Influence of biofeedback weight bearing training in sit to stand to sit and the limits of stability on stroke patients

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Abstract. [Purpose] The purpose of this study is to observe the influence of biofeedback weight bearing training in sit to stand to sit and limits of stability on stroke patients. [Subjects and Methods] For subjects of this study, 30 stroke patients were randomly divided into two groups of 15, a biofeedback weight bearing training group and a functional weight bearing training group. Biofeedback weight bearing training was conducted for 30 minutes, five times a week for eight weeks, using Biorescue. Analysis of sit to stand to sit was done with LUKOtronic while the analysis of limits of stability was done with Biorescue. [Results] In a comparison of sit to stand to sit and limits of stability between the two groups before and after intervention, Group I showed significant difference in sit to stand to sit and limits of stability when compared to Group II. [Conclusion] This study concludes that biofeedback weight bearing training is more effective in improving sit to stand to sit and limits of stability in stroke patients.

Key words: Biofeedback, Sit to stand to sit, Stroke

INTRODUCTION

Stroke is one of the high incidence diseases in modern society and is a representative disease that causes damage in the central nerve system with ischemia or hemorrhage of the cerebral artery1). It induces motor and sensory disorders by damaging the motor cortex, premotor cortex, and motor tract of the cerebrum and is accompanied by various symptoms, in which complex functional disorders occur depending on the damaged area2).

Most of the stroke patients exhibit at least a minimum of 27% weight bearing on the paralyzed leg while sustaining an erect posture3). Although lately various weight bearing training intervention methods have been offered to correct abnormal weight bearing and to improve execution of everyday movement of hemiplegia patients4), rehabilitation intervention methods based on biofeedback have been suggested due to lack of motivation and loss of interest in patients from existing weight bearing training intervention methods5).

Rehabilitation based on biofeedback is a training method to improve damaged function by using sensation of physical contact and body movement that creates interest in attendance. It is more effective than conventional training interventions6).

The sit to stand to sit is a movement from sitting to standing upright and then sitting down again, which is a basic everyday movement performed on average four times every hour7). Standing up from a chair requires complex movement and stability of knee and ankle joints. Patients with hemiplegia secondary to stoke show more weight bearing to the un-paralyzed leg than the affected leg when conducting the sit to stand to sit compared to normal people and required a longer time to perform. The center of gravity to anterior-posterior and interior-exterior is different from normal people8).

Balance is an ability to maintain the line of gravity of a body within the base of support to sustain positional stability. Stoke reduces physical activity and leads to left-right posture imbalance and asymmetry, affecting factors involved in upright
standing and balancing reaction which creates severe problems in balancing ability. Reduced balancing capability affects mobility which makes it difficult to carry on independent daily life. This study provides basic reference on rehabilitation of stroke patients by studying the influence of biofeedback weight bearing training in sit to stand to sit and LOS in stroke patients.

**SUBJECTS AND METHODS**

This study was approved by bioethics Committee of Sehan university center (IRB) (Approval number: 2015-15) on January 1, 2016. The participants’ rights were protected according to the guidelines established by the University of Sehan. Thirty in-patients who were diagnosed and being treated for stroke were included in this study. Detailed criteria for the selection were hemiplegia patient diagnosed with stroke less than a year, patients who are able to walk for at least 10 m by themselves, patients who are able to communicate and score K-MMSE 24 or over, and patients without musculoskeletal diseases that might affect the experiment. The subjects of this study were randomly selected and allocated into 15 patients in a biofeedback weight bearing group (Group I) and the other 15 patients in a functional weight bearing group (Group II).

Each received standard physical therapy including CNS development therapy prior to the experiment. For biofeedback weight bearing training, Biorescue (RM Ingenierie, France) which provides real-time feedback on movement of force plate and pressure center was used. Training was conducted for 30 minutes each day, five times a week, for eight weeks. The LUKOtronic movement analysis system (Lutz-Kovacs Electronic, Austria) was used to measure execution time of sit to stand to sit. Infrared markers were placed on C5, PSIS, greater trochanter, lateral epicondyle, lateral malleolus, and heel; and the subjects were asked to stand up in a comfortable pace from a sitting position at knee height (from ground to lateral femoral condylar) while hip, knee, and both ankles were flexed at 90° and both feet were apart as wide as the pelvis on a flat, adjustable chair with no back support and arm rest. Biorescue (RM Ingenierie, France), which is capable of measuring migration length and area of center of pressure (COS), was used to analyze and measure limits of stability (LOS).

The results of this study were analyzed with Windows SPSS 18.0 program. Characteristics of the subjects were analyzed with descriptive statistics, and comparison of sit to stand to sit and LOS between the two groups before and after intervention was done in analysis of covariance, with statistical reference level of α=0.05.

**RESULTS**

Data on the general characteristics of the subjects is summarized in Table 1. The difference between before and after intervention in sit to stand to sit and LOS between the biofeedback weight bearing training group and the functional weight bearing training group is summarized in Table 2. In comparison of sit to stand to sit and LOS between the two groups before and after intervention, Group I showed significant difference in sit to stand to sit (p<0.01) and LOS (p<0.05) when compared to Group II.

| Table 1. General characteristics of the subjects |
|-----------------------------------------------|
| Gender (male/female) | Group I (n=15) | Group II (n=15) |
|----------------------|----------------|-----------------|
| Age (years) | 58.6 ± 2.6 | 57.2 ± 3.2 |
| Weight (kg) | 66.2 ± 4.8 | 67.6 ± 3.2 |
| Height (cm) | 162.3 ± 3.2 | 161.9 ± 2.6 |
| Stroke duration (month) | 6.24 ± 1.57 | 6.87 ± 1.23 |

| Table 2. Comparison of sit to stand to sit and balance ability between groups |
|-----------------------------------------------|
| Group I (n=15) | Group II (n=15) |
|----------------|-----------------|
| Pre | Post | Pre | Post |
| STSTS (unit: sec) | 5.57 ± 1.57 | 3.12 ± 0.46** | 5.13 ± 1.82 | 4.25 ± 0.61 |
| LOS (unit: cm²) | 148.3 ± 24.6 | 154.6 ± 20.7* | 149.6 ± 23.1 | 152.3 ± 24.9 |

Values are show as the mean ± SD. *p<0.05, **p<0.01
Group I: biofeedback weight bearing training
Group II: functional weight bearing training
STSTS: sit to stand to sit; LOS: limited of stability
DISCUSSION

The result of the study, influence of biofeedback weight bearing training in sit to stand and LOS in stroke patients, shows there was significant improvement in sit-to-stand execution time and LOS capacity with biofeedback weight bearing training and is more effective in improving sit-to-stand execution time and LOS capacity compared to functional weight bearing training.

Cheng et al.\textsuperscript{15)\textsuperscript{16)} found significant differences in range of postural sway, weight bearing rate, and sit-to-stand execution time in the experiment group when conducting sit to stand to sit and a decrease in fall at follow-up after six months. The training was conducted five times a week for a three-week intervention with a total of 54 participants allocated into two groups, an experimental group of 30 subjects who received intervention program consisting of repetitive sit to stand and symmetrical weight bearing and control group of 24 subjects who received a general rehabilitation intervention program.

Sherrington et al.\textsuperscript{16)} studied 120 patients with iliac joint fracture who were divided into three groups of weight bearing, non-weight bearing and control group. The four month follow up shows a significant difference in LOS and five-times standing up test in the weight bearing group. Group I in the present study showed significant decrease in sit to stand to sit execution time after eight weeks of intervention of biofeedback weight bearing training. It is considered that biofeedback weight bearing training provides motivation and real-time feedback information to hemiplegia patients with difficulty in moving their weight center to their affected leg resulting in reduced sit to stand to sit execution time and improved weight bearing capability\textsuperscript{17)}.

Cheng et al.\textsuperscript{18)} divided 52 patients with hemiplegia caused by stroke into experiment groups of 28 who received an intervention of general rehabilitation training and dynamic visual feedback body weight shift and a control group of 24 who received general rehabilitation training. Intervention was conducted five times a week, for three weeks, and the balancing capability of each group was compared. The result showed the experiment group had a significant difference in dynamic balancing capability than the control group.

The study carried out by Morone et al.\textsuperscript{19)} divided 50 patients with hemiplegia from subacute stroke into experiment groups of 25 who conducted game-based balancing training and a control group of 25 who conducted general balancing training and arranged a four week intervention, three times a week. They reported that the experimental group showed significant improvement in the Berg balance scale (BBS), Barthel index, functional movement capability and 10 m walk capability compared to control group.

Srivatava et at.\textsuperscript{20)} researched visual feedback balance training that used sense of pressure on 40 stroke patients for four weeks, five times a week. The result showed significant improvement in BBS, LOS, gait speed and Barthel index. Balance capability was still intact at test on balancing capability after three months. The present study also proved that biofeedback weight bearing training improved balance capability. It has been found that visual biofeedback weight bearing training on stroke patients with asymmetrical weight bearing is effective in improving sit to stand to sit and LOS. Biofeedback weight bearing training paired with present nerve physical therapy is anticipated to result in a more effective outcome of functional improvement in stroke patients.

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