.495$).
- This one between TUG and hand velocity ($r = -0.139$) was not significant.
- GS seems to be more representative of the whole motricity of frail patients than the TUG.
- We propose that GS should be preferred over the TUG with these patients.

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ABSTRACT

In order to assess functional skills of older adults, both timed up and go (TUG) test and gait speed (GS) test are well validated concerning their predictive capacities. However, the question remains unclear which one of these tests represents better the whole physical performance of older adults. The aim of this study is to determine the more representative test, between TUG and GS, of the whole motor control quality. To study links between locomotion capacities and arm function, we measured, in a population of frail aged patients, the locomotion tests and the mean arm maximal velocity developed during a speed–accuracy trade-off. This arm movement consisted in reaching the hand toward a target in a virtual game scene. We plotted the different couples of variables obtained on graphs, and calculate Pearson correlation coefficients between each couple. The Pearson correlation between GS and hand maximal velocity was significant ($r = 0.495$; $p = 0.046$). Interestingly, we found a non significant Pearson correlation between timed up and go score (TUG) and hand maximal velocity ($r = -0.139$; $p = 0.243$). Our results suggest that GS score is more representative of the whole motor ability of frail patients than the TUG. We propose that the relative complexity of the TUG motor sequence could be involved in this difference. For a few patients with motor automatisms deficiencies, this motor sequence complexity could leads to a dual task perturbation. In this way, we conclude that GS should be preferred over the TUG with older adults.

1. Introduction

Pathological aging leads to physiological reserves decrease and results in falls, disability, hospitalization or even death [1]. It has been suggested that balance disorders observed during aging have a significant impact on the functional independence and quality of life of aged adults [2]. In this context, therapists are interested in the motor ability in order to maintain or improve this function as much as possible. The motor function may be assessed from different strategies. Among the functional tests, there are some that may be quickly and easily executed, being at once extremely informative about the patient's capacities. This is the case of the timed up and go (TUG) [3] as well as the gait speed (GS) tests [4].

The TUG test [3] is a clinical test that has been extensively used to assess functional stability and mobility, mainly in frail older people [5–9]. This test consists in standing up from a chair, walking a distance of 3 m, turning and walking back to the chair, and sitting down again. Older adults who are able to complete the task in less

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than 20 s are independent in transfer and have high scores on the Berg Balance Scale. In contrast, older adults requiring 30 s or longer to complete the task are more dependent in activities of daily living, require assistive devices for ambulation, and score lower on the Berg Balance Scale [8,9]. The potential of this test to predict falls is controversial: TUG test allows to predict the fall risk in several studies [7,10,11]. Shumway-Cook and colleagues measured a high sensitivity (87%) and a high specificity (87%) for the TUG test, when it is used with a cut-off value of 14 s for identifying elderly individuals who are prone to falls [8]. However, a few studies suggest that TUG test only is not able to predict falls [12,13].

The GS test consists in walking 10 m at usual speed, with a 1-m start-up before starting timing, and a stop order given after the finish line [14]. A score under 0.65 m by second reveals a frailty state [1]. The GS has been shown to predict as well the hospitalization [15,16], and the declines in function and health [4,17], as the falls [18,19]. Moreover, GS can predict a reduction in mortality in older adults [20].

Both tests are interesting in their predictive capacity about the general health and falls, and seem to be of similar efficiency, even if a recent study suggests that GS presents a better predictive capacity than TUG test [21]. However, if clinical tests aim to assess the whole functional abilities of patient in order to predict its outcomes, one of their objectives is also to inform therapists about the patients physical performance at the present moment, and to guide them in establishment of the "care plan". Systemic tests have been developed to respond to this objective [22,23]. However, even if they are very interesting, these approaches need a relatively long time, and are difficult to integrate in clinical practice. In this way, in order to propose an intermediate solution, it could be very helpful to identify which test, GS or TUG, is the most indicative of the patient motor control efficiency. Indeed, motor control allows to manage – whole body – global tasks, such as those assessed during GS and TUG, and fine motor tasks, usually performed by upper limbs in the activities of daily living. Is it a locomotor test, as GS or TUG test, that is linked with the fine motor control ability of upper limbs? To answer this question, and achieve our goal, we propose to test the relationship between both tests and the patients speed–accuracy tradeoff ability during a reaching arm movement using a virtual interface.

2. Material and methods

2.1. Patients

A total of 37 patients participated in the present study after giving their written consent. The French Committee for the protection of persons (CPP) approved the experimental protocol, which was carried out in agreement with legal and international requirements (Declaration of Helsinki, 1964). The participants were patients in the short-term rehabilitation service of the Benigne Joly Clinic, Burgundy, France. One inclusion criterion was to present a balance disorder, but also to be able to remain standing without any mechanical or human help. The patients all presented multiple causes of hospitalization, but all patients with pyramidal or extra-pyramidal syndrome or peripheral neuropathy were excluded. Nevertheless, inclusion required a conscientious examination, and the diagnosis of frailty was made by a geriatrician according to the clinical features of the syndrome. Frailty was defined as a clinical syndrome in which three or more of the following criteria were present: unintentional weight loss, self-reported exhaustion, weakness, slow walking speed, and low physical activity [1]. Moreover, patients were excluded if there was a suspicion of dementia (Mini Mental State Examination was performed, and dementia was considered for MMSE < 24). All of the patients were right-handed.

Table 1
Patients characteristics.

Parameter	Mean ± standard deviation
Age (years)	82.25 ± 6.01
Height (cm)	162.87 ± 8.04
Weight (kg)	68.57 ± 17.37
Body mass index (BMI)	26 ± 6.91
Timed up and go (s)	21.12 ± 7.05
Gait speed (m s^{-1})	0.64 ± 0.2
Gait speed in dual task (m s^{-1})	0.56 ± 0.19

Patients characteristics and functional abilities are presented in Table 1.

2.2. Experimental device

The set-up used is an active motion-capture system based on vision technology manufactured by Fovea Interactive®. This system is able to track the marker held by the patient in his right hand. The camera is positioned in front of the participant at a standard distance (d) depending on the patient's height ($d = 1.2 \times$ patient's height). The experimental device is placed underneath a large screen (200 cm × 130 cm, screen diagonal: 238 cm), onto which a marker position is projected. In this way, the right-hand movements are represented on the screen, with a short delay of 33 ms (i.e. the hand movement displays 33 ms late on the screen). The right index finger is represented on the screen by a white hand. In the lower part of the virtual scene, there is a half circle with many needles. Patients are asked to put their hand on this circle to pick up a needle (automatic pick-up). In this way, this half circle placed in the lower part of the screen is the starting point of the reaching movement. When the patient put his right hand on this half-circle, a yellow ball appears somewhere on the screen (the radius of the yellow ball was 10 cm), after a short variable delay (0.2–2 s) and in a random position (eight standard positions: four in the right half of the screen and four in the left half). This is repeated over 10 trials per sequence. For each target, the peak velocity is recorded. At the end of the 10 trials, the mean of this parameter is calculated and communicated to the patients (see Fig. 1 for experimental device).

2.3. Experimental procedure

Patients participated in only one evaluation session, in which they performed clinical tests and hand movements with the experimental device. This evaluation session was always conducted before any classical rehabilitation session. Initially, patients performed the following functional tests: timed up and go test (TUG) and gait speed (GS), as described in the introduction section. After this first clinical assessment, the therapist explained the game task to the patient, and showed a short demonstration of the game. The patient used the device first in a familiarisation sequence: the instruction was to burst the yellow ball with the right hand. Patients were asked to react as soon as possible and to reach the ball as fast as possible. After this first familiarization sequence (10 balls), patients were asked to perform 3 sequences with the same instruction. The experimental device recorded the hand positions during these 3 sequences.

2.4. Data recording of hand maximal velocity and statistical analysis

During the 3 maximal speed sequences of the session, right hand displacements were recorded using the experimental device (sampling rate: 60 Hz). The onsets of hand movement were calculated from a 5% threshold of the maximal speed of each velocity