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Quickness of trunk movements in a seated position, regardless of the direction, is more important to determine the mobility in the elderly than the range of the trunk movement

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ABSTRACT

Although trunk function is known to be critical for maintaining balance during gait, a detailed evaluation regarding the relationship between trunk function and mobility has not been performed. We previously reported that the ability of quick lateral trunk movements in a seated position reflects mobility in elderly people. In this study, we further examined whether trunk movement in the anterior–posterior direction is also a determinant of mobility. In addition, the correlation between range of lateral trunk movement and mobility was also examined. One hundred and forty community-dwelling elderly participants (73.3 ± 6.2 years) were enrolled in this study. We performed various trunk movement tests in a seated position, such as the seated side tapping test (SST), the seated anterior–posterior tapping test (APT), and the lateral sitting functional reach test (sitting reach test). Maximum gait speed and the timed up and go test (TUG) were performed to determine mobility. Parameters of trunk movement were compared. SST and APT showed moderate significant correlations with both maximum gate speed and TUG, while the sitting reach test weakly correlated (SST $r = -0.58$, $p < 0.01$, APT $r = -0.63$, $p < 0.01$, sitting reach test $r = 0.30$, $p < 0.01$). Moreover, multiple regression analysis revealed that SST and APT were independent indicators of both maximum gate speed and TUG, while the sitting reach test was not. These findings indicate that quickness, regardless of the direction of the movement, is more important than range in determining mobility in the elderly.

1. Introduction

Physical performance is affected by multiple facets of health and aging (Studenski et al., 2003). Thus, physical performance tests are useful as screening tools for identifying older adults whose health is at high risk (Viccaro, Perera, & Studenski, 2011). Gait speed and the timed up and go test (TUG) are well known indicators of mobility. In addition, gait speed is a good predictor of fall risk (Montero-Odasso et al., 2005), hospitalization (Cesari et al., 2005), activities of daily living (ADL) disability (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995), and survival (Studenski et al., 2011). The TUG is used as a screening test for assessing dynamic balance and basic mobility in the elderly (Podsiadlo & Richardson, 1991), and its results are correlated with fall risk and ADL disability. These tests have been proven to be valid and reliable (van Hedel, Wirz, & Dietz, 2005) and might be less influenced by culture, language, and education level (Guralnik et al., 1995). However, considering that falls often occur during locomotion (Helbostad & Moe-Nilssen, 2003), frail elderly individuals are at risk of falling while performing them. Furthermore, it is difficult to use these mobility tests to assess the physical performance of immobile patients (van Iersel, Munneke, Esselink, Benraad, & Olde Rikkert, 2008).

We performed the seated side tapping test (SST), which requires the subject to move their body laterally to the left and right in turn ten times as quickly as possible while remaining in a seated position. In community dwelling elderly, significant correlations were found between the results of SST and gait speed ($r = -0.43$), and TUG results ($r = 0.59$), and they were also significantly associated with instrumental ADL disability (Higuchi, Iwata, & Fuchioka, 2012).

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Moreover, in frail elderly individuals, significant correlations were detected between the results of SST and gait speed ($r = -0.59$), and TUG results ($r = 0.63$), and the results of the test also displayed significant relationships with ADL scores and the use of walking aids (Iwata et al., 2013). Thus, SST provides useful information about mobility in the elderly. However, we are not able to clarify why the results of SST are associated with mobility and which aspects of the test are most closely linked to mobility.

Lateral movements during walking are indicative of dynamic balance (Lark & Pasupuleti, 2009). Lateral instability has been reported to occur with aging (Rogers & Mille, 2003) and has a particularly profound effect on walking function (Schrager, Kelly, Price, Ferrucci, & Shumway-Cook, 2008) and fall risk (Maki, Holliday, & Topper, 1994). In contrast to anterior–posterior stability, lateral stability is more dependent on feedback and needs to be controlled more actively (Bauby & Kuo, 2000). Based on these findings, we devised an SST that requires the subjects to move their trunk laterally. However, it is not yet clear whether the relationship between trunk movement and mobility is affected by the direction of the movement. To clarify why SST is associated with their mobility, it is necessary to confirm whether the movement direction of the test can affect the mobility or not.

Movement velocity is affected by muscle power (Valour, Rouji, & Pousson, 2004), and muscle power declines more rapidly than strength in the elderly (Izquierdo et al., 1999). Muscle power production is closely associated with physical function (Bean et al., 2003) and has a large impact on mobility (Cuoco et al., 2004). Based on these findings, we assumed that trunk movement velocity is closely linked to mobility and developed SST to examine this. On the other hand, the functional reach test is a clinical measure of balance that measures maximal forward reach in the standing position (Duncan, Weiner, Chandler, & Studenski, 1990). Performance in this test decreases with age (Duncan et al., 1990) and is associated with walking speed (Weiner, Duncan, Chandler, & Studenski, 1992) and fall risk (Duncan, Studenski, Chandler, & Prescott, 1992). The lateral and backward maximal distances achieved during the multi-directional reach test are also significantly associated with the results of mobility tests (Newton, 2001). A seated version of this reach test has been used to evaluate sitting balance (Katz-Leurer, Fisher, Neeb, Schwartz, & Carmeli, 2009; Thompson & Medley, 2007; Tsang & Mak, 2004), and the distance achieved in this test was found to be correlated with mobility after acute stroke (Tsang & Mak, 2004). Thus, the maximal reach distance, which reflects the limits of stability, is also linked to mobility. Therefore, it would be interesting to know which of the two parameters (the quickness or range of movement) makes the most important contribution to mobility.

We hypothesized that: (1) lateral trunk movement in a seated position is a more important determinant of mobility than anterior–posterior trunk movement, and (2) that the quickness of trunk movement is more strongly associated with mobility than its range.

2. Methods

2.1. Participants

One hundred and forty community-dwelling elderly participants were enrolled in this cross-sectional study. The participants were recruited through local senior centers and local newspaper advertisements. The inclusion criteria were: (1) being ≥60 years of age, (2) being able to walk without any assistive devices, (3) being able to abduct their arms to 90 degrees without pain, and (4) the ability to understand and follow our instructions. This study was approved by the Human Ethics Committee of Osaka Prefecture University, and written informed consent was obtained from all participants.

2.2. Measurements

To address our hypotheses, we examined the strength of the relationship between the results of trunk movement tests in a seated position (i.e., SST, seated anterior–posterior tapping test (APT), and lateral sitting functional reach test (sitting reach test)) and those of mobility tests.

The participants performed the following physical performance tests in a random order: SST, APT, sitting reach test, maximum gait speed, TUG, five times sit to stand test (STS), and quadriceps strength. All timed performance tests were measured using a stopwatch and recorded to the nearest 0.1 s. Each test was performed twice after a practice trial, and the best time was used for the subsequent analysis.

2.3. Trunk movement tests

The apparatus used for SST is shown in Fig. 1 (Iwata et al., 2013). We put two stands on either side of the subject and a marker was placed on each stand. Before measurements were obtained, the participants raised their arms to shoulder height, and the stands were moved so that they were located 10 cm from the tips of their

Fig. 1. Apparatus required for the seated side tapping test (SST). MT: measuring tape; St: stand.