Supporter to Rectifying the Asymmetric Sitting Posture of Post Stroke

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Purpose: This study determined the best adjustable height supporter for stroke patients in wheelchairs for the maintenance of a symmetric sitting posture.

Methods: Thirty-one stroke participants and 20 age-matched control participants were recruited. The enrolled participants were evaluated by the Force Sensitive Application (FSA) System that was used to assess weight shift and symmetry in wheelchair sitting and assess the symmetric index (SI) of subjects according to 1, 2 and 3 cm height supporters.

Results: When a 1 cm height supporter was applied to the paretic side of stroke survivors, sitting postures of stroke patients were significantly more symmetrical ($p<0.01$). Cross tabulation between the SI of wheelchair sitting and that of the paretic side of stroke patients caused? by a 1 cm supporter showed that 21 SIs of 26 stroke patients were improved by a 1 cm supporter to the paretic side ($k=0.26$, $p<0.01$).

Conclusion: The findings of the present study demonstrate that stroke patients can maintain a more symmetrical sitting posture (than is possible when simply sitting in a wheelchair seat) if a 1 cm supporter is applied to the paretic side of stroke patients

Keywords: Stroke, Supporter, Wheelchair sitting

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Ⅰ. Introduction

Stroke is a major cause of mortality.[1] Fifty % of stroke survivors experience physical and functional disability. Seventy-nine % of stroke patients either undergo treatment or die within 10 years.[2] As a common symptom of stroke, hemiparesis can cause deficits in posture and balance. Stroke patients maintain abnormal postures and experience low efficiency when walking due to imbalances of body, lack of a sense of balance, imbalances in muscle strength, inadequate weight bearing capabilities, co-contraction, and degradation of motor ability control.[3,4] Disruption of balance can lead to limitations in functional activities and falls. Balance dysfunction can cause a long sedentary life of post-stroke patients. Physical therapy has been used as an intervention to improve functional abilities and balance, and reduce impairment. When sitting without trunk support, postural control occurs principally at the pelvis.[5] It is important that post stroke patients regain normal sitting balance to recover functional activities.[6,7] A variety of studies have been done to discover how stroke patients can regain a symmetric sitting posture post stroke.[8-10] After stroke, hemiparesis can cause a difference in weight distribution between the paretic side and the non paretic side in a sitting posture.

Some studies have been focused on weight-bearing asymmetry and analysis of balance post stroke. For this reason, a great deal of effort has been dedicated to the maintenance of a normal sitting posture in stroke patients, which has led to the appearance of a wide variety of wheelchair seat supporters.

A previous study assessed adjustable seats of an unsupported wheelchair, an unsupported normal seat chair, and a saddleshaped chair for stroke patients using a Force Sensitive Application (FSA; Vista Medical Inc., Canada) system.[11] The FSAsystem is a force platform system that is commercially available for the evaluation of symmetry. The FSA pressure-recording system used in the present study was very useful for assessing the mechanical characteristics of different height supporters.

Some comparative studies have been done in a sample of patients with spinal cord injury regarding the mechanical ability of different types of seats to prevent pressure ulcer.[12,13] However, it is difficult to find literature regarding the use of adjustable supporters for stroke patients. The principal objective of the present study was to determine what height supporter, on paretic and non paretic sides is best for placement on wheelchairs to maintain a symmetric sitting posture for stroke patients.

II. Methods

1. Subjects

Thirty-five stroke participants were recruited from an inpatient rehabilitation hospital. Subjects who met the following selection criteria were recruited: (1) hemiparesis caused by a first stroke within the last 2 months; (2) MMSE-K scores above 24; (3) patients who could maintain independent sitting postures without support. Four patients who were unable to flex both hip and knee at least 90 degrees were excluded from this study because they tended to slide out of their seats. Twenty age-matched controls were also recruited. All of the enrolled participants provided written informed consent prior to this experiment, in accordance with the ethical standards established in the Declaration of Helsinki.

2. Experimental methods

FSA System 4.0 software was used to assess the symmetry of participants. After participants were evaluated in the same wheelchair, they were randomly assessed in each seat. The FSA system is a computerized force platform system with four adjustable force transducers, which measure vertical force only. Center of force data are expressed as percentage change in body weight distribution. The measuring system consisted of a matrix of piezo-resistive pressure sensors. The resistance of each sensor was a function of the perpendicular force exerted on it. The matrix used in the present study measured 48 × 48 cm and the pressure transducers were approximately 0.36 mm thick. There were 16 rows and 16 columns of sensors, for a total of 256 sensors. The acquisition frequency was set at 5 Hz. The stated working range was 0~200 mmHg, with a resolution of 1 mmHg. A customized A/D converter was used to connect the sensing pad to a PC that supported data recording, processing, and graphic presentation application software. The system was also calibrated to assign absolute pressure values to the digital output, from the A/D converter connected to the sensing pad. This was done by applying a pressure distribution as similar to actual conditions as possible, within a 200 mmHg load value. For research purposes, this study used a basic wheelchair with a 50 cm floor to seat height, a 40 cm seat depth, and a 46 cm seat width.

We first measured the wheelchair seat in eyes-open conditions. During each trial, 1 cm, 2 cm or 3 cm height supporters (length 40 cm × width 20 cm, cotton) were alternatively placed on the paretic or the non paretic side of the wheelchair. The subject was then seated comfortably with arms folded and feet on the footrests, which were regulated to keep the joints flexed at 90 degrees. The pelvis was placed as far back on the seat as possible, with the thighs in a level position. The seat surface was horizontal and the backrest was tilted backwards without support. Bilateral 3 × 3 pressure transducer data of the area focusing on the ischial tuberosity were processed. This study used a 60-second measuring time for each 70 seconds of measuring duration (first and last 5 seconds were discarded).

The symmetry index (SI) was developed to calculate the differences in weight distribution between the nonparetic and paretic limbs during the stance phase of the gait cycle. In the present study, SI was used to assess the differences in pressure distribution on the seats. The unit of the SI was percentage. An SI of 0% indicated that the parameter was equal on both sides. The SI formula is shown below.[14,15]

$$\text{Symmetry Index}(\%) = \frac{\text{Variables (Nonparetic)} - \text{Variables (Paretic)}}{\text{Variables (Nonparetic)} + \text{Variables (Paretic)}} \times 2 \times 100$$

3. Data analysis

All statistics were calculated using PASW version 18.0. Descriptive statistics were analyzed (frequency, mean, standard deviation, range). Paired t-tests were used to analyze differences between lesion sides and differences among supporters within stroke participants. The SI of the age matched group was employed as normal criteria. Cross tabulation was employed to analyze the measure of agreement between the SI of wheelchair sitting and the SI of the paretic side of stroke patients that resulted from application of a 1 cm supporter.

III. Results

1. The general characteristics of the participants

Table 1 shows the general characteristics of the participants. Thirty subjects were aged 51~78 years the mean (±standard deviation) subject age was 61.0±10.5 years. The control group subjects were aged 55~73 years the mean age was 60.7±3.9 years. Twelve patients were right lesion types, and 17 patients were infarction types.

Table 1. General characteristics of participants (n=51)

	Control group (N=20)	Stroke group (n=31)
Age (years)	60.7±3.9	61.0±10.5
Gender male/female	6/14	13/18
Mean duration after stroke (days)		30.1±12.4
Infarction/Hemorrhage		17/14
Lesion side right/left		13/18
Symmetric index (Mean±SD)	5.04±1.13	14.17±34.16*

*p<0.01

2. Differences of SI according to supporter height on both sides

Table 2 lists differences in SI according to supporter height on both sides. When a 1 cm height supporter was employed to stroke patients' paretic side, SI was significantly decreased relative to just wheelchair sitting (p<0.05).

Table 2. Comparison symmetry index between paretic side and non paretic side applied by supporters. (Unit: %; Mean±SD)

Supported side		Paretic side	Non paretic side
Just sitting on wheelchair		14.17±34.16	
Supporter Height	1 cm	-5.76±26.97*	12.06±38.06
	2 cm	-22.28±28.08	22.93±39.69*
	3 cm	-35.15±30.99	56.09±44.67*

*p<0.01

3. Cross tabulation between wheelchair sitting and wheelchair sitting on the paretic side with a 1 cm supporter

Table 3 shows cross tabulation between just wheelchair sitting of stroke patients and wheelchair sitting on the paretic side applied by 1 cm supporter. During just wheelchair sitting of stroke patients, 5 patients were included within the SI criteria of the normal control group and 26 patients were over those criteria. When the paretic side of stroke patients was supported by a 1 cm height, 1 of 5 patients within the SI criteria of the normal control group improved and 21 of 26 patients, over the SI criteria of the normal control group, were changed into SI criteria of the normal control group (k = 0.26, p<0.01).

Table 3. Cross tabulation between just wheelchair sitting and wheelchair sitting 1 cm supporter to the paretic side (n=31)

		Just wheelchair sitting		Total
		Within normal criteria	Over normal criteria	
paretic side by 1 cm supporter	Improved	1	21	22
	Not improved	4	5	9
Total		5	26	31

*p<0.01
†k=0.26

IV. Discussion

The purpose of the present study was to determine the optimum supporter height to help stroke patients maintain a symmetric sitting posture on a wheelchair. In particular, this study assessed different heightsof supporters.

A previous study to see whether stroke patient's ability to achieve midline sitting existed, reported that stroke patients tended to sit with their torso? leaning towards their affected side.[16] Unlike the previous study, wheelchair sitting posture of our? stroke patients was asymmetrical, leaning to the nonparetic side. The reason for that was, we assumed, that our subjects elderly and at a subacute stage. When a 1 cm supporter was applied to the paretic side of stroke survivors, their sitting postures were more symmetrical. Supporters with other heights did not influence on symmetrical sitting of stroke patients. Taller supporters did not rectify the sitting posture of patients. The reason may be that because the subjects of the present study were attacked within only 3months, they compensated with poor sitting balance. Future studies can evaluate the compensated sitting posture of chronic stroke patients.

To confirm the resultsof the present study, we compared stroke patients and age matched normal subjects. Using data of age matched normal subjects, cross tabulations were performed to confirm changes in sitting posture of stroke patients. Twenty-one SIs of 26 patients over the mean SI of normal subjects were improved by a 1 cm supporter on the paretic side. This may be attributable to the fact that although the sitting posture of stroke patients caused them to lean to the nonparetic side, their posture was rectified by the supporter.

The findings of the present study show that, as compared to simply sitting in a wheelchair, the application of a 1 cm supporter to the paretic side can help to improve symmetric sitting of sedentary stroke patients in clinical settings.

We think that the results presented here are valid because different height supporters were compared using the same measurement system. The present study has some limitations. This study cannot be generalized to all stroke survivors because the sample was limited to 31 inpatients and they were all at a subacute stage. Future studies can assess the relationship between symmetry of sitting posture and functional activities. Additional studies in which a variety of cushion types are applied will be necessary to improve the symmetry of stroke patients.

V. Conclusion

In the present study, we attempted to determine what height supporters are the most effective to maintain symmetric wheelchair sitting posture of stroke patients. Stroke patients showed reduced asymmetry with a 1 cm height supporter to the paretic side. The other supporters did not helped rectify the sitting posture of stroke patients. The SIs of stroke patients over the mean SI of age matched normal patients were improved. By applying a 1 cm supporter to the paretic side, the symmetry of stroke patients' sitting posture can be maintained (as opposed to the case in which the subject simply sits in the wheelchair).

Author Contributions

Research design: Lee IH, Park SY
Acquisition of data: Park SY
Analysis and interpretation of data: Lee IH, Park SY
Drafting of the manuscript: Lee IH, Choi JH
Researchsupervision: Lee IH, Choi JH

References

1. Korea national statistical office. Annual report on the cause of death statistics. 2008.
2. Lee IH, Shin AM, Son CS, et al. Association analysis of comorbidity of cerebral infarction using data mining. J Kor Soc Phys Ther. 201022(1):75-81.
3. An SH, Lee YM, Yang KH. Effectiveness of gait training using an electromechanical gait trainer combined with simultaneous functional electrical stimulation in chronic stroke patients. J Kor Soc Phys Ther. 2008;20(1):41-7.
4. Milette D, Rine RM. Head and trunk movement responses in healthy children to induced versus self-induced lateral tilt. Phys Ther. 198567(11):1697-702.
5. Jorgensen HS, Nakayama H, Raaschou HO et al. Recovery of walking function in stroke patients: The copenhagen stroke study. Arch Phys Med Rehabil. 1995;76(1):27-32.
6. Ham R, Aldersea P, Porter D. Wheelchair user and postural seating: A clinincal approach. New York. Churchill Livingstone. 1998.
7. Perlmutter S, Lin F, Maksous M. Quantitative analysi of static sitting posture in chronic stroke. Gait Posture. 2010;32(1): 53-6.
8. Shackley CM, Hill HJ, Pound K, et al. The intra-rater reliability of balance performance monitor when measureing sitting symmetry and weight-shift activity after stroke in a community setting. Clin Rehabil. 2005;19(7):746-50.
9. Au-Yeung SS. Does weight-shifting exercise improve postural symmetry in sitting in people with hemiplegia? Brain Inj. 2003;17(9):789-97.
10. Nichols DS, Miller L, Colby LA, et al. Sitting balance: its relation to function in individuals with hemiparesis. Arch Phys Med Rehabil. 1996;77(9):865-9.
11. Park SY, Lee IH, Jeon CB, et al. Comparison of the sitting pressure of stroke patients according to seat shapes. 2010 Fall Conference of Ergonomics Society of Korea.
12. Gil-Agudo A, De la Pana-Gonzalez A, Del Ama-Espinosa A, et al. Comparative study of pressure distribution at the user-cushion interface with different cushions in a population with spinal cord injury. Clin Biomech. 200924(7):558-63.

13. Brienza DM, Karg PE, Geyer MJ, et al. The relationship between pressure ulcer incidence and buttock-seat cushion interface pressure in at risk elderly wheelchair users. Arch Phys Med Rehabil. 200182(4):529-33.
14. Hesse S, Reiter F, Jahnke M, et al. Asymmetry of gait initiation in hemiparetic stroke subjects. Arch phys Med Rehabil. 1997;78(7):719-24
15. Chen CH, Lin KH, Lu TW, et al. Immediate effect of lateral-wedged insole on stance and ambulation after stroke. Am J Phys Med Rehabil. 2010;89(1):48-55.
16. Taylor D, Ashburn A, Ward CD. Asymmetrical trunk posture, unilateral neglect and motor performance following stroke. Clin Rehabil. 1994;8(1):48-52.