Osong Public Health and Research Perspectives

Journal homepage: http://www.kcdcphrp.org

Original Article

Assessment of Weight Shift Direction in Chronic Stroke Patients

So Hyun Park*

Department of Physical Therapy, Youngsan University, Yangsan, Korea

Article history:

Received: April 12, 2018
Revised: May 29, 2018
Accepted: June 11, 2018

Keywords:

balance,
movement,
stroke

ABSTRACT

Background: In patients who have suffered a stroke, the measurement of center of pressure excursion in all directions including oblique direction, anterior-medial, anterior-lateral, posterior-medial, and posterior-lateral side is important for determining balance instability but no research has been reported.

Objectives: This study investigated weight shift in all directions to determine balance instability in stroke patients, including the oblique direction, using the multi-directional functional reach test.

Methods: Eleven subjects participated. Multi-directional functional reach test consisted of moving the unaffected arm as far as possible in 8 directions. The directions were as follows; anterior, middle of anterior and lateral in unaffected side, lateral in unaffected side, and middle of the posterior and lateral in unaffected side, posterior, middle of posterior and lateral in affected side, lateral in affected side, middle of anterior and lateral in affected side.

Results: Movement was the lowest in the affected posterior-lateral side, followed by affected posterior, affected anterior-lateral, non-affected posterior lateral, affected lateral, non-affected lateral, non-affected anterior-lateral and anterior side ($p < 0.05$).

Conclusion: Center of pressure excursion of the affected posterior-lateral side was the most challenging for stroke patients and their reach was lowest from posterior, to lateral, and anterior directions, whilst patients could move less on the affected side compared with the non-affected side.

https://doi.org/10.24171/j.phrp.2018.9.3.06
pISSN 2210-9099 eISSN 2233-6052

Introduction

Stroke patients have poor balance and have difficulty in weight shift, making them fear independent movement [1, 2]. Typically they experience a fall in the first 6 months after discharge from hospital [2]. Stroke patients with balance problems whilst dressing had the highest risk factor for falls, and stroke symptoms of residual balance, dizziness, or spinning were also a strong risk factor for falling [3]. Chronic stroke patients with multiple fall history were reported to have poorer balance and a greater fear of falling [4]. Falling is significantly associated with poor physical function [5]. Therefore, balance assessment is very important for stroke patients.

The evaluation of balance abilities is not simple because balance disturbances are affected by many factors such as decreased muscle strength, range of movement, abnormal muscle tone, motor coordination, sensory organization, cognition, and multisensory integration [6]. The following measurement tools are widely used in clinical practice: the Berg Balance Scale, the Timed Up and Go Test, the Tineti Assessment Tool, the Functional Reach Test (FR), the Fugl-Meyer Assessment, the Postural Assessment Scale for Stroke Patients, the Dynamic Gait Index, the Multidirectional Functional Reach Test (MFRT), the Activities-Specific Balance Confidence Scale, and the Fullerton Advanced Balance Scale [7]. Among these, FR and MFRT are the assessment tools which

*Corresponding author: So Hyun Park
Department of Physical Therapy, Youngsan University, Yangsan, Korea
E-mail: ptpsh@ysu.ac.kr

are related to the measurement of movement of the center of mass and the center of pressure (COP) in the foot [8, 9]. FR is portable, inexpensive, reliable, precise, and a reasonable clinical approximator of the margin of stability. It can assess limits of stability by measuring distance between the length of the arm and a maximal forward reach in the standing position, while maintaining a fixed base of support [10]. The clinical lateral reach test is performed in a similar way as FR, but the direction is changed to the lateral side. The lateral reach test significantly correlated with COP excursion and it was deemed a valid indicator of lateral stability limits [11]. The FR test and the lateral reach test combined to form the MFRT which measured forward, backward, right and left lateral COP excursions [9].

COP excursions in all directions including oblique, anterior medial, anterior lateral, posterior-medial, and posterior-lateral side are important. However, to our knowledge, there has been no study measuring MFRT in stroke patients. Therefore, we analyzed COP excursions in all directions including oblique, using the MFRT method to determine balance instability in stroke patients.

Materials and Methods

Eleven stroke patients were recruited from a social welfare center in Korea. Inclusion criteria were as follows: 18 to 80 years old; hemiparesis resulting from a stroke that occurred at least 12 months prior to the study; stand independently without aid for at least 60 seconds; raise arms at least 90°; stand up independently; without cognitive impairment (higher score of 21 using Mini Mental State Examination); and with normal eyesight. Exclusion criteria were as follows: significant neurologic disease; musculoskeletal disease; or other major systemic problems.

MFRT was performed as previously described [12]. Functional reach was defined as the maximum distance reached whilst standing and maintaining a fixed base of support [12]. For stroke patients, MFRT was performed on the unaffected hand and standing maintained for 10s with eyes open. The unaffected arm was extended whilst perpendicular to the trunk. The test involved moving the unaffected arm as far as possible in 8 directions [13]. The directions were as follows; anterior, middle of anterior and lateral in unaffected side, lateral in unaffected side, middle of posterior and lateral in unaffected side, posterior, middle of posterior and lateral in affected side, lateral in affected side, and middle of anterior and lateral in affected side. A yardstick was placed parallel to the subject's raised arm for the 8 directions [12]. This direction was marked on the ground for the examiner to indicate the correct direction. One examiner recorded the placement of the end of the patient's third metacarpal along the yardstick in the upright standing position, with the arm raised to a 90° position during the first measurement, and measurements recorded in the same way when subjects reached as far as possible in each direction [12]. The difference between movement before and after was defined as the MFRT value . The assistant recorded the direction, the correct the position, and ensured the patient was supported to prevent any falls. Subjects were asked to perform this procedure 3 times so they were accustomed to experiments, and the procedures performed on the fourth occasion were recorded and used as the data for this study.

The results were expressed as mean ± standard error. SPSS 20.0 was used to analyze the data. The repeated measure of 1 factor analysis with main effects comparisons with Fisher's Least Significant Difference test correction was used for comparing each direction. Statistical significance was accepted at $p < 0.05$.

Results

Nine left hemiplegia and 2 right hemiplegia subjects participated in this study. The average age was 57.45 ± 2.35 years, average height was 168.45 ± 2.14 cm, and average weight was 66.09 ± 4.14 kg (Table 1).

Table 1. Patient characteristics.

	Mean	SE
Age	57.45	2.35
Height (cm)	168.45	2.14
Weight (kg)	66.09	4.14
BMI	23.25	1.23
Left hemi paresis (*n*)	9	
Right Hemi paresis (*n*)	2	

The results in Table 2 showed the weight shift distance was smallest in the affected posterior-lateral side followed by affected posterior, affected anterior-lateral, non-affected posterior lateral, affected lateral, non-affected lateral, non-affected anterior-lateral and anterior side. There were significant differences in the degree of movement between the different directions assessed ($f = 5.82$; $p < 0.001$; Table 2).

Table 2. The weight shift distance in 8 directions using MFRT.

Direction		Mean (cm)	SE
Anterior	4, 5, 6, 7, 8	12.77	2.22
Non-affected anterior-lateral	5, 6, 8	11.15	1.82
Non-affected lateral	5, 6, 8	10.92	2.01
Non-affected posterior lateral	1, 5, 6	8.62	1.54
Posterior	1, 2, 3, 4	6.85	1.28
Affected posterior-lateral	1, 2, 3, 4, 7	5.15	1.66
Lateral	1, 6	9.08	2.00
Affected anterior-lateral	1, 2, 3	6.85	2.08

The superscripted values ($^{1, 2, 3, 4, 5, 6, 7, 8}$) indicates the results of the repeated measures of 1 factor analysis with main effects comparisons with Fisher's Least Significant Difference test correction and are significantly different with each direction at the $p < 0.05$ level. Each value indicated as follows: anterior, 1; non-affected anterior-lateral, 2; non-affected lateral, 3; non-affected posterior lateral, 4; posterior, 5; affected posterior-lateral, 6; lateral, 7; and affected anterior-lateral, 8.

Discussion

MFRT was used as an easy way to measure balance instability and to determine vulnerable directions of COP excursion for stroke patients. The results showed that COP excursion to the affected posterior-lateral side in stroke patients was the most challenging, followed by affected posterior, affected anterior-lateral, non-affected posterior lateral, affected lateral, non-affected lateral, non-affected anterior-lateral and anterior side.

In the present study, COP translation showed that the affected posterior-lateral direction for chronic stroke patients showed the most restricted weight shift distance in this study. Motion analysis was not performed in this study, but a previous study showed that older subjects avoided forward displacement of the COP by moving their pelvis backwards, rather than by avoiding trunk flexion for lowering their center of gravity. Reduced trunk rotation may lower forward reach test (FRT) scores in older subjects during the FRT [14]. The results from this study suggest that backward pelvis movement and reduced trunk rotation maybe the reasons for the difficulties observed in COP excursion in the posterior lateral direction.

In this study, the stroke patients weight shift distance was less from posterior, to lateral and anterior directions, and movement was shorter on the affected side compared with the non-affected side. In addition, lateral reach on the non-affected side was higher. According to statistical analysis, the lateral reach did not show significant differences between affected and non-affected sides, but the oblique direction showed significant differences in chronic stroke patients. Therefore, in chronic stroke patients, movement from FR to the oblique direction is more susceptible than lateral FR. To our knowledge, no research on COP excursion to the oblique direction using MFRT for stroke patients has been reported. A previous study demonstrated that MFRT was shown to be a highly reliable measurement tool, particularly for the paretic side than in the forward and non-paretic side for sub-acute stage post-stroke patients [9], and for subjects with greater lateral FR who had higher basic and instrumental activities of daily living scores than those with shorter lateral FR. However, there was no significant relationship between anterior FR and activities of daily living scores in older people [15]. These results indicated lateral FR was a more effective test than forward FR.

This study was limited by the small sample size and lack of reliability of the motion analysis. Further research is required to increase patient sample size and ensure reliable measurement and control of patient movement analyses.

Conflicts of Interest

The author has no conflicts of interest to declare.

Acknowledgements

This research was supported by 2016 Youngsan University research fund.

References

[1] Lamb SE, Ferrucci L, Volapto S, et al. Risk factors for falling in home-dwelling older women with stroke: the Women's Health and Aging Study. Stroke 2003;34(2):494-501.
[2] Forster A, Young J. Incidence and consequences offalls due to stroke: a systematic inquiry. BMJ 1995;311(6997):83-6.
[3] Lamb S, Ferrucci L, Volapto S, et al. Risk factors for falling in home-dwelling older women with stroke. Stroke 2003;34(2):494-501.
[4] Belgen B, Beninato M, Sullivan PE, et al. The association of balance capacity and falls self-efficacy with history of falling in community-dwelling people with chronic stroke. Arch Phys Med Rehabil 2006;87(4):554-61.
[5] Andersson ÅG, Kamwendo K, Appelros P. Fear of falling in stroke patients: relationship with previous falls and functional characteristics. Int J Rehabil Res 2008;31(3):261-4.
[6] OLIVEIRA CBd, MEDEIROS IRTd, Frota NAF, et al. Balance control in hemiparetic stroke patients: main tools for evaluation. J Rehabil Res Dev 2008;45(8):1215-26.
[7] Lendraitienė E, Tamošauskaitė A, Petruševičienė D, et al. Balance evaluation techniques and physical therapy in post-stroke patients: A literature review. Neurol Neurochir Pol 2017;51(1):92-100.
[8] Paillard T, Noé F. Techniques and methods for testing the postural function in healthy and pathological subjects. Biomed Res Int 2015;2015: 891390.
[9] Katz-Leurer M, Fisher I, Neeb M, et al. Reliability and validity of the modified functional reach test at the sub-acute stage post-stroke. Disabil Rehabil 2009;31(3):243-8.
[10] Jonsson E, Henriksson M, Hirschfeld H. Does the functional reach test

reflect stability limits in elderly people? J Rehabil Med 2003;35(1):26-30.
[11] Brauer S, Burns Y, Galley P. Lateral reach: a clinical measure of medio-lateral postural stability. Physiother Res Int 1999;4(2):81-8.
[12] Bennie S, Bruner K, Dizon A, et al. Measurements of balance: comparison of the Timed" Up and Go" test and Functional Reach test with the Berg Balance Scale. J Phys Ther Sci 2003;15(2):93-7.
[13] Maranesi E, Fioretti S. Functional reach test: Movement strategies in diabetic subjects. Gait Posture 2012;35:S40-S1.
[14] de Waroquier-Leroy L, Bleuse S, Serafi R, et al. The Functional Reach Test: strategies, performance and the influence of age. Ann Phys Rehabil Med 2014;57(6):452-64.
[15] Takahashi T, Ishida K, Yamamoto H, et al. Modification of the functional reach test: analysis of lateral and anterior functional reach in community-dwelling older people. Arch Gerontol Geriatr 2006;42(2):167-73.