Abstract. Objective: To compare the Timed “Up and Go” and Functional Reach tests to the Berg Balance Scale for concurrent validity in a broad adult population. Design: A prospective study of individuals with balance deficits. Setting: Neurological rehabilitation, skilled nursing, and acute care facilities. Subjects: Twenty subjects: 12 females and eight males, aged 38 to 86 years (\(\mu=68\), SD=14.5). Intervention: The order in which the three tests were performed on each subject was randomized and the scores from the three tests were analyzed using correlation coefficients. Main Outcome Measures: Balance and correlations were based on scores from each of the three balance tests performed. Results: There was a significant correlation between the Berg Balance Scale and Timed “Up and Go” test (\(r=0.47\), \(p=0.04\)) but no significant correlation between the Berg Balance Scale and the Functional Reach test (\(r=0.42\), \(p=0.06\)). Pairing the Timed “Up and Go” and Functional Reach tests however, revealed a significant correlation (\(R=0.56\), \(p=0.04\)). Conclusion: This study suggests that the Timed “Up and Go” test alone or a combination of the Timed “Up and Go” and Functional Reach tests can be used as a simple measure of balance comparable to the Berg Balance Scale.

Key words: Timed “Up and Go”, Functional Reach, Berg Balance Scale

INTRODUCTION

Balance assessment is necessary for most patients in physical therapy settings in order to help establish appropriate treatment goals, increase awareness of fall risk, and assign appropriate assistive devices. The Berg Balance Scale (BBS) and Tinetti Performance-Oriented Mobility Assessment (POMA) balance subscale are the most commonly used balance assessment tools.

Harada et al.\(^1\), in a 1995 study, compared the BBS, POMA, Timed “Up and Go,” and Barthel mobility subscale. The BBS was found to have high inter-rater (ICC = 0.98) and intra-rater (ICC = 0.99) reliability and high internal consistency (Cronbach’s alpha = 0.96). They also found the BBS to be a more valid measurement of balance than the POMA and other clinical laboratory balance tests. Stevenson and Garland\(^2\) compared the BBS with laboratory measures of balance. They found the BBS to have excellent reliability in elderly subjects with acute strokes.

The BBS, although valid and reliable, takes 15 to 20 minutes to perform. Simpler 5-minute balance tests, such as the Timed “Up and Go” (TUG) and Functional Reach (FR) are available. Podsiadlo and Richardson\(^3\) conclude that a timed version of the “Up and Go” test is a valid test for quantifying functional mobility useful in following clinical change over time. Their results showed that the
Timed “Up and Go” had intra-rater (ICC = 0.99) reliability and correlated well with the BBS (r = −0.72, log transformed r = −0.81).

Functional reach is the distance a person can reach forward beyond arm’s length while maintaining a fixed base of support in the standing position. Duncan and Studenski\(^4\) showed that the FR test has concurrent validity in the assessment of balance. Measurements taken on a sample of elderly male veterans used a yardstick and bony landmarks. In both the Podsiadlo and the Duncan studies, the sample was limited to elderly persons.

Research is needed to substantiate the validity of the FR and TUG tests as a substitute for the BBS in a broader population. Previous studies comparing balance tests\(^1\)–\(^4\) have been limited to an elderly population. Because balance deficits are found in individuals of all ages, our study addressed balance assessment in a broad adult population. This study compared the Timed “Up and Go” and the Functional Reach tests to the Berg Balance Scale for concurrent validity in such a patient population.

**METHODS**

**Subjects**

This study examined 20 subjects between the ages of 38 and 86. The subjects came from outpatient rehabilitation, inpatient rehabilitation, and acute care facilities based on where each of the researchers had a clinical affiliation. Subjects needed a minimum score of 20 on the Mini Mental State exam\(^5\) to participate. The subjects also had to be able to stand for 60 seconds with a supervision level of assistance, without the use of an assistive, prosthetic, or orthotic device. Subjects with severe visual or auditory deficits were excluded from this study.

**Reliability**

We completed the following reliability studies before beginning the data collection for subjects in this study. To test our inter-rater reliability, the three balance tests were administered by members of the group to six normal subjects and to three subjects with known balance deficits twice in the same day. While one member of the group was administering the test, the other members of the group were watching and scoring the tests independently of one another. We compared the scores from each subject and calculated an intra-class correlation coefficient. We found the inter-rater reliability to be high for the Timed “Up and Go” (ICC = 0.99), Functional Reach (ICC = 0.99), and BBS (ICC = 0.98).

To test for intra-tester reliability each researcher contributed data from the same 11 subjects, eight normals and three with balance deficits. The tests were administered twice on the same day to each of the subjects. We calculated intra-tester correlation coefficients for each of the three tests. Mean intra-tester correlation coefficients for each test were as follows: Timed “Up and Go” (ICC = 0.98), Functional Reach (ICC = 0.97), and BBS (ICC = 0.68).

**Tools**

The Mini-Mental State exam, administered orally, measures cognitive performance in adults. It is divided into two sections, the first requiring oral responses and the second being a task performance section, with a maximum combined score of 35 points. A piece of paper and a writing utensil are the required tools to perform the task performance section of the exam. The higher the subject’s total score the higher their cognitive functioning. The Mini-Mental State exam has good intra-rater (r = 0.89) and inter-rater (r = 0.83) reliability. For this study, a minimum score of 20 met the inclusion criteria.

In the Timed “Up and Go” test, timed subjects rise from a chair, walk three meters, turn, walk back, and sit down. During this test, subjects wear their routine footwear. No assistive, orthotic, or prosthetic device is allowed during the test. No physical assistance is permitted. All chairs used have an approximate seat height of 45 cm and armrest height of 65 cm. We used a stopwatch to time each test and recorded the time in seconds. The subjects received no score if they were unable to complete the test or required assistance to refrain from falling during the test.

Functional reach is the maximum distance that
one can reach forward while standing and maintaining a fixed base of support. To perform the Functional Reach test subjects stand comfortably parallel to a wall, make a fist, and raise their arms to 90 degrees of flexion. A yardstick is placed parallel to the subject’s raised arms. The examiner measures and records the placement of the end of the subject’s third metacarpal along the yardstick, this being termed Position 1. In Position 2, the subject reaches as far forward as possible without losing his/her balance and the examiner measures and records the placement of the same landmark along the yardstick. Functional reach is defined as the mean difference between Position 1 and Position 2 over three trials in which each subject participates. If the subject touches the wall or requires any assistance from the examiner, it invalidates the trial. The examiner guards all subjects at a supervision level of assistance during the maneuver.

The Berg Balance Scale evaluates a subject’s functional balance by his/her performance on 14 activities common in everyday life. The activities in the scale address the subject’s ability to maintain positions of increasing difficulty by progressively diminishing the base of support. There are three dimensions to the test: maintenance of a position, postural adjustment to voluntary movements, and reaction to external disturbances. All items are graded on a five-point scale, zero to four (zero = unable to perform, four = independent), with detailed criteria for each point. The scores may range from zero to 56. Points are based on the time the position can be maintained, the distance the arm is able to reach forward, or the time to complete the task. Subjects receive fewer points if supervision, cueing, or assistance is required during the task or if the time or distance requirements are not met. The test takes about 15 to 20 minutes to complete and requires a step stool, mat table, chair with arms, tape measure, stopwatch, pen, and table.

PROCEDURES

Patients who met the inclusion/exclusion criteria were invited to participate in this study; they signed an informed consent before participating. Due to our positions as students interning at the facilities, and possible time constraints, not all patients who met the inclusion/exclusion criteria were invited to be in the study. This, however, did not bias the results of our study because we were comparing various test scores for each subject, not among subjects. We collected demographic information, including diagnosis, age, gender, and whether or not the subject was receiving physical therapy. If so, we recorded the therapy setting and whether treatment was specifically for balance.

Each subject performed the three balance tests in a randomized order to minimize the learning curve. Randomization also minimized bias due to fatigue that could have occurred if the tests had been consistently administered in the same order. A randomized list, made in advance, dictated the order in which the tests were performed. Each examiner received a copy of the list. To minimize fatigue, all subjects took a five minute rest between performance of each of the tests. We analyzed the data using correlation coefficients.

RESULTS

Twenty subjects participated in this study (12 females and eight males) with a mean age of 68 years (SD = 14.5; min. = 38 years, max. = 86 years). Sixty-five percent (13 subjects) received physical therapy treatments previously. Of the subjects receiving physical therapy, 85% received treatment specifically for balance. Sixty-five percent of all the subjects came from neurological rehabilitation facilities, 20% were from skilled nursing facilities, and 15% were from acute care settings. Diagnoses included CVA, spinal cord injury, brain tumor resection, Parkinson’s disease, hip open reduction internal fixation, COPD, general debilitation, vertigo, and brain injury. The majority of patients in the facilities where this study was implemented used assistive devices. This limited our sample size, due to the testing protocol which did not allow assistive devices to be used.

The mean score on the Timed “Up and Go” (TUG) test was 21.6 seconds (SD = 10.6 sec.). The mean score on the Functional Reach test (FR) was 17.7 cm (SD = 7.1 cm). The mean score on the Berg Balance Scale (BBS) was 43.5 (SD = 7.7).

There was significant correlation between the TUG and BBS ($r = -0.47$, $p = 0.04$). The correlation between the FR and BBS was not significant ($r = 0.42$, $p = 0.06$). The correlation analysis for the FR and TUG tests with the BBS demonstrated a significant multiple correlation coefficient ($R = 0.56$, $p = 0.04$). The multiple correlation between
We calculated correlations separately for the subjects who were receiving balance therapy. For this group (n = 11), there was significant correlation between BBS and TUG (r = –0.67, p = 0.02). The correlation between BBS and FR (r = 0.60, p = 0.05) was not statistically significant. This most likely was due to the small sample size. The group not receiving balance therapy (n = 9) showed no significant correlation between either the BBS and TUG (r = 0.39, p = 0.30) or the BBS and FR (r = 0.31, p = 0.43).

DISCUSSION

Analysis of the data collected in this study showed moderate significant correlation between the TUG test and the BBS, indicating that the TUG can be used as a simple measure of balance comparable to the BBS. We found the greatest correlation when the TUG, FR, and age were compared with the BBS. The combination of the TUG, FR, and age explained 37% of the variability in BBS scores.

The group of subject who received balance therapy had higher correlation coefficients than the group of subjects not receiving balance therapy. The components of “balance therapy” were not specifically defined in our methods or data collection since we were unaware that this might be a factor affecting the correlation of the three tests. Further research in this area is indicated to determine why this variable affected correlation coefficients.

The validity of our data may have been affected by several different factors. One factor was a possible learning curve in the FR test. Three trials were performed, during which time the subjects may have increased their confidence in their ability to reach further, had an increasing desire to reach further each successive time, and/or become more familiar with the test. It was also our experience that subjects could easily compensate, such as leaning forward prior to the initial measurement, trunk rotation and/or scapular protraction during various parts of the test in their attempt to gain more distance with successive reaches. Other factors that may have affected the validity of our data were the attitude and cooperation of the subjects. Impatient or anxious subjects may have caused researchers to attempt to collect data more quickly, possibly leading to less accurate measurements or scores.

Today’s managed care climate requires therapists to use their limited evaluation and treatment time as efficiently as possible. This study suggests that physical therapists can save time by using the TUG, or a combination of the TUG and FR tests, and still have a workable assessment of balance, as compared to the more time-consuming BBS. Because of the broad adult population used in this study, therapists can more confidently apply the results to all adult patients requiring balance assessment.

During our data collection, we discovered that for most of our subjects and potential subjects with balance deficits an assistive device was still necessary at the completion of their physical therapy treatment. In many cases we anticipated that the patient would continue to use the assistive device after discharge for all ambulatory activities, or at least for community ambulation. Therefore, the development of a balance test which permits the use of an assistive device is needed for patients using assistive devices on a long term basis. Such a test would allow for a more functional balance assessment.

During the initial literature review for this study, we found conflicting information regarding which test was the most reliable and valid measure of balance that should be used as a standard of comparison. Both Tinetti POMA balance subscale and the BBS are commonly used tests which each take approximately 15 to 20 minutes to administer. We chose to use BBS as our comparative standard because of the higher reliability demonstrated in clinical situations1). A more recent study by Thorbahn and Newton5) however, showed that the Berg Balance Scale is limited in predicting the likelihood of falls among older adults. They found the BBS to have high specificity in identifying persons at risk for falls, but low sensitivity to whether the test can predict who will fall. The Tinetti POMA balance subscale was found to be a
predictor of falls that occur with no obvious biomechanical precipitant and of falls precipitated by perturbation of center of mass7). It was not, however, predictive of falls occurring by perturbation of base of support7. A follow-up study comparing TUG and FR to the Tinetti POMA balance subscale is recommended.

At this time we have not found a test which incorporates the assessment of a subject’s reaction to both perturbation of center of mass and perturbation of base of support during ambulation. Because most falls among older adults occur during walking, this type of comprehensive test would be the best assessment of dynamic balance and is a much needed assessment tool for the future detection and treatment of balance deficits by physical therapists.

REFERENCES