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ORIGINAL STUDY

Test-retest reliability of the 50-foot timed walk and 30-second chair stand test in patients with total hip arthroplasty

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The purpose was to investigate the test-retest reliability of the 50-Foot Timed Walk (50FWT), and 30-Second Chair Stand Test (30CST) in the patients with total hip arthroplasty (THA). The study was a test-retest study. Thirty-seven patients with THA performed two trials for both the 30CTS and 50FWT on the same day with one hour interval. To assess reliability, the intra-class correlation coefficient [ICC(2,1)], standard error of measurement (SEM), the smallest real difference at the 95% confidence level (SRD95) were calculated. The ICCs for the 50FWT and 30CTS were 0.98 and 0.94, respectively. The SEM and SRD95 for the 50FWT and 30CTS were 0.3 and 0.8 seconds and 0.4 and 1.2 repeats, respectively. The test-retest reliability of the tests was very high. The 50FWT and 30CST are very reliable to measure the functional performance in patients with THA in the clinical settings.

Keywords : hip ; gait ; outcome ; arthroplasty.

INTRODUCTION

Total hip arthroplasty (THA) is a safe and effective treatment for advanced hip arthritis that does not respond to conservative treatment (*19,21*). Evaluation of outcomes following THA is important because of the rising number of procedures, advancements in prosthetic design, and a corresponding expansion of the population considered eligible for these procedures (*14,19*).

It is reported that the most important priorities of patients after THA are pain reduction, return to normal daily living activities and having an active lifestyle. Walking and standing up from a chair are related to an active and independent lifestyle and are therefore important for achieving these goals (*18*). Therefore performance-based measurement methods are commonly used for measuring physical function in patient, planned or implemented THA (*9*). Walking short distances and sit-to-stand activities are recommended as the minimal core set

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of performance-based outcome measures in osteoarthritis research and clinical practice (*6*).

The 6-Minute Walk Test is widely used and well-defined method to measure physical function in many diseases, including THA (*19*). However, longer walk tests might overburden patients especially if they use walking aids, and may be more difficult to perform routinely in clinical practice. Thus, a shorter walk test is novel, and more clinically practical (*18*). The 50-Foot Timed Walk (50FTW) is a common gait assessment in trials involving people with rheumatic disease or osteoarthritis. The 50 feet is nearly 15.24 meters. Therefore the 50FWT represents a compromise between assessing walking performance over short distances, such as 8 or 10 meters, and long distances such as in the 6-Minute Walk Test.

The 30-Second Chair Stand Test (30CST) assesses the number of times a person can stand then sit in a chair in 30 seconds. There are earlier versions of the chair stand test which include 5 and 10 sit-to-stands. However, the 30CST protocol makes it possible to assess wider variations in ability levels and reduce potential floor effects (*9*).

Reliability is extremely significant, especially in research trials and clinical practice. Because measurement methods must be reliable in order to measure correctly the effectiveness of treatment and changes over time. The 50FWT and 30CST were reliable in subjects awaiting joint replacement surgery of the hip or knee (*9*). However, reliability is population-specific, it is important to examine the reliability of the 50FWT and 30CST in patients who have undergone THA.

The purpose of this study was to investigate the test-retest reliability of the 50FWT and 30CST in the patients with THA.

PATIENTS AND METHODS

The study was designed as a test-retest research. Thirty-seven patients with primary THA were recruited from the university outpatient clinic on June 2013-October 2013. All patients informed consent that was obtained in accordance with the Declaration of Helsinki. This study was approved by the Ethics Committee of Dokuz Eylül University. All the patients had been operated by the same surgeon. The patients older than 18 years old and at least one year passed after their THA operation were included in the study. The exclusion criteria were unable to understand verbal and written instructions, experienced hip pain at rest of more than 50 mm on a 100-mm visual analogue scale (VAS), having previously orthopaedic (e.g. fracture) or neurological disorder (e.g. hemiplegia) that causes gait disturbance, and revision THA.

In addition to the demographic and clinical data of patients, the Harris Hip Score (HHS) was recorded. The HHS is reliable measurement method which is commonly used to follow patients after an operation for a degenerative disorder of the hip and contains questions about pain, function, absence of deformity, and range-of-motion (*11*). The best possible score is 100 points.

The protocol described by Gill and McBurney was used for the 30CST (see Appendix, Table III) (*9*). The starting position of patients was standardized including buttock placement, back support, use of hands and foot placement in the 30CST (*9*). The same chair which had a height of 17 inches was used in all assessments. Thirty seconds were measured with a handheld stopwatch. The total number of completed chair stands within 30 seconds was counted.

The protocol described by Gill and McBurney was also used for the 50FWT (see Appendix, Table IV) (*9*). The 50FTW has been completed by walking 25 feet, turning around 180 degrees and walking 25 feet back to the starting position (*9*). Subjects were advised to 'go as fast as you can safely walk'. Walking tests can be applied in two ways ; "normal speed" and "as fast as possible". However, "as fast as possible" method was shown more reliable in a study (*10*). Therefore, we preferred "as fast as possible" walking protocol in this study. Time was assessed with a hand-held stopwatch and recorded in seconds with one decimal.

All assessments were applied by the same physiotherapist who has been working in the orthopaedic field for five years and was familiar with these tests. Additionally, this physiotherapist was trained for the test protocols by the primer author. "Warm-up" trials were done for each test to allow the measurements to stabilize and limit any learning effects prior to reliability testing. The 30CTS and 50FWT were performed in 5-minute intervals. Patients performed two trials for both the 30CTS and 50FWT on the same day. Between the trial 1 and 2, patients waited for an hour on sitting position in order to prevent fatigue. During this period, patients were recommended drinking water, but not allowed to drink tea or coffee. Prior to each trial, we gave standardized verbal instructions to the patients on how to perform the test. No

patients needed to use any assistive device (e.g. crutches, cane) during the tests.

Before and after each test trial, we examined the hip pain experienced by the patients, using a 100-mm VAS which typically consists of one horizontal or vertical 100 mm long line, with endpoints – visible to the patients – of "no pain" and "worst pain imaginable". A VAS may be only formed from a straight line or it may be written in words that describe pain at equal intervals on this line. It is generally accepted that a VAS with a vertical line that is more easily understood (*4*). In this study, before and after each trial a 100-mm vertical VAS was used to assess hip pain.

Statistical Analysis

The Kolmogorov-Smirnov/Shapiro-Wilk tests were used for the determination of the normal distribution. Paired-samples t test was used for comparing the difference between the pain levels before and after the trials. The level of significance was determined at $p < 0.05$. The intra-class correlation coefficient (ICC) test was used for calculation of reliability between the two tests. The ICC (2,1) model was used due to a single value that measures for each patient and each subject was rated by the same rater (*2,19*). The standard error of measurement (SEM) was calculated to ensure the accuracy of the measurement method. The SEM was calculated from the square root of the mean square error term in the repeated measures ANOVA. The smallest real difference at the 95% confidence level (SRD95) was calculated (*15*). The SRD95 was obtained by multiplying the point estimate for the SEM by the $z = 1.95$ for the 95% confidence interval (i.e. the SRD95 was calculated according to the formula ; $SRD95 = SEM \times 1.96 \times \sqrt{2}$). All data were analysed using the IBM® SPSS® Statistics (Version 20.0) software.

RESULTS

Thirty seven patients with THA participated in this study. The mean age was 54.5 (15.5) years. There were 20 female and 17 male patients. The functional level of the patients was excellent. The mean time after THA operation was 5.3 (3.5) years. The demographic and clinical characteristics of the patients are shown in the Table I.

In this study, the ICCs for the 50FWT and 30CTS were 0.98 and 0.94, respectively. The SEMs for the 50FWT and 30CTS were 0.3 seconds and 0.4 repeats, respectively. The SRD95s was 0.8 seconds for the 50FWT and 1.2 repeats for 30CTS. The test-retest reliability results are shown in the Table II. There was no significant difference in the mean VAS scores measured end of the tests between the first and the second the 50FWT and 30CST trials ($p > 0.05$). No test trial was disqualified from the analysis.

DISCUSSION

Total hip arthroplasty has led to greater acceptance of this intervention based on solid evidence that demonstrates the efficacy, safety, and cost-effectiveness of this surgical intervention as compared with other medical interventions. Unfortunately, there are no gold standards in terms of THA outcome tools (*5*). Ideally, outcome measurements used to assess an intervention such as THA must be valid, reliable, and responsive to changes in a patient's condition. Establishing the reliability of an outcome measure is a prerequisite to establishing

Table I. — The demographic and clinical characteristics

Variables	Mean (SD) or frequency, n = 37
Age (years)	54.5 (15.5)
Number of Female / Male	20 (54.1%) / 17 (45.9%)
BMI (kg/m^2)	28.35 (5.25)
Time after THA operation (years)	5.3 (3.5)
HHS – Right / Left	93.3 (8.3) / 93.2 (8.1)

BMI, Body Mass Index ; HHS, Harris Hip Score.

Table II. — The test-retest reliability results of the 50FWT and 30CST in patients with THA

	First Trial mean (SD)	Second Trial mean (SD)	ICC (2,1)	95% CI	SEM	SRD95
50FWT (seconds)	20.2 (8.4)	19.9 (8.7)	0.98	0.97 to 0.99	0.3	0.8
30CTS (repeats)	12.8 (3.8)	13.4 (4.1)	0.94	0.88 to 0.97	0.4	1.2

THA, Total hip arthroplasty ; 50 FTW, 50-Foot Timed Walk ; 30CST, 30-second Chair Stand Test ; ICC, Intra-class correlation coefficient ; CI, Confidence interval ; SEM, Standard error of measurement with a 95% CI ; SRD95, Smallest real difference at the 95% confidence level.

meaningful data. However, there has not been any study showing the reliability of the 50FWT and 30CST after THA. This is the first study that investigated the reliability of the 50FWT and 30CST in patients with THA. The results of this study showed that the 50FWT and 30CST had very high test-retest reliability in patients with THA.

By six months, patients have usually completed physical therapy and are quite active, and most patients consider the hip to have recovered fully by this time (*16*). All the patients were operated at least one year ago at the testing time. Additionally, we performed the HHS to determine the functional level and the results showed that the patients had an excellent functional level. These findings showed that the patients had plateaued after the surgery and they were at suitable stage to be included this test-retest reliability study. Pain level in all patients had not been determined any significant increase at the end of the tests according to the VAS. This result suggests that clinicians can use these tests safely without increasing pain levels and these tests can also be tolerated by patients.

Walking is related to an active and independent lifestyle (*19*). Walking speed is an important aspect of gait and is commonly used as an objective measure of functional mobility in both clinical and research settings. Walking speed has been shown to be a key factor in determining rehabilitation needs and discharge location and has the potential to predict the future health status, functional decline, fear of falling, and fall risk (*8*). In addition to these objectives, assessment of walking after THA provides important information about the healing process (*19*). Therefore, walking has to be assessed in patients with THA. These values are important when investigating the effect of interventions on functional performance in THA. The current study is the first study that investigated the reliability of the 50FWT and it was found that the 50FWT had the ICC of 0.98 for subjects with THA. Grace *et al* showed that the 50FWT had the ICC of 0.90 for subjects with rheumatoid arthritis (*10*). Schilke *et al* also found that 0.97 for subjects with knee osteoarthritis (*17*). Gill and McBurney showed that the 50FWT had an excellent reliability in people awaiting joint replacement surgery of the hip or knee (*9*). Taking all these results into consideration, the 50FWT is a reliable measurement method for subjects with THA. The benefits of the shorter walk test require a stopwatch, and as little as a 50 feet space to walk forward, it requires no special equipment, it requires little additional time.

The ability to rise from a chair is an important activity of daily living and is one of the activities used in functional indexes and in test batteries of physical functioning (*7,12,20*). Decreased ability to rise from a chair is important, because it can limit independence or contribute to institutionalization. The inability to rise from a sitting position is recognized by the World Health Organization as a disabling condition. Chair rise performance correlates with walking speed, independent ambulation and stair climbing (*7,20*). Chair stand test can be an indicator of lower extremity strength. Hughes *et al* showed that a person requires an average of 97% of lower extremity muscle strength for rising from a chair (*12*). The chair sit and stand activity is commonly used in both assessment and therapy. The benefits of the simple chair rise test of extensor mechanism function are that it requires no special equipment, it requires little additional time, and it can be performed in the examining room as a part of every patient evaluation (*7*). For the 30CST, the

ICCs between 0.84 and 0.92 were found in community dwelling older adults (*13*). Gill and McBurney also demonstrated the ICCs between 0.95 and 0.98 for people awaiting joint replacement surgery of the hip or knee (*9*). In our study the 30CST has very high reliability in the patients with THA.

The scores obtained on outcome measures must have meaning to clinicians. The ICC values are not enough to be useful in clinical practice. Therefore the SEM was used to identify the error associated with a patient's score and to estimate the value of SRD95, which provide a threshold for interpreting the scores in the tests over time (*1*). These values are important when investigating the effect of interventions on functional performance in THA. A greater change than SRD95 is often interpreted as a true change. Our study has shown that the 50FWT and 30CST have SRD95 of 0.8 seconds and 1.2 repeats, respectively. Clinicians and researchers can use these values to detect the real differences in the patients' performances.

Study Limitations

Like many other studies, we used time or distance as an indicator of physical function. We do not profess that time or distance is the sole indicator of physical function ; however, we believe that time or distance captures the essence of physical function to a much greater extent than pain, which traditionally has been viewed as requiring an independent assessment (*3*). Second, we chose the 50FWT and 30CST because they are simple, practical, and appropriate for THA patients. However, there are other performance-based tests available, and we are not able to recommend which are best to evaluate physical function in THA patients. Third, psychometric properties beyond reliability should be assessed for the 50FWT and 30CST in patients with THA.

CONCLUSION

The test-retest reliability of the 50FWT and 30CST was very high for patients with THA. In addition, the 50FWT and 30CST were well received by patients and most were willing and able to complete both tests during postoperative office visits. These tests are simple, less time consuming and reliable methods to measure the functional performance in patients with THA in the clinical settings.

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APPENDIX

Table III. — Protocol for the 30-second Chair Stand Test *(9)*

Patient Set-up	1. Use a chair with a 17-inch seat height. 2. Place the chair against the wall to prevent it from moving during the test. 3. Two lines are placed on the seat 10 and 14 inches from the front edge of the chair. 4. Flat or low-heeled shoes must be worn. If the patient has high-heeled shoes of greater than one inch, ask them to perform the test barefooted. 5. Sit the patient in the middle of the chair so that their sacrum is somewhere between the two lines at a place the patient finds comfortable. 6. Allow the patients to position their feet as they find comfortable. 7. Do not allow them to lean against the backrest of the chair but ask them to sit up with their back straight. 8. Ask them to cross their arms across their chest.
Instructions to patient	1. 'This test looks at how many times you can stand and sit from a chair in 30 seconds.' 2. 'If you do not fully stand or sit down so that your bottom touches the seat, that repetition will not be counted.' 3. Demonstrate the movement. 4. Allow one practice stand by the patient. 5. 'When I say "GO", I want you to stand up and sit down as many times as you can in 30 seconds.' 6. 'If you have pain that becomes too uncomfortable, you are allowed to stop the test.' 7. 'Do you understand what you need to do ?' 8. 'Are you ready ?' 9. 'Ready, set, GO.'
General guidelines	1. If the patient is more than halfway up at the end of 30 seconds, it counts as a full stand. 2. Do not offer any encouragement before or after each test other than 'well done'. 3. If a patient expresses concern about performing a task, tell him/her to 'do the best that you can'.

Table IV. — Protocol for the 50-Foot Timed Walk *(9)*

Patient Set-up	1. Mark out a 50-foot walkway with lines on the floor at each end. 2. Instruct the patient to stand with toes touching the line facing the length of the 50-foot walkway.
Instructions to patient	1. 'I am going to time how fast you can walk 50 feet.' 2. 'I want you to go as *fast as you can safely walk*. Do not slow down until after you pass the end line.' 3. Demonstrate the test and show patient where the end line is. 4. 'I want you to start when I say "GO", and I'll give you a "Ready, Set, GO".' 5. 'Remember, I want you to walk as fast as you can whilst still being safe.' 6. 'If you have pain that becomes too uncomfortable, you are allowed to stop the test.' 7. 'Do you understand what you need to do ?' 8. 'Are you ready ?' 9. 'Ready, set, GO.' 10. When repeating the test, read the script from 'Remember, I want you to walk as fast…'
General guidelines	1. Timing: start the stopwatch on 'GO', stop the stopwatch when the first part of the patient's trunk crosses the 50-foot line. 2. Walk a pace behind the patient to avoid influencing their speed but close enough to ensure their safety. 3. The patient is allowed to use a gait aid if this is their usual practice. 4. Do not offer any encouragement before or after each test other than 'well done'. 5. If a patient expresses concern about performing the task, tell him/her to 'do the best that you can'.