Does Training on Swiss Ball Improve Trunk Performance after Stroke?- A single blinded, quasi experimental study design

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Abstract

Back Ground

Trunk performance is important for functional outcome and also an predictor for activities of daily living after stroke. Swiss ball training is superior to ground based exercise in their ability to recruit trunk muscles by increasing their demand and trunk balance on healthy individuals and athletes. However retrievable literature evidences for Swiss ball training on trunk performance is not available in stroke population.

Objective

To evaluate trunk performance on Swiss ball training after stroke.

Design

An acocncor blinded, quasi experimental study design.

Setting

Physiotherapy Department of Kasturba Medical College and hospital, Mangalore, Manipal University.

Participants

Ielwe subjects having first ever unilateral stroke who can able to sit on a stable surface independently for one minute were recruited.

Intervention

In addition to conventional physiotherapy all the study subjects received 10 hours of individual and supervised trunk exercises on Swiss ball, 45 minutes with adequate rest periods 10-15 minutes, 6 times a week, for 3 weeks.

Outcome Measurement

Trunk performance was evaluated by Trunk Impairment Scale (TIS) by Verheyden.

Results

Post intervention the study group has shown an improvement in TIS score. A significant improvement was seen in dynamic balance and coordination subscales and also in total score (p value <0.05) of TIS.

Conclusion

Training on Swiss ball improve trunk performance after stroke.

Key Words

Stoke, Trunk performance, Trunk control, Swiss ball

Introduction

Good trunk stability is essential for balance and extremity use during daily functional activities and performance of higher level motor tasks. Trunk control and stability, coordination of movement patterns, and balance all involve complex pyramidal and extra pyramidal systems that are frequently disrupted by stroke.1

Impairment of trunk control in hemiplegic or parietic patients has been documented and characterized by asymmetry in performance of rotatory and side bending activities.2,3 This loss of selective trunk activity could result from a reduction in the strength and amplitude of trunk movements, especially on the paretic side. Several studies have identified deficits of trunk muscle strength and poor trunk control in unihemispheric stroke patients.4,5 Trunk performance using clinical measurement tool has found that significantly lower scores in people with stroke compared with age and gender-matched healthy individuals.6

Trunk performance remains impaired after stroke and also found to be strong relation with measures of balance, gait, and functional ability after stroke.9

Trunk performance after stroke has been evaluated in various ways. Standard clinical assessment tools to measure trunk performance are Trunk Control Test (TCT), Trunk Impairment Scale (TIS) by Verheyden and Trunk Impairment Scale by Fujimura. A systematic review of clinical tools designed to evaluate trunk performance after stroke has concluded Trunk impairment scale developed by Verheyden et al has found to be with essential psychometric properties in stroke.10

Despite evidence demonstrating the importance of trunk performance which has been found to be important early predictor of activities of daily living11 and long term functional outcome after stroke,12 studies evaluating therapy aimed at improving trunk control are limited in literature.

Swiss ball has become a widely used mode of training device in the recreational and clinical training environment for core stability exercises. Training on Swiss balls has been advocated on the belief that a labile surface will provide a greater challenge to trunk control and dynamic balance.

In stroke rehabilitation, Swiss ball are commonly used by physiotherapist for postural control and dynamic balance training. There are evidences that Swiss ball training is superior to ground based exercise in their ability to recruit trunk muscles by increasing their demand and trunk balance on healthy individuals and athletes.13-15 However retrievable literature evidences for Swiss ball training on trunk performance is not available in Stroke population.

Material and Methods

Subjects

Participants are stroke subjects who were admitted for a comprehensive rehabilitation program in Kasturba Medical
College and Hospital, Mangalore. The clinical diagnosis of Stroke was confirmed by the consultant appointed at the hospital on the basis of neurological examination and Computed Tomography or Magnetic Resonance Imaging. Subjects were included if they met the following criteria 1) first onset of unilateral supra-tentorial stroke (ischemic or hemorrhagic) who are stable and referred by physician for rehabilitation 2) post stroke duration less than 1 month duration 3) Mini Mental Status Scale score e’24 4) subject can able to sit unsupported on a bed with their feet touching the ground for one minute. Subjects were excluded from the study if they were 1)70 years of age or older 2) subjects who were not able to understand the instructions 3) subjects with non-stroke related sensory or motor impairments which affecting their motor performance.

Design

The design of this study was a single-blinded quasi-experimental study.

Procedure

Ethical committee clearance was obtained from the institution to conduct the study. A briefing regarding the purpose of study and the procedure were given to all the participants and a signed informed consent was taken from the interested participants. Over a 9-month period (January 2009 to September 2009), 43 patients were attending the stroke rehabilitation program and total of 17 subjects were interested and eligible for inclusion criteria. With 5 drop outs because of early discharge, recurrent stroke and musculoskeletal complaints, 12 subjects were assigned to the study group (conventional rehabilitation program and 10 hours of additional Swiss ball exercises over a period of 3 weeks). Variables collected to describe our sample were age, gender, time since stroke onset, type of stroke, paretic side, Fugl-Meyer scale for motor recovery and the primary outcome measure Trunk Impairment scale (by Verheyden et al) was assessed by blinded assessor, a qualified physical therapist. At the end of 3 weeks of intervention period, the same assessor reevaluated participant’s performance in TIS before discharge from the hospital.

Intervention

Participants in the study group received the conventional multidisciplinary stroke rehabilitation program which is patient-specific with main emphasis on the neurodevelopmental treatment concept and motor relearning strategies. In addition to the conventional treatment, they received 45 minutes of additional exercises consisted of selective movements of the upper and lower part of the trunk in Swiss ball with adequate rest periods 10-15 minutes, 6 times a week, for 3 weeks. In total, 10 hours of individual and supervised trunk training were given.

The exercise protocol on Swiss ball includes as follows:

Supine exercises

1. Bridging: The subject is on the mat with his hip flexion and knee in extension, placed on the ball. The subject was asked to lift his pelvis off the mat and was asked to maintain. Initially the ball is kept close to the body i.e. under the knees and as the exercise is progressed the ball is placed away from the body i.e. under the foot making it more difficult for the subject to maintain it.

2. Unilateral Bridging: The subject is on the mat with affected leg swiss ball with hip flexion and knee in extension and the unaffected leg is to be maintained in air. The subject is asked to lift his pelvis off the mat. The exercise is progressed by asking the subject to move the unaffected limb into abduction and adduction.

3. Trunk rotations:
   a. Upper Trunk: The subject is asked to rest on the ball with his trunk on the ball and his foot flat on the ground with knees flexed. In this position the patient is asked to flex and rotate his upper trunk to the opposite side with the hands clasped across the shoulder.
   b. Lower Trunk: The subject is on the mat with both his lower limbs on the swiss ball then the subject is asked to rotate his pelvis to either sides. Initially the swiss ball is placed under the knees then as the subject gains control it is moved towards the foot.

Sitting Exercises

1. Static sitting balance: The subject is made to sit on the swiss ball and asked to maintain correct back posture and balance.

2. Trunk flexion
   a. The subject is in sitting position on the swiss ball, in this position he is asked to flex and extend his trunk without moving his trunk forwards or backwards.
   b. In the same above mentioned position the subject is asked to flex and extend his lumbar part of the spine; involving selective ante flexion and retro flexion of the lower part of the trunk.

3. Flexion extension of the hip: The subject was asked to sit on the swiss ball, then he is asked to do flexion and extension of the hips with trunk extended (with an extended trunk, the movement is initiated in the hips and the subject brings the extended trunk forwards and backwards).

4. Trunk lateral flexion: Subject is in sitting position on the swiss ball then he is asked to laterally flex his trunk, initiation is done from the shoulder and pelvis girde.

5. Trunk rotations:
   a. Upper Trunk: The subject is in sitting position on the swiss ball, maintaining balance he is asked to rotate his upper trunk by moving his each shoulder forwards and backwards.
   b. Lower Trunk: With subject in sitting position on the swiss ball he is asked to move knees forwards and backwards.

6. Weight shifts: While sitting on swiss ball the subject shifts weight from one side to the other and by moving forward and backwards.

7. Forward reach: In sitting position on the swiss ball the subject attempts to reach destined object by forward flexing the trunk (rotation component also might be involved).

8. Lateral reach: while in sitting position on the swiss ball the subject attempts to reach the object by flexing his trunk laterally.

9. Perturbations: Subject is in sitting in sitting position, the therapist give perturbations in all directions.

Exercises were gradually introduced and the number of repetitions was determined by the therapist on the basis of the patients' performance.

Outcome measurement

The primary outcome measure used in this study is the TIS and its subscales. A standardized sitting position is used throughout the assessment. Movements are performed in the sagittal, frontal and horizontal plane. Quality of movement is
taken into account by observing whether or not the task is performed with compensations. The TIS assesses static sitting balance, dynamic sitting balance, and trunk coordination on a scale ranging from 0 to 23 points, a higher score indicating a better trunk performance. The subscale static sitting balance evaluates if a patient can maintain a sitting posture with both feet on the floor and with the legs crossed. Furthermore, the patient is asked to cross the nonaffected leg over the hemiplegic leg while keeping the trunk upright and stable. The dynamic sitting balance subscale evaluates lateral flexion initiated from the upper and lower part of the trunk. Adequate movement and possible compensations are scored on a dichotomous scale. Finally, trunk coordination is assessed by asking the patient to selectively rotate the upper and lower part of the body. Again, adequate rotation and compensations are evaluated. The maximum score on the subscales of the TIS are 7, 10, and 6 points, respectively.

**Data analysis**

Data analysis was performed using SPSS for Windows version 14.0 and the level of significance for all analyses was set at p < 0.05. Descriptive statistics were generated in order to obtain frequency tables for all independent variables and Wilcoxon signed rank test was used to test difference between pre and post treatment.

**Results**

In total, 12 subjects (8 men and 4 women) were included in the study.

Table 1 indicates the characteristic of group with means and standard deviations for age, duration of stroke, fugl-meyer scale and frequency counts for sex and hemiparetic side. The mean age of subjects in the group was 56.6±6.3 years. The mean time since stroke onset was 12±8.7 days. 8 subjects had left paretic and 4 subjects had right paretic side. The mean score of motor recovery in Fugl-Meyer Scale was 58±7.4 which shows they have moderately impaired in motor function.

Table 2 indicates the pre and post TIS scores with mean and standard deviation and Wilcoxon signed rank test shows highly significant difference in total score of TIS (p value 0.002) and also dynamic sitting balance (p value 0.002) and trunk coordination subscales (p value 0.001).

**Table 1: Characteristics of the group**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group (n=12)</th>
</tr>
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<tbody>
<tr>
<td>Age (mean±SD) years</td>
<td>56±6.3</td>
</tr>
<tr>
<td>Gender (men/women)</td>
<td>0(07%)/4(33%)</td>
</tr>
<tr>
<td>Time since stroke onset (mean±SD) days</td>
<td>12±8.7</td>
</tr>
<tr>
<td>Type of stroke(ischemic/haemorrhagic)</td>
<td>5/7</td>
</tr>
<tr>
<td>Paretic side (left/right)</td>
<td>8(87%) /4(33% )</td>
</tr>
<tr>
<td>Motor component of Fugl- Meyer scale (mean±SD)score</td>
<td>58(7.4)</td>
</tr>
</tbody>
</table>

**Table 2: Pre and post treatment scores of Trunk Impairment Scale**

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Pre treatment</th>
<th>Post treatment</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk impairment scale (range 0-23)</td>
<td>12.83(1.40)</td>
<td>17.66(2.44)</td>
<td>.002*</td>
</tr>
<tr>
<td>Static sitting balance (range 0-7)</td>
<td>0.53(3.58)</td>
<td>0.00(1.05)</td>
<td>.414</td>
</tr>
<tr>
<td>Dynamic sitting balance (range 0-10)</td>
<td>4.33(7.77)</td>
<td>7.33(1.15)</td>
<td>.002*</td>
</tr>
<tr>
<td>Coordination (range 0-6)</td>
<td>2.66(1.07)</td>
<td>4.33(0.69)</td>
<td>.001*</td>
</tr>
</tbody>
</table>

Values are presented as mean (SD)

*Significant difference in p value (<0.05)

aspects when weight is shifted in any plane, the trunk responds with a movement to counteract the change in the centre of gravity. Training on Swiss ball as a change in the surface stability may influence trunk muscle activity due to different biomechanical demands of the exercises and also influence anticipatory postural adjustment which may improve the trunk performance.

Our results suggest that extra task-specific practice of trunk exercises on Swiss ball aiming to improve trunk performance resulted in short-term improvement on the dynamic sitting balance and coordination subscale and also total score of the TIS. Over a 3-week period, the mean scores on the dynamic sitting balance improved from 4.33-7.33 with p value <0.05 and coordination subscale improved from 2.66 to 4.33 with p value <0.05 and the TIS score improved from 12.83 to 17.66 with p value <0.05. For the static sitting balance subscale, there is no notable result in pre and post treatment as the participants in the study already were able to sit without support for one minute and also level of the mean score on the static sitting balance subscale pretreatment was already 6 out of a maximum of 7 points.

A recent study on posturographic assessment of sitting balance recovery has shown that lateral balance control which depends on trunk muscles is most crucially affected than Anterior-Posterior direction in stroke and also suggested that it may be important to use an unstable support for sitting balance training to improve lateral postural instability.16 Our study supports this finding as the subjects trained in Swiss ball an unstable surface are found to be significant improvement in dynamic sitting balance and trunk coordination.

A recent study by Verheyden el al who has concluded that 10 hours of additional trunk exercises on ground level results change in dynamic sitting balance and not coordination subscale in TIS.17 This present study we found significant change in both dynamic sitting balance and coordination subscale of TIS. The change in coordination score may be as we trained the subjects in labile surface which may result in better recruitment of trunk muscles and also stress the anticipatory postural control system.18

**Implication for practice**

Results of this study support the importance of Swiss ball training to improve trunk performance after stroke.

**Limitations of the study**

The relatively small and selected group of patients included in the study challenges the generalizability of the outcome of this study. Significant improvement in trunk performance may be due to spontaneous functional recovery as selected subjects
are less than one month post stroke duration. As the present study was 3 weeks duration, long term follow up studies are required to know the carry over effects of the intervention. Impairment in trunk position sense which is not addressed in this study may affect the performance. Future studies need to investigate effects of Swiss ball training on stroke population with randomized controlled clinical trials and also with outcome measures such as manual dynamometry, posturography and electromyographic analysis.

References