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[REVIEW ARTICLE]

The effectiveness of trunk training on Trunk Performance & trunk control in Patients with Stroke: A Systematic Review.

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ABSTRACT :

Background: The trunk muscle weakness and the loss of proprioception concerning the affected side can interfere with balance, stability, and functional disability. Trunk control has been identified as a significant early predictor of functional outcomes after Stroke.

Objective: To explore the literature regarding using trunk training exercises (TTE) in patients with Stroke to improve trunk performance and Control.

Methods: PubMed/MEDLINE, Google Scholar, and CINHAL databases were searched with the keywords Stroke and trunk Training Exercises according to MESH criteria and reference lists screened to identify randomized controlled trials (RCTs) of trunk training exercises in stroke survivors. Two reviewers independently screened references, selected relevant studies, extracted data, and assessed trial report quality.

Results: A total of 09 studies with 328 participants met the inclusion criteria. Out of the 9 studies, 5 included both acute & subacute, 1 study included only acute & 3 only chronic patients with Stroke. Trunk training exercises, Core stability exercises, and weight shifting exercises performed with either stable or unstable surfaces showed moderate evidence to improve trunk performance and Trunk Control in Patients with acute & subacute Stroke.

Conclusion: Trunk Training Exercises performed on a stable surface have been used widely to improve Trunk control in patients with Stroke. However, its effect on functional tasks needs to be explored through well-designed research studies with specific outcome measures.

Keywords: Subacute Stroke, Trunk Training, Trunk Control, Surface.

Introduction

Stroke is a shared global healthcare problem and a major concern of long-term neurological disability in adults. It is also a significant cause of death worldwide[1]. After suffering a stroke, the patients show spasticity, cognitive dysfunction, impaired balance, and sensorimotor deficit. Also, trunk muscle insufficiency of strength or tone may be present[2,3]. The trunk muscle weakness and the loss of proprioception concerning the affected side can interfere with balance, stability, and functional disability and may reduce the ability to control posture[4]. Motor function deficits due to Stroke affect the patients' mobility, limitations in daily life activities, participation in society, and odds of returning to professional activities4. These patients have an increased risk of falling toward the paretic side and limited functional abilities[5]. They frequently show an increased posture sway, decreased dynamic stability, and impaired weight-shifting ability onto the paretic lower limb when sitting and standing[6].

Balance impairment in sitting and poor sitting ability are common clinical problems after Stroke[7]. Stroke patients show a significantly reduced level of trunk performance compared to healthy individuals of the

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same age and sex and a remarkable asymmetry of the trunk and pelvis[8]. The recovery of sitting balance is commonly assumed to be essential to obtain independence in other vital functions such as reaching, rising to stand, and sitting down[9].

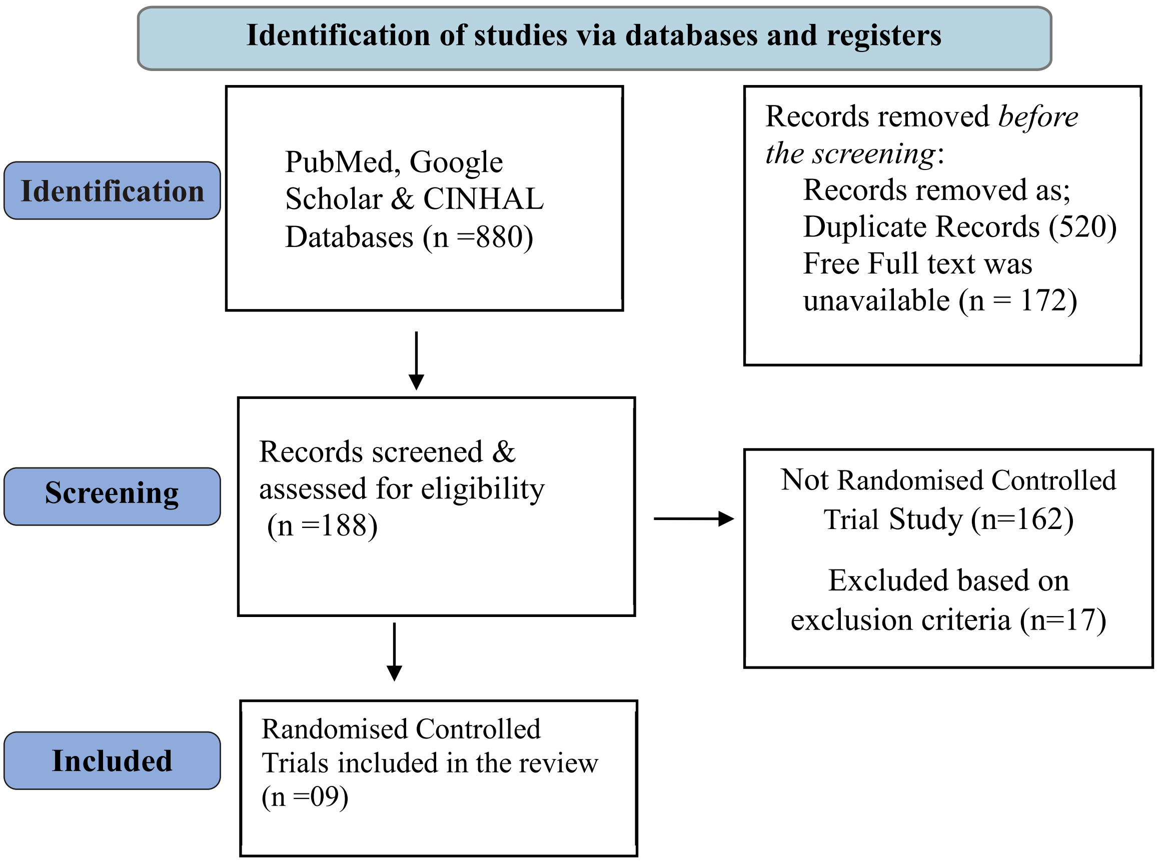
Some studies have demonstrated that, in general, any exercise can improve mobility and functional balance in adults with chronic Stroke. Still, the advantages of specific and focused exercise programs are being determined, as well as what mechanisms underlie the improvements in patients' conditions[10]. Kim reported that trunk stabilizing exercises using appropriate proprioceptive neuromuscular facilitation (PNF) are effective in improving the implementation of tasks in the daily lives of stroke patients[11].

Our main objective in this review is to evaluate the effectiveness of trunk training exercises (TTE) approaches in improving trunk performance and trunk Control in patients with Stroke compared with Conventional or Occupational physical therapy. Also, To Understand the Mechanisms That Underlie the Improvement.

Methodology

A systematic search was undertaken using commonly used search engines (PubMed, Google Scholar, and CINHAL) from June 2013 to June 2023. The search strategy comprised of the following terms: Trunk Training, Stroke.

The pulmonary functions FEV1, FVC, FEV1/FVC and PEFR of both groups i.e., group A with normal craniovertebral angle and group B with Forward Head Posture were compared. The correlation between PFT and craniovertebral angle was tested by comparing FVC, FEV1, FEV1/FVC and PEFR values with the values of craniovertebral angle by using Pearson correlation test. P value of <0.05 was consider significant.



Selection criteria for rct studies:

Type of study- Only studies published in English with free full text evaluating Trunk Training exercises in patients with Stroke were included.

Type of participants- Studies involving adult patients who could understand instructions without any other neurological disease that might affect balance. Patients with Severe visuospatial impairment such as hemineglect or Pusher syndrome and patients who have other musculoskeletal conditions that cause severe balance problems (such as cerebellar or basal ganglia disorders).

Type Of Intervention trials that evaluated TTE performed either on a stable or an unstable surface to improve trunk function and sitting balance, with or without conventional physiotherapy, were included. Home-based interventions or Tele-rehabilitation were excluded from the review.

Data extraction:

The Data Analysis was done through PubMed, Google Scholar, and the CINHAL Electronic Database searched by SJ. The Title and Abstract of all the retrieved results were then screened for eligibility by SJ & SG. The Screening process aimed to narrow the volume of articles by rejecting the studies that were not relevant or appropriate according to previously stated criteria; SJ and SG evaluated full-text versions of all relevant articles.

Result:

Table 1 - Rating of methodological quality of articles included in review using pedro scale23.

Authors	Umair Ahmed et al.	Rosa Cabanas-Valdés et. al.	Pei-Yun Lee	Tamaya Van Criekinge	Nam G. Leeet. al.	Koshiro Haruyama et. al.	Pil Neo Hwangbo	Yuji Fujino et al.	Yuji Fujino et al.
Random allocation	Yes	Yes	yes	Yes	Yes	Yes	yes	Yes	Yes
Concealed allocation	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Groups similar at baseline	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Participants blinding	No	No	No	No	Yes	No	No	No	No
Therapists blinding	No	No	No	No	No	No	No	No	No
Outcome assessor blinding	No	Yes	yes	Yes	No	Yes	No	yes	Yes
Less than15% dropouts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intention- to treat analysis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Between Groups Statistical Comparison	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Point Measures and Variability Data	Yes	yes	Yes	Yes	Yes	Yes	yes	yes	Yes
PEDro score	8	9	9	9	8	8	6	8	9

Table no. 2 Summary of RCT Studies

	Year of publication	Authors	No. of patients	Type of Stroke	Outcome measures	Intervention	Result
1.	2021	Umair Ahmed et. al. [12]	74 (Allocation ratio 1:1)	Subacute Stroke Patients	TIS scores. Berg balance scale, 10-meter walk test, Timed-up-and-go test, timed-Up-Go–cognitive, Stroke Impact Scale-16	Group A -more diagonal and lateral plane trunk movements than sagittal movements, trunk exercises with DT practice, and conventional treatment. Group B- Conventional physiotherapy SCTR. Time- 1 hour Of Conventional Rehab & 45 Min. Of trunk Training 3 sets of 9-13 reps per session, 5 times weekly for	The between-group difference in effect size on the dynamic balance subscale, TUG, TUGC, and BBS, was 1.09, favoring HIMTD therapy.

						3 months. No additional Hours of T/t for EG	
2.	2021	Rosa Cabanas-Valdés et. al.[13]	n=110 (EG) n=110(CG)	Patients with Acute Stroke	TIS score, Berg Balance Scale; gait speed by BTS G-Walk ; rate of falls, lower-limb spasticity by Modified Ashworth Scale; Barthel Index.	Group A- The experimental group performs core stability exercise(CSE) in addition to CP. Group B- Conventional PT. Time- 1 hour of treatment a day, 5 times a week for 5 weeks The experimental group performed core stability exercises for 15 minutes daily. Additional 6.15 Hours of T/t for EG.	The mean difference (SD) Trunk Impairment Scale 2.0 (total score) was 0.78 points; for the subscale dynamic sitting balance, it was 0.52 points; for the Function in Sitting Test, it was 2.52 points; for the Brunel Balance Assessment total score, it was 0.60 points, for the stepping section (gait), it was 0.82 points; for the Berg Balance Scale, it was 3.30 points; and for the Tinetti test (gait), it was 1.11 points.
3.	2020	Pei-Yun Lee et. al.[14]	CG=17 EG=18	Subacute	1. Center of pressure (COP) motion derived from the force platform. 2. Trunk Impairment Scale (TIS) and 3. 6 m walk time.	The EXP group received trunk exercises training in hook-lying and sitting on stable and unstable surfaces. The CON received upper limb range of motion exercises at comfortable speeds in a well-supported sitting position. 30 min training, two non-consecutive days per week for a total of six weeks No additional hours of therapy for EG.	The between-group values. Outcome measures | p-value COM forward | 0.195 (With foot support)0.045 (Without foot support) COP peak forward displacement | 0.078 (with foot support)0.001 (without foot support) THIS | 0.035 6MWT | 0.012
4.	2020	Tamaya VAN CRIEKINGE[15]	EG= 19 CG= 20	Acute & Subacute	1. Temporal patterning on EMG 2. MU recruitment as measured on EMG for Various muscles of the involved side	The control group performed seated cognitive exercises (trunk activity excluded), The experimental group focused on increasing trunk control (core-stability exercises to increase trunk control in a supine and seated position on both stable and unstable surfaces). one hour a day, four days a week, continuing for four weeks	The between-group p- p-values. Outcome measures | p-value M. Erector Spinae (hemiplegic side) | 0.021 Erector Spinae (non-hemiplegic side | 0.024

						Conventional therapy & Occupational Therapy, each for 1 hour, were additionally given No additional hours of therapy for EG.	Vastus Lateralis: 0.467 Rectus Femoris: 0.936 Medial Hamstring: 0.414 Lateral Hamstring: 0.817 M. Tibialis Anterior: 0.824 M. Gastrocnemius: 0.728
5.	2018	Nam G. Leeet. al. [16]	n=14 (EG) n= 14 (CG)	Adults with chronic hemiparetic Stroke	1. EMG for APA time for bilateral EO, TrA, IO, and ES activation during rapid shoulder flexion. 2. Trunk Impairment Scale (TIS), 3. Berg Balance Scale (BBS), and 4. Falls Efficacy Scale (FES)	Group A-DNS: The patient was asked to breathe in against the therapist's hand, which was applied around the lower abdominal and inguinal area and maintained for 5 seconds. Group B - conventional core Stability exercises. Time- 20 sessions of conventional core stabilization or DNS training for 30 minutes per session 5 times a week during the 4 weeks. No additional hours of therapy for EG.	The between-group p-values For Non-paretic Tr. A & ES were 0.022 & 0.011, respectively, during non-paretic shoulder flexion. For nonparetic shoulder flexion, the mean of between group p values for Tr.A& ES was 0.005
6.	2017	Koshiro Haruyama et. al. [17]	n=16 (EG n= (16)	Patients with the first Stroke. Acute & Subacute stage of Stroke.	1. TIS and its subscales 2. ROM in the sagittal plane (pelvic AROM), 3. Balance Evaluation Systems Test–brief version (Brief-BESTest), 4. Functional	Group A- Core stability training (ADIM) in place of conventional Core stability programs Group B- conventional programs. Time- 60 min/day, five times a week for 4 weeks in both groups. No additional hours of	The between-group p values for TIS, Pelvic ROM & BEST were < 0.001. TUG & FAP Were 0.008& 0.022 respectively.
					Reach test (FRT) 5. Timed Up-and-Go test (TUG), 6. Functional Ambulation Categories (FAC)	therapy for EG.	
7.	2016	Pil Neo Hwangbo [18]	n=15(EG) n= 15(CG)	Chronic stroke patients.	Trunk Impairment Scale total score and the Berg Balance Scale	Group A- received the proprioceptive neuromuscular facilitation neck pattern (30 min) along with CT (30 min)	Between the groups, the p-value was < 0.05 for both BBG & TIS.

						Group B – Conventional therapy (60min) Time –60 minutes to both groups five times a week for six weeks. No additional hours of therapy for EG.	
8.	2015	Yuji Fujino et. al. [19]	n=15(EG) n=15(CG)	Patients with Stroke.	1. TCT, 2. Trunk lateral motion was evaluated kinematically	Group A- standardized lateral sitting training without leg support on a platform tilted 10◦ to the paretic side in the frontal plane, in addition to CT Group B horizontal platform trunk training along with CT. Time - 60 times/session, with 6 sessions/week. No additional hours of therapy for EG.	This result showed the expansion of the angles from the midline to the paretic side after training. In the trunk laterally task of lateral transfer to the non-paretic side, the group | time interactions for the head orientation and the body axis were significant
9.	2014	Kyoungsim Jung [20]	EG=19 CG=20	Subacute PWS	1. Trunk reposition error (TRE), 2. Trunk Impairment Scale (TIS), and 3. Timed Up and Go (TUG)	The WST group underwent weight-shift training on an unstable surface using a Balance Pad (Airex®, Aalen, Germany) and Dynamic Ball Cushion. Those in the control group participated in a conventional exercise program simultaneously. Time - 30 min, five times a week for four weeks. Ten additional hours of therapy for EG.	The between-group values. Outcome measures – p-value TRE – 0.027 THIS – 0.004 TUG – 0.015

Discussion

This review aimed to evaluate the use of trunk training exercises (TTE) to improve trunk performances and sitting balance. This study included 09 trials with a total of 328 patients who were treated with various trunk training approaches along with conventional Physiotherapy & if required, occupational therapy. Out of the 9 studies, only 1 study included exclusively acute stroke patients, 2 studies included exclusively chronic stroke patients & 5 studies included patients with acute & sub-acute Stroke. One of the studies has yet to mention the phase of the study. The experimental treatment duration was a minimum of 15 min. and a maximum of 1 hour. On average, 20 minutes of trunk training exercises were given 4 times a week and continued for 5 weeks. An Additional duration of treatment was only provided by 2 studies out of 9, which was about 6.5 hours & 10 hours; in all the other studies, the Control group performed exercises for the same duration as that of the experimental group.

Out of 9 trials, 7 used TIS as a primary or secondary outcome measure & found a significantly improved score post their respective trunk training approaches. One study used a Trunk control test as the primary outcome measure & found significant improvement In the experimental group. TIS provides much greater information about the quality of trunk movements by detecting small changes in trunk ROM that may not be observed clinically, which may be necessary in justifying treatment approaches. It has significant potential for enhancing the understanding of trunk impairment and compensatory trunk movements post-stroke21,13.

Umair Ahmed et al. reported positive changes in TIS score with Multidirectional trunk exercises, dual tasks, and high intensity. He attributed the changes to the effect of the multidirectional exercises on maximizing good muscle synergy & minimizing the effect of destabilizing muscle synergy[12].

Rosa Cabana et al. found that Core stability exercises were more effective than conventional trunk training as co-activation of the diaphragm, transversus abdominis, and internal oblique improves postural Control22. This was also consistent with the study of Koshiro Haruyama et al., who found that core stability training was more effective as compared to conventional rehabilitation; trunk stabilization achieved through core stability training improved balance and mobility, which is due to co-contraction of the global muscles of the trunk while the core is activated[17]. Another study by Tamaya Van Criekinge et al. found a significant improvement in walking speed due to Core stability training. This may be due to core stability training, which increased vertical CoM displacements while decreasing step width and horizontal CoM displacements[15].

The Dynamic Neuromuscular Stabilisation (DNS) better reduced the Anticipatory Postural Control (APA) times in stroke patients as compared to controls, which may be due to the DNS exercise paradigm, emphasized a subconscious feedforward mechanism, was mediated via relatively fast, short-loop latency, thereby mandating fast APA time was reported in the study by Nam G. Lee et al.[16]

Trunk control training on an unstable surface was reported to be very effective in increasing proprioceptive inputs to the neuromuscular system, which in turn affects trunk control, as reported by Mudie et al[14]. Awareness of the center of pressure by smartphone-assisted visual biofeedback training (SPVFTCT) system has the potential to improve proprioception in the sitting position and maybe the possible explanation for effective improvement in TIS score in the experimental group as compared to the control group in the study by Doo-Chul Shin et al.23

Pil Neo Hwangbo et al. found that PNF neck pattern exercise contributed to the ability to control the trunk and maintain balance more than traditional rehabilitation therapy, eventually decreasing the risk of falling18. Whereas Space balanced 3D training was found to be more effective in improving balance as voluntary trunk control maintaining the standing position for 30 min at subacute stage influenced BBS scores along with gait parameters in the study by Hyeon-Jeong Noh et. al. [24]

Conclusion:

It can be concluded that Trunk Training Exercises performed on a stable surface have been used widely to improve Trunk control in patients with Stroke. However, well-designed research studies with specific outcome measures must explore its effect on functional tasks.

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