ORIGINAL ARTICLE

Minimal Detectable Changes of the Berg Balance Scale, Fugl-Meyer Assessment Scale, Timed "Up & Go" Test, Gait Speeds, and 2-Minute Walk Test in Individuals With Chronic Stroke With Different Degrees of Ankle Plantarflexor Tone

Vimonwan Hiengkaew, PhD, Khanitha Jitaree, MSc, Pakaratee Chaiyawat, PhD

ABSTRACT. Hiengkaew V, Jitaree K, Chaiyawat P. Minimal detectable changes of the Berg Balance Scale, Fugl-Meyer Assessment Scale, Timed "Up & Go" Test, gait speeds, and 2-minute walk test in individuals with chronic stroke with different degrees of ankle plantarflexor tone. Arch Phys Med Rehabil 2012;93:1201-8.

Objective: To determine test-retest reliability and absolute and relative minimal detectable changes at the 95% confidence level (MDC_{95}) of measures to detect postural balance and lower limb movements in individuals with chronic stroke who were able to walk and had differences in ankle plantarflexor tone.

Design: Test-retest study. Data were collected on 2 occasions, about 6 days apart.

Setting: Outpatient physical therapy clinics.

Participants: Volunteers (N=61) with chronic stroke who were able to walk and had differences in ankle plantarflexor tone: no increase in ankle plantarflexor tone (n=12), a slight increase in ankle plantarflexor tone (n=32), and a marked increase in ankle plantarflexor tone (n=17).

Intervention: Not applicable.

Main Outcome Measures: Reliability and absolute and relative MDC_{95} of the Berg Balance Scale (BBS), the lower limb subscale of Fugl-Meyer Assessment (FMA-LE), the Timed "Up & Go" test (TUG), the comfortable gait speed (CGS), the fast gait speed (FGS), and the 2-minute walk test (2MWT).

Results: Excellent reliability of the BBS, FMA-LE, TUG, CGS, FGS, and 2MWT for all the participants combined and for the subgroups was shown. All the participants combined showed the absolute and relative MDC_{95} in the BBS of 5 points and 10%, FMA-LE of 4 points and 16%, TUG of 8 seconds and 28%, CGS of 0.2m/s and 34%, FGS of 0.1m/s and 21%, and 2MWT of 13m and 23%. The absolute and relative MDC_{95} of the subgroups were varied based on ankle plantarflexor tone.

Conclusions: The BBS, FMA-LE, TUG, CGS, FGS, and 2MWT are reliable measures to detect postural balance and lower limb movements in individuals with chronic stroke who have differences in ankle plantarflexor tone. The absolute and relative MDC_{95} of each measure are dissimilar in those with differences in ankle plantarflexor tone. The relative MDC_{95} seems more useful than the absolute MDC_{95} because the relative value can be used for a single individual.

Key Words: Cerebrovascular accident; Leg; Movement; Muscle hypertonia; Outcomes assessment (health care); Rehabilitation.

INDIVIDUALS WITH STROKE generally experience lower limb motor deficits.[1-3] To improve lower limb performance, interventions usually focus on postural balance training and lower limb mobility exercises.[4-6] There are several standardized outcome measures in stroke rehabilitation for postural balance assessment and lower limb movement evaluation. Therefore, a minimal change score of reliable outcome measures in a specific condition in individuals with stroke is needed for correct detection of change in the individual's status.

The minimal detectable change (MDC) is the smallest real difference score, and it is important because it helps clinicians to understand data in the clinical setting.[7] The difference score can be ascribed to an unsystematic mistake at a particular confidence level, usually 95%.[8] The minimal detectable change at the 95% confidence level (MDC_{95}) is an absolute value and depends on the units of measure.[9] However, it can be expressed as a percent value (percent value minimal detectable change at the 95% confidence level [MDC_{95}%]) to determine a change from baseline over time, and the MDC_{95}% is independent of the units of measurement.[9] The MDC_{95} is associated with the standard error of measurement.[9,10] Thus, it evaluates change scores in terms of variability of measure.

List of Abbreviations

ANOVA	analysis of variance
BBS	Berg Balance Scale
CGS	comfortable gait speed
CI	confidence interval
FGS	fast gait speed
FMA-LE	lower limb subscale of Fugl-Meyer Assessment
ICC	intraclass correlation coefficient
MAS	Modified Ashworth Scale
MCID	minimal clinically important difference
MDC	minimal detectable change
MDC_{95}	minimal detectable change at the 95% confidence level
MDC_{95}%	percent value minimal detectable change at the 95% confidence level
TUG	Timed "Up & Go" test
2MWT	2-minute walk test
6MWT	6-minute walk test
12MWT	12-minute walk test

From the Faculty of Physical Therapy, Mahidol University, Nakhon Pathom, Thailand.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

Reprint requests to Vimonwan Hiengkaew, PhD, Faculty of Physical Therapy, Mahidol University, 999 Phutthamonthon 4 Rd, Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand, e-mail: *ptvhk@mahidol.ac.th.*

In-press corrected proof published online on Apr 12, 2012, at www.archives-pmr.org.

0003-9993/12/9307-00920$36.00/0
doi:10.1016/j.apmr.2012.01.014

The Berg Balance Scale (BBS), the lower limb subscale of the Fugl-Meyer Assessment (FMA-LE), the Timed "Up & Go" test (TUG), the comfortable gait speed (CGS), and the fast gait speed (FGS) are reliable outcome measures that clinicians usually use to detect the functional abilities of lower limbs in individuals with stroke. The MDC_{95} on these measures has been reported in individuals with stroke in various conditions. Individuals with chronic stroke who had mild to moderate disability showed an MDC_{95} on the BBS of 6.7 points.[11] In addition, in 48 individuals with stroke undergoing inpatient rehabilitation, the BBS was tested on consecutive days.[12] The MDC_{95} was 6.9 points for all individuals with stroke, 6.3 points for individuals with stroke who walked independently, 6.0 points for individuals with stroke who required standby assistance, and 8.1 points for individuals with stroke who required physical assistance.[12] The MDC_{95} on the FMA-LE was 4.9 points in 49 individuals with stroke who were examined within 3-week intervals,[13] and 3.8 points in 60 individuals with chronic stroke undergoing outpatient therapy.[14] In 50 community-dwelling individuals with stroke, the MDC_{95}% on the TUG, CGS, and FGS was 23%, 22%, and 16%, respectively.[15]

Besides the reliable postural balance and lower limb movement measures, the 2-minute walk test (2MWT), 6-minute walk test (6MWT), and 12-minute walk test (12MWT) are simple tests showing acceptable inter- and intrarater reliability and high interest correlation when used for walking assessment in individuals with stroke.[16] In 50 community-dwelling individuals with stroke, the MDC_{95}% was 13% of the 6MWT.[15] Compared with the 6MWT and 12MWT, the advantages of the 2MWT are that it is time efficient and reduces the effects of fatigue.[16] Furthermore, the 2MWT showed high interrater reliability (intraclass correlation coefficient [ICC]=.85) and high intrarater reliability (ICC=.85).[16] Therefore, the 2MWT is an interesting measure for walking assessment in individuals with chronic stroke, and its MDC should be established.

Individuals with stroke show a variety of physical impairments. One of these is increased muscle tone in both the upper and lower limbs[17] that disturbs functional movements.[4,5,18] The ankle plantarflexors show the highest degree of spasticity of all the muscle groups of the affected lower limb in individuals with stroke.[17] The reduction of ankle plantarflexor tone is a physical intervention aimed to improve the walking ability of individuals with stroke.[19,20] Those who have decreased ankle plantarflexor tone show improvement in the TUG, 10-minute walking test, and cadence.[21] This reveals that a change in ankle plantarflexor tone alters lower limb ability. In addition, individuals with stroke who have normal muscle tone have better motor and activity performance than those with spasticity.[22] Activities in the BBS, FMA-LE, TUG, CGS, FGS, and 2MWT require ankle movement.[23,24] Because muscle tone is commonly assessed in the clinic, can change over time, and affects functional movements, a homogenous group of individuals with stroke should be recruited to investigate whether those with different muscle tone require different MDC values to gain genuine change.

The purposes of the present study were to evaluate test-retest reliability and to determine the absolute and relative values of the MDC_{95} of the BBS, FMA-LE, TUG, CGS, FGS, and 2MWT in individuals with chronic stroke who were able to walk and had differences in ankle plantarflexor tone.

METHODS

Participants

Sixty-one individuals with chronic stroke (N=61) volunteered to participate in the study. They had been receiving physical therapy 1 to 4 days a week at outpatient physical therapy clinics, were more than 6 months poststroke, had no lesion in the brainstem or cerebellum, had no musculoskeletal conditions interfering with standing and walking performance, had no cognitive impairment, had unilateral hemiparesis, were able to walk independently and continuously with or without assistive devices for more than 15m, and had at least passive functional range of motion of the ankle.

Participants were classified into the following 3 groups based on the Modified Ashworth Scale (MAS)[25] of ankle plantarflexor tone: (1) participants who showed no increase in ankle plantarflexor tone (MAS=0; n=12); (2) participants demonstrating a slight increase in ankle plantarflexor tone (MAS=1–1+; n=32); and (3) participants showing more marked or a considerable increase in ankle plantarflexor tone or showing rigid ankle plantarflexors (MAS≥2; n=17). The characteristics of all participants are shown in table 1.

Protocols

The study was approved by the local ethics committee. All participants had given informed written consent.

On the first day of the study (test 1), after being informed about the study, participants performed the following tests once each, in order: BBS, FMA-LE, TUG, CGS, FGS, and 2MWT. Five to 10 days later (test 2), they performed the tests again in the same series and at approximately the same time of day as on test 1. During performing the tests, participants were allowed to rest for 3 to 5 minutes on a comfortable chair between each test. Each participant was assessed by the same tester, and the results were not reported until the tests were completed.

Testers

Two physical therapists (K.J. and another) who were not involved in any treatments of participants served as testers. They had more than 6 months of experience administering the BBS, FMA-LE, TUG, CGS, FGS, and 2MWT. The reliability between testers was excellent ($ICC_{2,1}$=.95–1.00) for all measures.

Outcome Measures

Berg Balance Scale. The BBS[26] is a functional balance measurement and consists of 14 items. Each item is a 5-point ordinal scale ranging from 0 to 4, with 0 indicating an inability to complete the task entirely and 4 indicating an ability to complete the task criterion. Scores can range from 0 to 56. The higher the score, the better the postural control.

For individuals with stroke, the internal consistency of the BBS was .97[26] or ranging from .92 to .98.[27] The interrater reliability had an ICC of .95 (95% confidence interval [CI], .93–.97),[27] and the test-retest reliability had an $ICC_{2,1}$ of .98.[28]

Lower limb subscale of Fugl-Meyer Assessment. The FMA-LE[29] is a subscale measuring lower limb motor recovery. It examines movement, coordination, and reflex action of the hip, knee, and ankle in the supine, sitting, and standing positions. Each item is scored on a 3-point scale (0, cannot perform; 1, partially performs; 2, performs fully). The score range is 0 to 34, with higher scores indicating better lower limb motor performance.