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Maximal lateral reaching distance on the affected side using the multi-directional reach test in persons with stroke

Won-Jeong Hwang, MSc, PT[1)], Jung-Hyun Kim, MSc, PT[1)], Seo-Hyun Jeon, MSc, PT[1)]
Yijung Chung, PhD, PT[2)*]

[1)] *Department of Physical Therapy, The Graduate School, Sahmyook University, Republic of Korea*
[2)] *Department of Physical Therapy, College of Health and Welfare, Sahmyook University: Cheongmyangni, P.O. Box 118, Seoul 130-650, Republic of Korea*

Abstract. [Purpose] This study aimed to examine the relationship between maximal lateral reaching distance on the affected side and weight shifting using the Multi-directional Reach Test in persons with stoke. [Subjects] Fifty-one chronic stroke participants were recruited from two rehabilitation hospitals. This study administered the Berg Balance Scale, Timed Up-and-Go, Trunk Impairment Scale, Modified Barthel Index and measured different maximal reaching distances. [Results] The maximal lateral reaching distance on the affected side was correlated with the BBS (r=0.571), TUG (r=−0.478), TIS (r=0.561), and MBI scores (r=0.499), the lateral reaching distance in all directions on the non-affected side (r=0.785), the maximal backward reaching distance (r=0.723), and the maximal forward reaching distance (r=0.673). The maximal reaching distance on the affected side was also affected by that on the non-affected side, in addition to the maximal backward reaching distance and MBI score. The final step model of stepwise multiple regression was explained 69.5%. [Conclusion] Maximal lateral reaching distance on the affected side as determined by the Multi-directional Reach Test is a good method of assessing functional performance in stroke patients. Data regarding maximal reaching distance on the non-affected side can be used to measure functional impairment on the affected side in clinical settings.
Key words: Reaching, Stroke, Weight shifting

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INTRODUCTION

Weight shifting is very important for locomotion and independent activities of daily living[1)]. Most persons with stroke place more weight on their non-affected leg and therefore have an asymmetrical posture. Transferring their body weight to the affected leg is a more difficult task than transferring it to the non-affected leg[2–5)]. Difficulty in transferring body weight is also seen in both high and low stepping[6)]. One study reported an approximate 95.0% ability of subjects to transfer their body weight to each leg. In contrast, persons with stroke were only able to transfer 65.5% of their body weight to the affected leg. Furthermore, they had an 85.0% ability to transfer their body weight onto the non-affected leg[4)]. Diskstein and Avulaffio studied differences in postural sway and found that persons with stroke have larger mediolateral postural sway than healthy people. Stroke causes more significant sway on the affected side than on the non-affected side[7)]. Persons with stroke who have impaired balance are at an increased risk of falls. Those at most risk of falling tend to have more significant mediolateral sway than the non-fallers[8, 9)]. The risk of falling is also associated with mediolateral balance in community-dwelling elder people. Stroke patients with a history of falling also have larger mediolateral sway than non-falling stroke patients and healthy subjects while performing standing and sitting maneuvers[10)].

Many studies have reported successful training for increased weight shifting, producing increased physical performance. Weight-shifting training in the sitting position improved the trunk position error (TRE) and trunk impairment scale (TIS) and Timed Up and Go (TUG) scores in chronic strokes patients[11)]. After an intervention, one study reported increased Berg Balance Scale (BBS) scores and forward reaching at the shoulder level with the non-affected arm[1)]. McCombe and Prettyman studied a regime involving five arm exercises that improved the BBS score while standing[12)].

It is important that treatment for weight bearing and shifting during standing is associated with maintaining balance, good posture, and activities of daily living (ADL). In addition, fall risk increases with decreased functional performance in the stroke population. The purpose of this study was to show that the maximal lateral reaching distance on the affected is correlated with other reaching distances and

*Corresponding author. Yijung Chung (E-mail: yijung36@syu.ac.kr)

functional performance using the Multi-directional Reach Test (MDRT) for weight shifting. We also aimed to assess whether maximal lateral reaching distance on the affected side is a predictor of other variables.

SUBJECTS AND METHODS

This study included 51 subjects with chronic stroke. Table 1 shows their general characteristics. They were recruited from two rehabilitation hospitals. The inclusion criteria were a Brunnstrom recovery stages of 3–5, ability to stand for 30 seconds without assistive devices, no other neurologic and orthopedic diseases, and acute stage completion. The exclusion criteria were pain, musculoskeletal problems, and a Mini Mental State Examination-Korean version score < 24. This study used harnesses and observers for safety purposes. All tasks were measured by two physical therapists with over 7 years of work experience. Maximal reaching distance and posture maintained for 3 seconds were assessed three times. Weight shifting ability was examined for each direction of maximal reaching by the MDRT[13, 14]. However, reaching on the affected side was performed with the non-affected arm because it was difficult for patients to maintain the affected arm above shoulder level. During the examination, the subjects stood in a comfortable upright posture without assistive devices and raised their non-affected arm to the height of the acromion process. While pushing a yardstick, they kept their feet planted on the floor and pushed in each direction as far as possible. Maximal backward weight shifting was measured by leaning back while pushing on the yardstick. Maximal lateral reaching was measured by pushing the yardstick using the acromion of the affected side. The scales used were known to have good validity and reliability. Balance was examined with the BBS and TUG test. Trunk performance was measured using the TIS and ADL were assessed using the MBI. The study was approved by the Sahmyook University institutional review board. All subjects understood the aim of study and signed an informed consent form.

All data were analyzed using PASW Statistics version 18.0 (SPSS Inc., Chicago, IL, USA). P-values of < 0.05 were considered statistically significant. Pearson's correlation coefficient was used to compare variables, and a stepwise multiple regression model was used to analyze maximal lateral reaching distance on the affected side to identify any causal relationships among variables including general characteristics, the BBS, TUG, TIS, and MBI scores; and other maximal reaching distances.

RESULTS

Table 1 shows the general characteristics of the 51 subjects. There were 30 men and 21 women. All had been suffering from stroke for an average of 13.5 months. The subjects' functional abilities are shown in Table 1, including their BBS (36.1±7.7), TUG (33.5±17.1), TIS (11.7±3.3), and MBI scores (59.8±15.4). The maximal lateral reaching distance on the affected side (9.2±5.5) was shorter than the maximal forward reaching distance (13.2±6.9) and maximal non-affected side reaching distance (10.2±5.4), but not the backward reaching distance (7.7±4.8).

Table 1. Common characteristics and functional performance in the participants (N=51)

Variables	Value
Gender (male/female)[a]	30/21
Affected side (rt/lt)[a]	26/25
Age (yrs)[b]	57.4±11.9
Height (cm) [b]	165.8±9.2
Body weight (kg) [b]	63.4±12.1
Poststroke duration (months) [b]	13.5±10.4
BBS [b]	36.1±7.7
TUG [b]	33.5±17.1
TIS [b]	11.7±3.3
MBI [b]	59.8±15.4
Maximal reaching distance (cm)	
Forward [b]	13.2±6.9
Backward [b]	7.7±4.8
Non-affected side [b]	10.2±5.4
Affected side [b]	9.2±5.5

[a]Numbers, [b]Mean±SD

The maximal lateral reaching distance on the affected side was correlated with all variables except general characteristics. The maximal affected side reaching distance was correlated with the BBS (r=0.571), TUG (r=−0.478), TIS (r=0.561), and MBI scores (r=0.499), maximal forward reaching distance (r=0.673), maximal backward reaching distance (r=0.723), and maximal non-affected side reaching distance (r=0.785).

The final step of our stepwise multiple regression analysis demonstrated that the reaching distance on the non-affected side, backward weight shifting, and MBI score explained 69.5% of the variation in maximal lateral reaching distance on the affected side (r=0.834).

DISCUSSION

Measurement of maximal reaching distance using MDRT revealed different distances in all directions. The longest reaching distance was observed in the forward direction. The maximal lateral reaching distance on the affected side was the shortest, excluding the backward direction. The same result was reported by Newton[13]. It may be that the backward direction does not mirror much visual information to the direction. Individuals need to maintain their balance during weight shifting. Most persons with stroke have difficulty shifting their weight toward the affected side compared with the non-affected side. A previous study found greater affected side sway in stroke patients[7]. All functional performances and maximal reaching distances in each direction correlated with the maximal lateral reaching distance on the affected side. The direction with the strongest relationship was the non-affected side. In particular, the BBS and TIS scores showed strong correlation with the maximal lateral reaching distance on the affected side. However, there were low significant correlations for the TUG and MBI scores. The correlation of MDRT scores in all directions with BBS and

TUG scores have previously been studied in elderly adults[13]. Stroke researchers have also examined the Functional Reach Test (FRT)[15–17]. But FRT has only a forward direction, while the MDRT has four directions: forward, backward, right, and left. Stroke patients have unilateral impairment, which is why they have asymmetry of posture and less weight bearing and shifting on the affected side leg. Regarding use of the FRT for stroke patients, a multidirectional approach is better than unidirectional approach for elucidating the situation clearly. The lateral affected side reaching distance can especially predict not only balance but also trunk impairment and ADL. The maximal lateral reaching distance on the affected side is related to the maximal reaching distance on the non-affected side, in addition to backward for weight shifting and MBI score. Stroke patients were previously shown to have difficulty in successfully performing weight transfer and holding a single-limb stance on the affected side during gait[5]. If a stroke patient has a serious impairment or deficiency on the affected side, therapists are unable to train in weight bearing and sifting on the affected side to improve functional performance. In this situation, a good method that can be tried is to get the stroke patients to attempt to perform ADL when moving in different directions, such as moving toward the non-affected side and backward.

This study used the MDRT to show that persons with stroke have different maximal reaching distances in all directions. Healthy people rarely perform backward walking and arm activities without trunk rotation during ADL. Therefore, this study concentrated on the maximal lateral reaching distance on the affected side rather than backward leaning. The maximal lateral reaching distance on the affected side was related to balance and trunk impairment and was influenced by the maximal lateral reaching distance on the non-affected side, maximal backward reaching distance, and MBI score.

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