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Comparison of physio ball and plinth trunk exercises regimens on trunk control and functional balance in patients with acute stroke: a pilot randomized controlled trial

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Abstract

Objective: To examine the effects of trunk exercises performed using the physio ball as against the plinth, on trunk control and functional balance in patients with acute stroke.

Design: An observer-blinded pilot randomized controlled trial.

Subjects: Thirty patients with acute stroke (mean post-stroke duration 12 (95% confidence interval (CI) 2–34) days) who had the first onset of unilateral haemorrhagic or ischaemic lesion and an independent ability to sit for 30 seconds.

Setting: Inpatient stroke rehabilitation centre.

Interventions: The experimental group performed task-specific trunk exercises on an unstable surface (physio ball) while the control group performed them on a stable surface (plinth). In addition to regular acute physiotherapy, both the groups underwent 1 hour of trunk exercises a day, four days a week for three weeks.

Main measures: Trunk Impairment Scale and Brunel Balance Assessment.

Results: The difference between the baseline characteristics of the patients belonging to both groups was not statistically significant. Post-intervention, both the groups improved on trunk control and functional balance but the experimental group improved more significantly than the control group (change scores of between-group comparison for the total Trunk Impairment Scale 3.06 (1.43), dynamic sitting balance 1.47 (1.36) and coordination 1.3 (0.67) subscales of Trunk Impairment Scale; the total Brunel Balance Assessment 1.8 (1.4) and stepping 1.87 (1.6) component of Brunel Balance Assessment). The level of significance was set at $P < 0.05$.

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Conclusions: The trunk exercises performed on the physio ball are more effective than those performed on the plinth in improving both trunk control and functional balance in acute stroke patients, suggesting a task-specific effect and also a carry-over effect.

Keywords

Physio ball, trunk rehabilitation, trunk control, acute-stroke, balance

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Introduction

Trunk control requires appropriate sensorimotor ability of the trunk in order to provide a stable foundation for balance functions in patients with stroke.[1,2] It is the ability of the trunk muscles to allow the body to remain upright, adjust weight shifts and perform selective movements of the trunk that maintains the base of support during static and dynamic postural adjustments.[3] Unlike hemiplegic limb muscles, the trunk muscles are impaired multidirectionally following a unilateral stroke.[4–7] Trunk muscle strength in stroke patients was reduced for bilateral lateral flexors, measured by means of a hand-held dynamometer, when compared with that of age-matched controls.[8] Studies using an isokinetic dynamometer have shown a weakness of the trunk flexors, the extensors and the bilateral rotators in patients with stroke.[9,10] A recent study using a clinical measurement tool also found that selective movements of the upper and the lower trunk are impaired after a stroke.[11] Trunk control has also been identified as an important early predictor of functional outcome after a stroke.[12–14]

One of the neurodevelopmental principles states that the control of movement proceeds from the proximal to the distal part of the body. The trunk being the central key point of the body, proximal trunk control is a prerequisite for distal limb movement control, balance and functional mobility.[15,16] A cross-sectional study revealed a positive relation between trunk control and measures of balance, gait and functional ability in patients with stroke.[17] Although the importance of the trunk following stroke has been documented in the literature, studies focusing on trunk rehabilitation are scarce when compared with those on limb rehabilitation.

Recent work by Verheyden et al.[18] demonstrated that 10 hours of additional task-specific trunk exercises performed on the physio plinth along with regular physiotherapy had a beneficial effect on the selective movement control of the lateral flexion in patients with subacute stroke. Although many physiotherapists working with patients after a stroke in order to improve their trunk control and balance use a dynamic treatment instrument (i.e. physio ball), the efficacy of the method has never been researched. Trunk muscle exercises performed on a physio ball lead to better trunk muscle activity in healthy individuals.[19,20] It is therefore possible that the same may be beneficial for patients who have had a stroke.

The potential activation of trunk musculature is better when the exercises are performed on a physio ball rather than when they are performed on a plinth, since the movement of a ball beneath the participants provides a postural perturbation to which the muscles respond in order to maintain the desired posture.[21]

In patients with stroke, poorer balance was associated with falls, as well as greater restriction of activities after fall.[22] Hence, there is a need for a trunk exercise regime that studies the task-specific effect and also a carry-over effect on functional balance. The aim of the study was to investigate the comparative efficacy of the two interventions mentioned above in improving trunk control and functional balance using the Trunk Impairment Scale and the Brunel Balance Assessment, respectively. The objective of the study was to determine whether trunk exercises performed on a physio ball are more beneficial than those performed on a plinth in patients with acute stroke. We hypothesized that task-specific trunk exercises performed on a physio ball are more effective than similar exercises performed on a plinth in improving trunk control and functional balance in patients with acute stroke.

Method

This observer-blinded, pilot randomized controlled study was conducted in the neurological rehabilitation centre of the inpatient stroke unit of a multi-specialty teaching hospital. Acute stroke patients who were medically stable and able to understand and follow simple verbal instructions were screened for eligibility for the study. Stroke diagnosis was confirmed by the neurologists on the basis of clinical examination, computed tomography (CT) and magnetic resonance imaging (MRI). Patients (mean post-stroke duration 12 (95% confidence interval (CI) 2–34) days) who had the first onset of unilateral supratentorial lesion associated with ischaemic or haemorrhagic stroke and could sit independently for 30 seconds on a stable surface, were included in the study. Patients were excluded if they had a neurological disease affecting balance other than a stroke, such as for instance a cerebellar disease, Parkinson's disease and/or a vestibular lesion; musculoskeletal disorders such as low backache, arthritis or degenerative diseases of the lower limbs affecting motor performance.

The patients included in the study were randomly assigned to receive trunk exercises performed either on the plinth (control group) or on the physio ball (experimental group) through the block randomization method. The method of allocation was concealed in sequentially numbered, sealed, opaque envelopes. An independent observer who performed the randomization procedure was not involved in conducting interventions and collecting the outcome measures.

The Trunk Impairment Scale and the Brunel Balance Assessment were the outcomes used to measure trunk control and functional balance in patients with stroke, respectively. The Trunk Impairment Scale is a 2-, 3- or 4-point ordinal scale which evaluates static sitting balance, dynamic sitting balance and coordination. In earlier studies it had been documented for its reliability, validity and responsiveness.[3,11,12,23] The Brunel Balance Assessment consists of a hierarchical series of functional performance tests that range from supported sitting balance to advanced stepping tasks. It combines a 12-point ordinal scale and is found to be a reliable, valid measure of balance assessment in post-stroke patients.[24–26] An independent blinded observer who measured both the outcomes was not aware of the allocation of treatment groups.

The study protocol was approved by the Ethics and Scientific Committee of the Institution, Manipal University, India and written informed consent was obtained from all the patients whose active participation was sought.

Interventions

All the patients included in the study underwent regular acute-phase physiotherapy treatment, such as tone facilitation and a range of movement exercises for the hemiplegic side. In addition, both the groups received 1 hour of trunk exercises a day, four days a week for three weeks. All the patients received exercises consisting of task-specific movements of the upper and lower part of the trunk both in the supine and sitting positions. The supine exercises involved the pelvic bridge, the unilateral bridge, the flexion rotation of the upper and lower trunk. Sitting exercises included selective flexion extension of the lower trunk; lateral flexion of the upper and lower trunk; rotation of the upper and the lower trunk; weight shifts; forward and lateral reach.

All the treatment sessions were delivered by research physiotherapists. The trunk exercises were initiated with moderate assistance and progressed to a state of no assistance. The number of repetitions and intensity of the exercise were determined by the physiotherapists based on the patient's performance. The exercises were performed with adequate rest periods in between.

The intensity of the exercises was increased by introducing one or several of the following changes: (1) reducing the base of support; (2) increasing the lever arm; (3) advancing the balance limits; or (4) increasing the hold time. The control group performed task-specific trunk exercises on a stable surface (i.e. the plinth),[18] while the experimental group performed them on an unstable support (i.e. the physio ball).

Experimental group

The supine exercises were as follows: the pelvic bridge was performed by placing both the patient's legs on a physio ball and asking him or her to lift the pelvis off the support surface. Initially the ball was kept beneath the knees and advanced to the lower leg. The exercise intensity was further increased by flexing the uninvolved upper limb. The unilateral pelvic bridge was performed by lifting the uninvolved leg off the ball while maintaining the pelvic bridge position. Upper trunk rotation was executed by having the patient rest his or her trunk on the ball with knee flexed at 90 degrees and the feet flat on the support surface. The patient was asked to perform a task-specific reach-out for an object kept above the hip by a flexion rotation of the upper trunk. Lower trunk rotation was performed by placing the both the patient's legs on the ball and asking him or her to move the ball to both the left and the right by rotating the pelvis. Initially the ball was placed beneath the knees, and then advanced towards the ankles. The flexion rotation of the lower trunk was achieved by bringing the ball diagonally towards the shoulder while holding the ball in between the knees.

The sitting exercises were as follows: The patient was seated on the physio ball with hips and knee bent at 90 degrees and the feet kept flat on the support surface. The patient performed all the task-specific dynamic exercises while balancing in a sitting posture on the ball. Selective flexion extension of the lower trunk was performed by anteflexion and retroflexion of the lower part of the trunk. Upper trunk lateral flexion was executed by initiating movement from the shoulder girdle so as to bring the elbow towards the ball. Lower trunk lateral flexion was achieved by initiating movement from the pelvic girdle so as to lift the pelvis off the ball and bring it towards the ribcage. Upper trunk rotation was performed by moving each shoulder forwards and backwards. Lower trunk rotation was performed by moving each knee forwards and backwards. Weight shifting was executed by letting the ball roll forward until it touched the back of the legs, thereby allowing the lower spine to curve, followed by rolling the ball backward as far as possible and allowing the lower spine to arch. A forward reach was performed by asking the patient to reach a fixed point at shoulder height by forward flexing the trunk at the hips. Furthermore, progression was made by a forward diagonal reach at shoulder height. A lateral reach was performed by asking the patient to reach out for a fixed point at shoulder height so as to elongate the trunk on the weight-bearing side and shorten the trunk on the non-weight-bearing side.

Data analysis

Data were analysed using the SPSS version 11.5 statistical package. The comparison between groups of baseline characteristics such as age, gender, post-stroke duration, hemiplegic side and type of stroke were analysed by descriptive statistics. To examine the effect of randomization procedure, the demographic variables and pre-intervention outcome measures between the groups were evaluated by Student's unpaired t-test for continuous measures and a chi-square test for dichotomous measures, respectively.

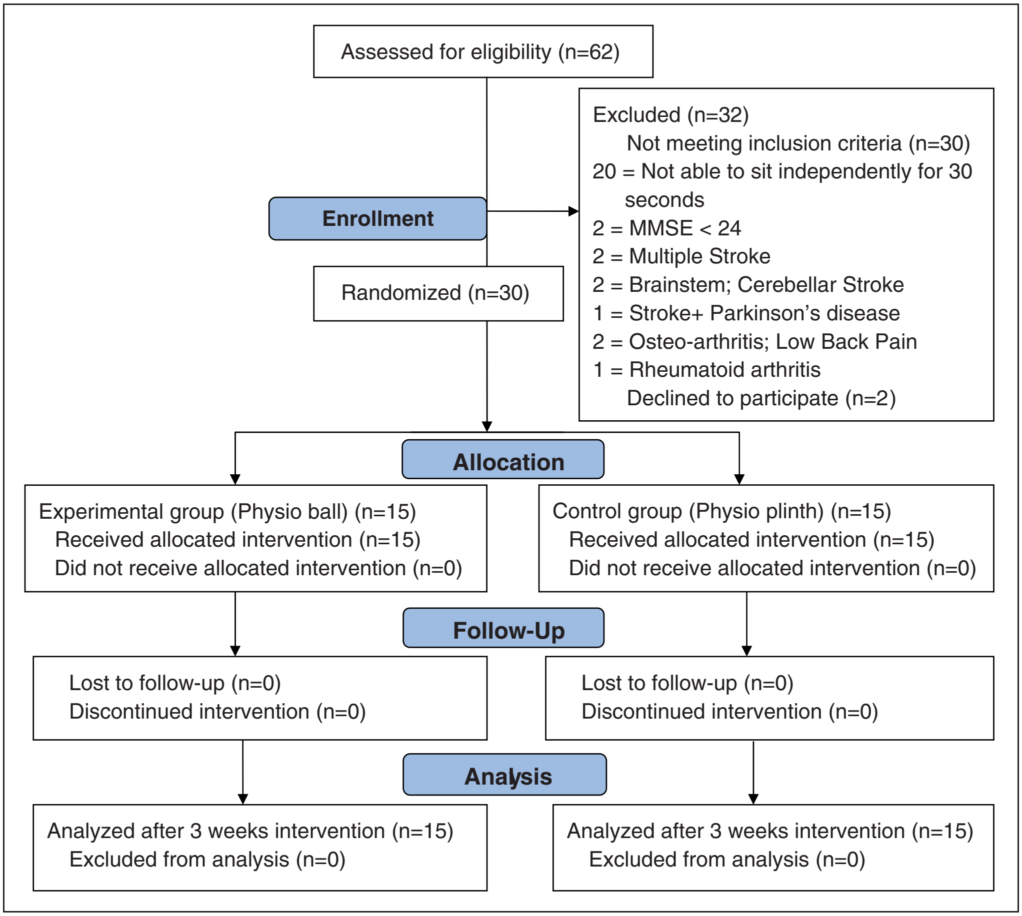

Figure 1. Flowchart of the study.

The equality of variances for the continuous measures was assessed by Leven's test. The parametric test results within the group and between the groups were obtained and statistically analysed using Student's paired and unpaired *t*-tests, respectively.

Effect size index (d) was calculated for each of the outcome measures and its subscales/components using the formula $(X_{ball}–X_{plinth})/SD$, where X_{ball} and X_{plinth} are the physio ball and control groups means, and SD is the common standard deviation. The change scores of within-group comparison, between pre- and post-intervention levels, were the groups mean and standard deviation. SD was calculated by averaging the standard deviation of both the experimental and the control groups. It was defined by using Cohen's classification of the effect size index (d), where small $d = 0.20$, medium $d = 0.50$ and large $d = 0.80$.[27]

Results

Figure 1 shows patients' enrolment and allocation with no patient drop-out in the intervention period. Of the 62 patients screened for study eligibility, a total of 30 patients were included for analysis, of whom 15 were in the control group (physio plinth) and 15 were in the experimental group (physio ball). The characteristics of the

Table 1. Demographic and outcome variables: mean (SD) or *n* (%)

Group item	Control ($N = 15$)	Experimental ($N = 15$)	*P*-value
Age (years)	55 (6.5)	59.8 (10.5)	0.145[a]
Post stroke duration (days)	12.1 (7.5)	11.8 (8.1)	0.755[a]
Gender (male/female)	9 (60%)/6 (40%)	8 (53%)/7 (47%)	0.713[b]
Hemiplegic side (right/left)	9 (60%)/6 (40%)	10 (67%)/5 (33%)	0.703[b]
Stroke type (ischaemic/haemorrhage)	8 (53%)/7 (47%)	9 (60%)/6 (40%)	0.713[b]
Trunk Impairment Scale (0–23)	11.47 (1.95)	11.27 (2.31)	0.800[a]
Static sitting balance (0–7)	5.6 (0.74)	5.73 (0.59)	0.590[a]
Dynamic sitting balance (0–10)	4.13 (1.18)	4.13 (1.18)	1.000[a]
Coordination (0–6)	1.67 (0.62)	1.4 (0.91)	0.356[a]
Brunel Balance Assessment (0–12)	4.4 (0.74)	4.47 (1.06)	0.843[a]
Sitting (0–3)	3	3	1.000[a]
Standing (0–3)	1.4 (0.74)	1.47 (1.06)	0.843[a]
Stepping (0–6)	0	0	1.000[a]

[a]Analysed by Student's unpaired *t*-test.
[b]Analysed by chi-square test.

experimental and control groups are shown in Table 1. No significant differences between the groups were found for the demographic variables, stroke-related parameters and outcome measures at the pre-intervention level.

Outcome measures of experimental and control groups are shown in Table 2. The change score of between-group comparison for the total Trunk Impairment Scale (3.06 (1.43)) favours the experimental group ($P < 0.0001$). For the dynamic sitting balance subscale of the Trunk Impairment Scale, the change score of between-group comparison supports the experimental group (1.47 (1.36)), indicating a 15% improvement (1.47/10) in the highest possible score of this subscale ($P < 0.002$). Furthermore, the change score of between-group comparison for the coordination subscale of the Trunk Impairment Scale (1.33 (0.61)) favours the experimental group, the change being 22% (1.33/6) of the highest possible score ($P < 0.0001$). The within-group change score of 4.07 (1.33) on the dynamic sitting balance subscale of the Trunk Impairment Scale suggests a 41% improvement for the experimental group in the post-intervention phase.

For the control group, the change score of 2.6 (0.98) on dynamic sitting balance subscale suggests a 26% improvement post intervention. The change scores of within-group comparison, between pre- and post-intervention levels on the coordination subscale of the Trunk Impairment Scale for the physio ball (2.53 (0.52)) and control (1.2 (0.41)) groups indicate a 42% and a 20% improvement, respectively.

For the total Brunel Balance Assessment, the comparison between the groups showed a change score of 1.8 (1.4), favouring the physio ball trunk exercise training ($P < 0.0001$). The change score of between-group comparison for the stepping component of the Brunel Balance Assessment (1.87 (1.6)) supports the experimental group (i.e. a change of about 31% (1.87/6) of the highest possible score of this component ($P < 0.002$)). The change score of 0.07 (0.64) between the groups for standing component of the Brunel Balance Assessment was not statistically significant ($P = 0.843$). However, the change scores of within-group comparison were statistically significant for both the physio ball 1.53 (1.06) and the control 1.6 (0.74) groups in the standing component of the Brunel Balance

Table 2. Comparison of outcome measures (change scores of within-group and between-group comparison)[a]

	Control group (plinth) (within-group comparison)[b]			Experimental group (physio ball) (within-group comparison)[b]			
Outcome measures	Pre-intervention	Post-intervention	Change scores (post–pre)*	Pre-intervention	Post-intervention	Change scores (post–pre)*	P-value[c]
Trunk Impairment Scale (0–23)	11.47 (1.95)	16.34 (1.11)	4.87 (1.25)	11.27 (2.31)	19.2 (1.56)	7.93 (1.28)	0.0001
Static sitting balance (0–7)	5.6 (0.74)	6.8 (0.2)	1.2 (0.68)	5.73 (0.59)	7	1.27 (0.59)	0.814
Dynamic sitting balance (0–10)	4.13 (1.18)	6.73 (0.88)	2.6 (0.98)	4.13 (1.16)	8.2 (0.94)	4.07 (1.34)	0.002
Coordination (0–6)	1.67 (0.62)	2.87 (0.52)	1.2 (0.41)	1.4 (0.91)	3.93 (0.88)	2.53 (0.52)	0.0001
Brunel Balance Assessment (0–12)	4.4 (0.74)	8.8 (1.15)	4.4 (0.83)	4.47 (1.06)	10.67 (1.29)	6.2 (0.94)	0.0001
Standing (0–3)	1.4 (0.74)	3	1.6 (0.74)	1.47 (1.06)	3	1.53 (1.06)	0.843
Stepping (0–6)	0	2.8 (1.15)	2.8 (1.15)	0	4.67 (1.29)	4.67 (1.29)	0.0001

Sitting (0–3) component of Brunel Balance Assessment was not analysed as pre-intervention score was at the maximum in both groups.
[a]Values expressed as mean (SD).
[b]Analysed by Student's paired *t*-test.
[c]Analysed by Student's unpaired *t*-test.
*Change scores (post–pre) for all outcome measures were statistically significant (*P*-value < 0.05).

Assessment, suggesting more than a 50% improvement for both the groups in the post-intervention period.

The effect size index (*d*) calculated for all the outcome measures are listed below: for total Trunk Impairment Scale (2.1); dynamic sitting balance (1.1) and coordination (2.2) subscale of Trunk Impairment Scale; total Brunel Balance Assessment (1.3); standing (0.1) and stepping (1.2) subscale of Brunel Balance Assessment, respectively. The overall effect size index (1.7) for trunk control and balance was determined by averaging both the total Trunk Impairment Scale and Brunel Balance Assessment effect size indices.

Discussion

The aim of the study was to examine whether task-specific trunk exercises performed on the physio ball are more beneficial than similar exercises performed on the plinth. The study results showed that trunk exercises performed on the physio ball are more effective than those on the plinth for improving lateral flexion and rotation of the trunk as measured by dynamic sitting balance and the coordination subscales of the Trunk Impairment Scale, respectively. Furthermore, the experimental (physio ball) group showed greater improvement in functional balance, particularly in the stepping component of the Brunel Balance Assessment, than the control group, suggesting a carry-over effect with trunk rehabilitation. The overall effect size index (1.7) observed in the study is in favour of the experimental group.

To the best of our knowledge, this study is the first of its kind using a physio ball, the dynamic treatment instrument for trunk rehabilitation in patients with acute stroke. In addition, the

Brunel Balance Assessment has been used for the first time as a functional balance outcome measure in an acute stroke intervention study.

The treatment techniques incorporated in our study were based on the task-specific system and ecological motor control theory. Task-specific trunk exercises practised in a challenging environmental field (i.e. a stable as against an unstable surface) provided a gradual biomechanical demand on the trunk muscles. The trunk control improvement was quite impressive in our study, suggesting better trunk muscle activity due to destabilizing forces while exercises were performed on the physio ball. The effect size index (2.1) observed in the total Trunk Impairment Scale supports for trunk exercises performed on the physio ball indicated an appreciable improvement.

A study on electromyography analysis observed that the anticipatory postural adjustment of trunk muscles activity is impaired in patients with stroke.[28] Furthermore, there was a reduced recruitment of high threshold motor units of trunk muscles after stroke.[9,10] These are, in fact, essential for reactive postural adjustments during external perturbation.[29] The possible reason for better trunk control improvement in the experimental group may be that the movement of the physio ball beneath the patients provides a postural perturbation in a gravitational field to which the trunk muscles respond reactively in order to maintain the desired postural stability.

Our study results showed that task-specific trunk exercises performed on a physio ball resulted in a greater improvement of the trunk lateral flexion (frontal plane dynamic postural control), as measured by the dynamic sitting balance subscale of the Trunk Impairment Scale as compared with the improvement registered by the control group. A study by Verheyden et al.[18] found that 10 hours of additional trunk exercises along with regular physiotherapy improved the lateral flexion of trunk in patients with subacute stroke. In our study it was observed that difference in effect between the two interventions (trunk exercises on the physio ball vs. those on the plinth) was 1.47 for the dynamic sitting balance subscale, which may be compared with the observed mean difference of 2.22 between the two interventions (trunk exercises on the plinth as against regular physiotherapy) in the study done by Verheyden et al. Although the change score between the groups was slightly lower in our study than indicated by earlier trunk research, a greater improvement (4.07) was observed in our experimental group (i.e. those who performed trunk exercises on the physio ball) than the improvement (3.47) observed in the experimental group (i.e. those who performed trunk exercises on the plinth) of the study undertaken by Verheyden et al.

The above-mentioned change scores of between-group and within-group comparison, in addition to the greater effect size index (1.1) for the dynamic sitting balance subscale of the Trunk Impairment Scale, therefore favour the trunk exercise regime performed on the physio ball.

An interesting finding was the trunk rotation improvement (i.e. horizontal plane dynamic postural control) as measured by the coordination subscale of the Trunk Impairment Scale. Coordination of the trunk is the mobility over stability task which requires counter rotation between the upper and lower trunk. Furthermore, the better weight shift ability towards the hemiplegic side is essential for coordination of the trunk, particularly for the lower trunk rotation.[15,16] Clinical observation also suggests that the rotation of the lower part of the trunk is more difficult for stroke patients.[11] Recent studies on posturographic analysis observed that stroke patients tend to avoid shifting their centre of pressure towards the hemiplegic side in sitting[29] and standing.[30]

A study by Mudie et al.[31] found that training the patient in the awareness of trunk position could improve weight symmetry in sitting after the early phase of the stroke. The probable reason for the significant trunk rotation improvement may be the improved weight shift ability with the physio ball training.

Furthermore, the trunk training performed on the plinth involves the same exercises as physio ball training, but the inadequacy of plinth training acting on coordination would only be due to lack of postural perturbation. The effect size index (2.2) for the coordination subscale of the Trunk Impairment Scale is in favour of the experimental group.

Another exciting finding of this study was that trunk exercises performed on the physio ball had a carry-over effect in improving functional balance such as standing and stepping. The greater effect size index observed in the total Brunel Balance Assessment (1.3) and the stepping component of the Brunel Balance Assessment (1.2) support our study hypothesis. Dean et al.[31,32] demonstrated an improvement in standing balance following dynamic reaching tasks undertaken for objects beyond arm's length when the patient was in the sitting position. Experts in the field of neurological rehabilitation have addressed the trunk as the central key point of the body. The neurodevelopmental treatment principle states that the control of movement proceeds from proximal to distal body regions. Proximal stability of the trunk is a prerequisite for distal limb movement.[15,16] Therefore, proximal trunk control improvement influences the functional balance involved in activities such as standing and stepping. A recent cross-sectional study by Verheyden et al.[17] favours this hypothesis. In their study, there was a positive association found between trunk control and balance after an acute stroke.

According to Tyson,[34] people with acute stroke progressing from one level to another level is of clinical importance for the Brunel Balance Assessment. In our study, the physio ball group had advanced almost two levels more than the control group, and this may affirm a factual clinical importance for Brunel Balance Assessment. Patients with acute stroke treated with the physio ball were able to walk 5 m without an aid in one minute, which means they could change the base of support between double and single stance. Furthermore, they had attained a dynamic single stance level (i.e. placing the sound leg twice on and off a step while standing on the hemiplegic leg for 15 seconds). The reason for the significant stepping balance improvement using the physio ball intervention may be an improvement in lower trunk muscle control which is essential for the stabilization of the pelvis. If an improved level of proximal pelvic stability is attained, a better distal lower extremity mobility might be anticipated, such as that involved in stepping balance.

A study involving analysis of trunk kinematics in stroke subjects found unstable and asymmetrical pelvic movements during walking.[35] A study on posturographic analysis of trunk movements also confirmed that these movements are executed by the upper trunk with very little lower trunk (pelvic movement) after stroke.[36] An intervention study by Trueblood et al.[37] gives further support to this hypothesis. In their study, proprioceptive neuromuscular facilitation (PNF)-based resisted anterior elevation and posterior depression of pelvic movements for lower trunk muscles resulted in an improvement in walking in early phase stroke patients.

The study findings are of clinical importance for the treatment of dynamic sitting balance, coordination of the trunk, standing and stepping balance in patients with acute stroke who are able to sit independently for 30 seconds. Inclusion of the dynamic treatment equipment (i.e. physio ball) may thus be considered to have not only a beneficial task-specific effect on the selective trunk movement control of lateral flexion and rotation, but also a carry-over effect on functional balance in the comprehensive rehabilitation of acute stroke care.

The study findings warrant caution when interpreting and generalizing the observed trunk control and functional balance improvement in acute stroke patients. First, the study had a limited number of stroke patients recruited from a single geographical location. Therefore, future multicentre trials with a larger number of patients are needed to confirm our study results. Second, there was a lack of follow-up of patients to find out if improvement was carried over. Third, although we presumed better trunk muscle activity with selective trunk muscle training on a physio ball, it was not studied using surface electromyography (sEMG). Analysing the efficacy of a similar rehabilitation programme on trunk muscle activity by means of sEMG may be the choice for future research. Fourth, the functional status of the patients was not assessed following intervention. Future studies should assess the long-term effects of trunk rehabilitation on the level of falls self-efficacy and of re-integration into the community of patients with stroke.

Clinical message

- Task-specific trunk exercises using physio ball is superior to similar exercises performed on plinth in improving trunk control and functional balance in patients with acute stroke.

Authors' contributions

SK: Designing study, specifying the question, translating protocol into practice, collecting and handling outcome measures data, identifying, analysing and interpreting data, writing, reading, editing and checking, identifying relevant references. NA: Designing study, obtaining ethics committee approval, conducting interventions, identifying, analysing and interpreting data, identifying relevant references. KV: Specifying the question, ensuring randomization process, analysing and interpreting data. ZKM, BVS: Stroke diagnosis, screening for medical stability and referring the patients for the study, reading and checking. SG, AMJ: Reading, checking and reviewing protocol.

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