RELIABILITY AND VALIDITY OF FOUR STEP SQUARE TEST IN OLDER ADULTS

ABSTRACT

Introduction: The aim of this Cross-sectional descriptive study was to determine the reliability and validity of Four Step Square Test for use to evaluate balance ability in older adults.

Materials and Method: Participants were 44 men and 36 women (n=80; Mean age of the participants were 72.69±5.09 years. Participants performed the Four Step Square Test, the Time Up & Go test, the Functional Reach test, the One Leg Standing test and completed the Berg Balance Scale.

Results: The Four Step Square Test has good Cronbach’s Alpha (0.96) with the other balance measures. The Four Step Square Test has good correlations with the Time Up & Go test (p<0.001) and in the same way there were a good correlations between the Four Step Square Test and Berg Balance Scale (p=0.001).

Conclusion: Four Step Square Test is a reliable and valid tool for measuring the dynamic balance ability in older adults.

Key Words: Postural Balance; Aged; Reproducibility of Results.

YAŞLILARDA DÖRT ADIM KARE TESTİNİN GEÇERLİLİK VE GÜVENİLİRLİK ÇALIŞMASI

Öz

Giriş: Bu çalışma dengeyi değerlendirmek için kullanılan Dört Adım Kare Testi (Four Step Square Test’i) yaşlılar üzerinde geçerlilik ve güvenirlibilik çalışması yapmak amacıyla planlanmıştır.


Bulgular: Dört Adım Kare Testinin geçerliliği için; daha önce geçerlilik ve güvenirlibilik saptanmış testler ile Dört Adım Kare Testi skorları karşlaştırılmıştır. Cronbach Alpha ölçümü sonucu ise 0,96 bulunmaktadır. Dört Adım Kare Testi ile Süreli Kalk Yürü Testi arasında güçlü bir ilişki (p<0,001) ve aynı şekilde Dört Adım Kare Testi ile Berg Denge Skalası arasında da güçlü bir ilişki (p<0,001) bulunmaktadır.

Sonuç: Dört Adım Kare Testi yaşlılar için geçerli ve güvenir bir testtir.

Anahtar Sözcükler: Postural Denge; Yaşlı; Geçerlilik ve Güvenirlibilik.
INTRODUCTION

The ageing process has chronological, biological, social and psychological dimensions. The physiological and physical changes that occur among the elderly limit or prevent some activities in individuals (1). The prevalence of some acute and chronic diseases is related to the ageing process. Ageing is related to a high incidence of functional and physical deficiency regardless of whether it is related to a particular disease (2). Falls resulting in injuries increased by 46%–60%, depending upon the amount that physical activity level decreases of 19%–26% on elderly (3). The most important causes of falling among older adults are a decrease in mobility and in ability to maintain balance. Most falls that result in injuries occur during movement. The balance is the ability of keeping the centre of body gravity within the support level and ability of maintaining this situation (1,2,4).

Clinical, laboratory and functional approaches are used to evaluate balance in the elderly (1,4,5). Clinical balance measurements include static balance tests, such as timed heel-toe stance and single leg stance (4,5,6). Laboratory balance tests assess dynamic postural reflexes using various tools and force platforms. In addition, balance evaluations in the laboratory environment frequently combine static and dynamic balance tests (4,5).

This study was planned with the aim of improving the objective evaluation method of the Four Step Square Test (FSST) used by the medical team that evaluates balance of older patients in the clinical setting. This study includes evaluating both its validity and reliability. The result of this study may help clinicians to use balance assessment to improve the quality of health of the elderly.

MATERIALS AND METHOD

Our study was conducted between May and August of 2013 on the elderly residents, aged 65–85 in nursing homes. Before starting the study, informed consent was obtained from the volunteer participants. Using inclusion and exclusion criteria described below, a total of 80 cases were found suitable for participating in the study.

Inclusion Criteria of the Study

- Healthy individuals aged 65–85
- No history of surgery of a lower extremity or the lumbar spinal region
- Able to independently perform activities of daily living

Exclusion Criteria of the Study

- Individuals with a result of 7 or less on the Hodkinson’s Abbreviated Mental Test
- Presence of a cognitive, vision or hearing impairment,
- Individuals with a lower extremity impairment that could affect balance.

This study was certified by the Pamukkale University Medical Ethics Committee (B.30.2.PAU.0.20.05.09/90).

Outcome Measurement

Demographic features, dominant extremity, educational background, additional diseases, use of adaptive mobility equipment and vision and hearing disorders of all participants were recorded.

Static and dynamic balance tests were used to evaluate balance level of the participants. The Single Leg Stance Test (SLST) and Functional Reach Test (FRT) were used as static balance tests. The Four Step Square Test (FSST), Timed Up and Go Test (TUGT) and Berg Balance Scale (BBS) were used as dynamic balance tests.

Before obtaining measurements, we informed the participants regarding the tests and the positions they would be asked to perform in them. The physical therapist (PT), who recorded each test in the study, demonstrated the correct way to perform each position. Then, before each test, the participants were allowed to make one timed trial to accustom them to the measurement method and decrease the potential negative effect of unfamiliarity with the test on their scores. Because multiple tests were recorded per session, 5-min rest breaks were provided to the participants to reduce the potential effect of fatigue on the results.

Static Balance Tests

The Single Leg Stance Test (SLST); one leg is raised without touching the standing leg. At the beginning, the eyes remain open. The patient is instructed to close his/her eyes, and he/she should sustain his/her balance for 30 second. If the raised leg touches the supporting leg, if the raised leg touches the ground, if the patient hops on the standing leg, or if he/she touches something for balance, the presence of a balance disorder is suspected.
Inability to balance on one leg for 30 s during SLST is an indicator of decreased balance function. However, the clinical expectation for the ability to balance on one leg decreases based on the patient’s age. Healthy individuals who are 60–69-year-old should be able to stand on one leg with eyes open for at least 5 s (7).

Functional Reach Test (FRT); developed by Duncan et al., FRT is a reliable and validated test used in clinical measurement of balance. While standing barefoot in a relaxed position, the patient is instructed to raise his/her right arm to 90° and then to reach forward with the right arm to the farthest position that he/she can without taking a step and losing his/her balance. During FRT, the physical therapist observes whether the patient keeps both feet on the ground and does not step forward. If either of these behaviors occurs, the patient repeats the test. Functional Reach Test is repeated three times, and the best measurement is recorded (8). Decreased reach ability indicates that the patient’s has an increased future fall risk; a value of 15 cm or lower indicates a markedly increased fall risk, whereas a value of 15–25 cm indicates a mild fall risk (9,10).

Dynamic Balance Tests

The Four Step Square Test (FSST); test clinically assesses the ability to change directions while stepping. At the beginning of the test, the patient stands on the upper left square (Square 1) and faces in the direction of Square 2. First, the stepping sequence is clockwise: Square 1, followed by Squares 2, 4 and 3. Then, the stepping sequence is counterclockwise: Square 3, followed by Squares 4, 2, and 1. The patient is instructed to step through the sequence as quickly as possible without touching the canes and contacting both feet with the ground in each square (10). The physical therapist demonstrates the test and the patient is allowed to practice the pattern to learn the sequence. The test is repeated if the patient cannot complete the sequence successully or if he/she either loses his/her balance or touches the cane. Two scores are obtained, and the better of these two scores is recorded. The timed effort begins when the first foot touches the ground in Square 2 and then ends when the patient’s second foot contacts the ground in Square 1 (10,11,12).

Timed Up and Go Test (TUGT); the test evaluates functional mobility, balance and performance in adults aged 65 years and older. Wearing his/her regular shoes and customary walking aids, the patient begins the test seated in a standard armchair with his/her back against the chair, arms rested on the chair’s arms and both feet flat on the floor. The patient is instructed to rise and walk to a line on the floor 3 m away, turn around at the line, walk back to the chair and sit down in the chair. The test ends when the patient’s buttocks touch the seat. The test is repeated twice; the fastest time is recorded.

A time of <10 s is classified as mobile; <20 s as generally independent and >30 s as limited mobility (10,13,14).

Berg Balance Scale (BBS); test is a 14-item scale designed to measure balance of the elderly in a clinical setting. It can be used to detect the fall risk. Each item is scored between 0 and 4 points in accordance with the ability of the patient to meet specific time and distance requirements of the test. The lowest level of function indicates ‘0’ indicates the lowest level of function and ‘4’ indicates the highest level of function. The patient’s score the score indicates the ability in terms of completing the duty independently. The total score ranges from 0 to 56. For this study, scores ranging from 41 to 56 indicate that the patient’s balance is good; scores ranging from 21 to 40 indicate that the patient’s balance is acceptable (may need some assistance), and scores from 0 to 20 indicate that the patient’s balance is poor (cannot ambulate) (12,13).

Statistical Evaluation

All data were computed and calculated using Statistical Package for the Social Sciences (SPSS) for Windows statistical program (20.0 versions) p<0.05 was accepted statistically significant. Descriptive results were given as min-max., mean± standard deviation (mean±sd) and percentage (%). The Reliability Analyze was used to look Cronbach alpha value a selected sample (n=20) with one week interval (test-retest). Pearson correlation analysis was used to show the relation between FSST and other four balance tests (15).

RESULTS

A total of 80 were participants included in the study with average age of 72.69±5.09 participated to the study; 55% (n=44) were male and 45% (n=36) were female. Average height, body weight and body mass index (BMI) were 165.35±6.29 cm, 71.05±8.72 kg and 25.90±2.02 kg/m², respectively. The right lower extremity of 78.8% (n=63) was dominant, whereas the left lower extremity of 21.2% (n=17) was dominant.

Test-Retest Reliability

Test-Retest analysis was done to look Cronbach alpha (internal consistency) it was found to be 0.96 (p<0.001).
When static balance test results were examined, the average values of SLST and FRT were 16.37±10.54 s and 9.38±4.02 cm, respectively. According to FRT results, the majority of participants showed a high fall risk. When dynamic balance test results examined, the average values of FSST, TUGT and BBS were 15.24±5.06 s, 15.18±5.61 s and 50.08±4.19, respectively. Berg Balance Scale results showed no significant balance impairment in our study group. Static and dynamic test results are shown in Table 1.

**Simultaneous Validity**

When the relationship between FSST and the other balance tests was examined, a negative statistically significant (r=-0.348; p <0.01) relationship with SLST among static balance tests was observed. Similarly, a negative statistically significant (r=-0.232; p=p<0.05) relationship was observed between FSST and FRT.

When the relationship between FSST and other dynamic balance tests was examined, a positive statistically significant (r=0.595; p<0.001) relationship was observed with TUGT among static balance tests. A negative (r=-0.641; p<0.001) relationship was observed between FSST and BBS. The relationship of FSST with static and dynamic balance tests is shown in Table 2.

**DISCUSSION**

In our study, according to the test-retest reliability results of FSST, it was determined that FSST was homogenous and has strong internal reliability. When simultaneous validity results were examined, it was determined that FSST is a valid test method for assessing balance among the elderly.

Dite et al. (3) studied 81 geriatric patients (average age, 70 years) to rate validity and reliability of FSST in Australia. Their participants were divided into three groups. The first group consisted of patients who had fallen two or more times in the previous 6 months, the second group consisted of patients who had fallen less than once in the previous 6 months and the third group consisted of patients who had never fallen in the previous 6 months. They used TUGT, FRT and FLST tests as well as FSST to assess balance and observed a negative relationship (r=-0.83) between FSST and TUGT scores as well as a negative relationship (r=-0.47) with FRT and a positive relationship (r=0.88) with TUGT (p<0.001). The optimum score of the FSST to differentiate between the individuals with decreased balance and an increased risk of falling from healthy individuals was at 15 s. The results of our study showed scores similar to those of Dite et al.; this indicates that FSST can be used effectively to rate balance and fall risk in both of these communities.

Whitney et al. observed average FSST scores among their 32 participants (average age, 67.3 years) of 13.6 s. They divided participants into three groups based on the number of falls each participant reported per day. The group of participants who had no falls received FSST scores from 9 to 11 s; the individuals who fell once a day received scores from 12 to 18 s, and the participants who reported falling two or more times per day received scores from 14 to 21 s. The average FSST score in our study was 15.24 s. Comparing our scores with those of Whitney et al., we observed that our FSST scores were reliable to identify our participants as individuals with a significant risk of falling (16).

Blennerhassett, et al. used FSST method to assess pre-treatment and post-treatment balance on 37 ambulatory hemiparetic individuals (14 right hemiparetic, 16 left hemiparetic and seven bilateral hemiparetic), with an average age of 53 years. Average FSST score of the pre-treatment individuals was 20.8±15.0 s; Average FSST score of the post-treatment individuals was 17.9±11.6 s. According to these results, FSST is
a sensitive and reliable test not only for healthy elderly individuals but also for evaluating balance changes receiving hemiparetic rehabilitation services (17).

Ceceli et al. measured SLST scores of their elderly participants to be 12.4±10.73 s. In our study, the average SLST score was 16.37±10.54 s, which negatively correlated (r=-0.348) with FSST (p<0.01) (18,19). In contrast, Ceceli et al. stopped recording when their participants successfully reached the time of 30 s. Therefore, two groups of SLST scores differed.

Finally, several tests have clinical uses to evaluate balance in the elderly. We observed there are very few easily understandable clinical methods that are simple and fast to administer. We believe that FSST, whose validity and reliability we evaluated in this study, is important because it is easy to administer, requires only a short time to administer, is easy to understand and produces valid and objective results. We believe that studies on the application of FSST to patient populations with different types of impairments as well as with other age groups can help to determine valid cut-off scores that may indicate risks of falling.

Conflict of Interest

All authors of this study declare no conflict of interest.

REFERENCES