

doi:10.3969/j.issn.1673-5374.2012.25.008 [http://www.crter.org/nrr-2012-qkquanwen.html]

Karthikbabu S, Chakrapani M, Ganeshan S, Rakshith KC, Nafeez S, Prem V. A review on assessment and treatment of trunk in stroke: a need or luxury. *Neural Regen Res.* 2012;7(25):1974-1977.

A review on assessment and treatment of the trunk in stroke

A need or luxury

Suruliraj Karthikbabu¹, Mahabala Chakrapani², Sailakshmi Ganeshan³, Kedambadi C Rakshith⁴, Syed Nafeez¹, Venkatesan Prem¹

1 Department of Physiotherapy, Manipal College of Allied Health Sciences, Manipal Hospital, Bangalore 560017, Karnataka, India

2 Department of Medicine, Kasturba Medical College, Manipal University, Mangalore 575003, Karnataka, India

3 Doctoral Advisory Committee, Manipal University, Manipal 576104, Karnataka, India

4 Department of Neurology, Kasturba Medical College, Manipal University, Mangalore 575003, Karnataka, India

Abstract

Trunk function has been identified as an important early predictor of functional outcome after stroke and the same deteriorates on both contralateral and ipsilateral sides of the body following stroke. The primary contribution of the trunk muscles is to allow the body to remain upright, adjust weight shifts, and control movements against constant pull of gravity and is considered central key point of the body. Proximal stability of the trunk is a pre-requisite for distal limb mobility, balance, gait and functional activities and its positive correlation in hemiplegia has been demonstrated in a cross-sectional study. Both isokinetic and handheld dynamometer muscle strength testing demonstrated the weakness of bilateral trunk flexors, extensors and rotator muscles in both acute and chronic hemiplegic patients. This was confirmed by electromyography analysis which identified poor bilateral trunk muscles activity in patients with stroke. Trunk impairment scale is sensitive to evaluate the selective muscle control of upper and lower trunk, and it has been reported that lateral flexion of the trunk is easier than rotation of the trunk and the clinical observation concurs to the difficulty in lower trunk rotation of stroke patients. However, trunk exercises given early after stroke could produce enhanced balance performance post-stroke. This review attempts to report the evidence supporting the involvement of the trunk and its influence on balance and functional performance in post-stroke hemiplegia.

Suruliraj Karthikbabu, MPT,
Assistant professor,
Department of
Physiotherapy, Manipal
College of Allied Health
Sciences, Manipal Hospital,
Bangalore 560017,
Karnataka, India

Corresponding author:
Suruliraj Karthikbabu,
Department of
Physiotherapy, Manipal
College of Allied Health
Sciences, Manipal Hospital,
Bangalore 560017,
Karnataka, India
karthik.babu@manipal.edu

Received: 2012-05-21
Accepted: 2012-06-30
(NY20120516002/ZLJ)

Key Words

stroke; hemiplegia; trunk control; balance; function; electromyography; trunk muscle activity; strength; trunk impairment scale; review

Research highlights

- (1) Trunk-functional assessment post-stroke is important as a requirement in predicting the probable clinical outcome of the patient with stroke and designing an effective rehabilitation protocol.
- (2) Authors recommend researchers to lay focus on the effects of trunk rehabilitation on the outcome of stroke in further investigation.

Abbreviations

TIS, trunk impairment scale; EMG, electromyography

INTRODUCTION

Stroke is a clinical syndrome characterized by rapidly developing signs of focal or global disturbance of cerebral functions, lasting for more than 24 hours or leading to death, with no apparent causes other than vascular origin^[1]. This results in muscle weakness which is recognized as a limiting factor in the motor recovery after stroke. Contrary to the extremities, trunk is involved bilaterally in stroke whose identification plays a crucial role in planning treatment strategies in rehabilitation. As recruitment of trunk precedes recruitment of the limb joints, it begins to move earlier and continues moving even after the limbs have stopped at the target. Involvement of trunk in turn has an impact on balance and functional ability of subjects which is assessed clinically using tools like trunk control test, and two trunk impairment scales (TIS) proposed by Verheyden and Fujiwara. Hand held dynamometers, isokinetic dynamometers, posturography and surface electromyography (EMG) are of choice to quantify the involvement of trunk. This literature review intends to throw light on the various tools used for trunk assessment post-stroke emphasizing its importance in trunk rehabilitation.

TRUNK MUSCLES IN PATIENTS WITH POST-STROKE HEMIPLEGIA

Trunk is the central key point of the body with its primary contribution to stabilize spine and trunk^[1]. Trunk control 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. Although hemiplegia affects unilateral limb activity, it has a potential to deteriorate the function of trunk muscles on both sides of the body affecting the proximal control. The lack of proximal stabilization influences the limbs profoundly in that the arm and leg can only be moved in spastic synergy patterns. In an attempt to move upright against gravity, this loss of fixation is compensated by increased distal spasticity. Loss of selective activity in these muscle groups of trunk fails to enable the patient to stabilize his/her thoracic spine in extension while using lower abdominals in isolation, which is reflected in walking^[2-3]. A cross-sectional study on transcranial magnetic stimulation among stroke patients had shown that the recovery of trunk function after stroke is associated with increased ipsilateral motor evoked potentials in external oblique muscle upon stimulation of unaffected

hemisphere. This suggested a role of compensatory activation of uncrossed pathways in recovery of trunk function^[4]. Computed tomography of trunk muscles demonstrated an increase in paravertebral muscle cross section area bilaterally by 3–4% after 3 months of a conventional rehabilitation program. However, the contralateral paravertebral muscle cross section area was larger than ipsilateral side. This was related to degree of impairment (stroke impairment assessment set, trunk control test) and functional limitation (functional independence measure) of the subjects^[5].

TRUNK MUSCLE WEAKNESS IN PATIENTS WITH HEMIPLEGIA

Trunk muscle strength is impaired multidirectionally in hemiplegic patients. Isokinetic dynamometric testing reported weakness of trunk flexors and extensors and peak torques of these muscles were significantly smaller in chronic hemiplegic patients than in healthy controls except for flexors at angular velocity of 0° per second. The tested isometrically flexor and extensor strength was determined as 88% and 64%, respectively compared to those in control subjects. However, extensor muscle strength was determined as 88% and 64% was weaker than that of flexors. The insufficient recruitment of high threshold motor units at high angular velocities and disuse are possible explanations for trunk muscle weakness in chronic stroke^[6]. Isokinetic testing also found that trunk rotatory muscle strength is smaller in chronic hemiplegic patients than that of controls; however, there was no difference in the performance of trunk rotators to right and left directions^[7]. In addition, trunk lateral flexor muscle weakness of the paretic side was more compared to non-paretic side measured using hand held dynamometer^[8-10]. EMG studies reporting the characteristics of anticipatory postural adjustment in axial-lateral and posterior-anterior trunk muscles during the performance of upper and lower limb flexion tasks after stroke showed major impairments in the activity of the trunk muscles. The impairments manifested as reduced activity of the lateral muscles, delayed onset, and reduction in synchronized activation of pertinent muscle pairs. This reduction in electromyographic anticipatory postural activation was also noted in latissimus dorsi and external oblique muscles of the affected side. Motor (motor assessment scale and trunk control test) and functional (Bartel Index) deficits were found associated to it^[11]. It was considered that the altered EMG activity of trunk muscles, particularly rectus abdominus may be one of the reasons for the occurrence of compensatory

strategies in patients with hemiplegia^[12]. Furthermore, trunk flexion when analyzed dynamically though did not alter the amplitude of flexion, a decreased displacement of center of pressure with limited weight bearing on feet was observed. This is suggestive of a smaller displacement of the body mass compared to healthy subjects in sub-acute stroke. Trunk movements are executed involving upper trunk and a very little anterior pelvic tilt was noted in hemiparesis patients^[13]. Analysis of trunk kinematics found that pelvic movements in stroke patients were unstable and asymmetrical during walking^[14].

TRUNK CONTROL AND ITS INFLUENCE ON BALANCE AND FUNCTION IN STROKE

Alteration of trunk position sense^[15] and weakness^[16] of trunk muscles in stroke has a significant influence on balance difficulty in these patients. Anticipatory postural adjustments of trunk muscles play a major role in maintaining antigravity postures like sitting and standing when a reaching task is executed^[17]. Sitting balance recovery when correlated in a posturographic assessment reported that lateral balance was more affected than antero-posterior balance. In addition, lateral balance control showed the strongest association with the berg balance scale as a clinical measure of balance capacity. This suggests that leg muscles may assist in stabilizing the trunk in the antero-posterior direction whereas lateral sitting balance almost completely depends on trunk muscles^[18]. Increased risk of falls due to poor balancing in stroke subjects after discharge in turn leads to poor functional performance^[19]. Recent evidence supports that the ability of balance and walking in stroke subjects depends on the performance of trunk function as measured by trunk control test and TIS^[20]. It is the important functional predictor at discharge after stroke^[21-24]. Hemiparetic patients with poor trunk function (trunk control) at admission stayed longer in a rehabilitation ward compared to patients who had better initial trunk function and could walk longer distances with speed at discharge^[21]. Monaco *et al*^[25] demonstrated that not only trunk performance in sitting position but also postural balance in lying, sitting and standing post-stroke predicted functional ability and destination at discharge from inpatient rehabilitation. Ability to ambulate independently at discharge had a significant relationship to early unsupported sitting balance and also found that this ability could predict independent ambulatory status in the later stage of stroke recovery^[26]. A multi center trial had shown the total TIS and its static sitting balance subscale at admission and functional ability measured at discharge

from the rehabilitation center (median days post-stroke, 20) are the most important predictors of Barthel Index score at 6 months after stroke. With an explained variance of 50% and more, the TIS total and static sitting balance subscale were even more important predictors than Barthel index itself on admission to the rehabilitation center^[24].

TRUNK REHABILITATION

Despite the trunk performance is considered to be the important predictor for balance and functional performance, the evidence supporting the effectiveness of trunk rehabilitation is scarce. Mudie *et al*^[27] found that training the stroke patients in the awareness of trunk position enhanced weight symmetry. Trueblood *et al*^[28] reported that proprioceptive neuromuscular facilitation-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. Additional trunk exercises to regular physiotherapy improved trunk lateral flexion performance in sub-acute stroke patients^[29]. A recent randomized controlled trial of truncal exercises early after stroke reported an improved balance ability and mobility^[30]. Trunk exercises performed on a physio ball not only produced better trunk rotator control compared to similar exercises performed on a plinth but also its effect was carried over to the stepping balance performance in subjects with acute-stroke^[31]. Recent pre-post design trial showed that administration of trunk rehabilitation in chronic stroke patients improved their balance performance and gait parameters^[32].

INFERENCE

Further to this literature review, the authors believe that trunk functional assessment post stroke is important as a requirement in predicting the probable clinical outcome of the patient with stroke and in designing an effective rehabilitation protocol. We recommend researchers to lay focus on the effects of trunk rehabilitation on the outcome of stroke in further investigation.

Author contributions: Suruliraj Karthikbabu participated in the study concept and design, specifying the question, identifying relevant references and writing the manuscript. Chakrapani Mahabala, Sailakshmi Ganeshan and Kedambadi C Rakshith supervised the review process. Syed Nafeez and Venkatesan Prem participated in reading and checking the manuscript.

Conflicts of interest: None declared.

REFERENCES

- [1] Cholewicki J, Panjabi MM, Khachatryan A. Stabilizing function of trunk flexor-extensor muscles around a neutral spine posture. *Spine*. 1997;22:2207-2212
- [2] Davis PM. Problems associated with the loss of selective trunk activity in hemiplegia. In: Davis PM, ed. *Right in the Middle: Selective trunk activity in the treatment of adult hemiplegia*. Heidelberg: Springer. 1990.
- [3] Edwards S. An analysis of normal movement as the basis for the development of treatment techniques. In: *Neurological physiotherapy. A problem-solving approach*: Churchill Livingstone. 1996.
- [4] Fujiwara T, Sonoda S, Okajima Y, et al. The relationships between trunk function and the findings of transcranial magnetic stimulation among patients with stroke. *J Rehabil Med*. 2001;33:249-255.
- [5] Tsuji T, Liu M, Hase K, et al. Trunk muscles in persons with hemiparetic stroke evaluated with computed tomography. *J Rehabil Med*. 2003;35:184-188.
- [6] Tanaka S, Hachisuka K, Ogata H. Muscle strength of the trunk flexion-extension in post-stroke hemiplegic patients. *Am J Phys Med Rehabil*. 1998;77:288-290.
- [7] Tanaka S, Hachisuka K, Ogata H. Trunk rotatory muscle performance in post-stroke hemiplegic patients. *Am J Phys Med Rehabil*. 1997;76:366-369.
- [8] Bohannon RW. Lateral trunk flexion strength: impairment, measurement reliability and implications following unilateral brain lesion. *Int J Rehabil*. 1992;15:249-251.
- [9] Bohannon RW, Cassidy D, Walsh S. Trunk muscle strength is impaired multidirectionally after stroke. *Clin Rehabil Res*. 1995;9:47-51.
- [10] Bohannon RW. Recovery and correlates of trunk muscle strength after stroke. *Int J Rehabil*. 1995;18:162-167.
- [11] Dickstein R, Shefi S, Marcovitz E, et al. Anticipatory postural adjustments in selected trunk muscles in poststroke hemiparetic patients. *Arch Phys Med Rehabil*. 2004;85:261-273.
- [12] Pereira LM, Marcucci FC, Menacho MO, et al. Electromyographic activity of selected trunk muscle in subjects with and without hemiparesis during therapeutic exercise. *J Electromyogr Kines*. 2011;21: 327-332.
- [13] Messier S, Bourbonnais D, Desrosiers J, et al. Dynamic analysis of trunk flexion after stroke. *Arch Phys Med Rehabil*. 2004;85:1629-1624.
- [14] Tyson SF. Trunk kinematics in hemiplegic gait and effect of walking aids. *Clin Rehabil*. 1999;13:295-300.
- [15] Ryerson S, Byl N, Brown D, et al. Altered trunk position sense and its relation to balance functions in people post-stroke. *J Neurol Phys Ther*. 2008;32:14-20.
- [16] Karatas M, Cetin N, Bayramoglu M, et al. Trunk muscle strength in relation to balance and functional disability in unihemispheric stroke patients. *Am J Phys Med Rehabil*. 2004;83:81-87.
- [17] Moore S, Brunt D. Effects of trunk support and target distance on postural adjustment prior to a rapid reaching task by seated subjects. *Arch Phys Med Rehabil*. 1991;72: 638-641.
- [18] Van Nes JW, Nienhuis B, Latour H, et al. Posturographic assessment of sitting balance recovery in the subacute phase of stroke. *Gait Posture*. 2008;28:507-512.
- [19] Mackintosh SF, Hill K, Dodd KJ, et al. Falls and injury prevention should be part of every stroke rehabilitation plan. *Clin Rehabil*. 2005;19:441-451.
- [20] Verheyden G, Vereeck L, Truijten S, et al. Trunk performance after stroke and the relationship with balance, gait and functional ability. *Clin Rehabil*. 2006;20:451-485.
- [21] Duarte E, Marco E, Muniese J, et al. Trunk control test as a functional predictor in stroke. *J Rehabil Med*. 2002;34: 267-272.
- [22] Hsieh CL, Sheu CF, Hsueh IP, et al. Trunk control as an early predictor of comprehensive activities of daily living function in stroke patients. *Stroke*. 2002;33:2626-2630.
- [23] Franchignoni FP, Tesio L, Ricupero C, et al. Trunk control test as an early predictor of stroke rehabilitation outcome. *Stroke*. 1997;28:1382-1385.
- [24] Verheyden G, Nieuwboer A, De Wit L, et al. Trunk performance after stroke: an eye catching predictor of functional outcome. *J Neurol Neurosurg Psychiatry*. 2007;78:694-698.
- [25] Monaco MD, Trucco M, Monaco RD, et al. The relationship between initial trunk control or postural balance and inpatient rehabilitation outcome after stroke: a prospective comparative study. *Clin Rehabil*. 2010;24: 543-554.
- [26] Nitz JC, Gage A. Post stroke recovery of balanced sitting and ambulation ability. *Aus J Physiotherap*. 1995;41:263-267.
- [27] Mudie MH, Winzeler-Mercy U, Radwan S, et al. Training symmetry of weight distribution after stroke: A randomized controlled pilot study comparing task-related reach, Bobath and feedback training approaches. *Clin Rehabil*. 2002;16:582-592.
- [28] Trueblood PR, Walker JM, Perry J, et al. Pelvic exercise and gait in hemiplegia. *Phys Ther*. 1989;69:18-26.
- [29] Verheyden G, Vereeck L, Truijten S, et al. Additional exercises improve trunk performance after stroke: a pilot randomized controlled trial. *Neurorehabil Neural repair*. 2009;23:281-286.
- [30] Saeys W, Vereeck L, Truijten S, et al. Randomized controlled trial of truncal exercises early after stroke to improve balance and mobility. *Neurorehabil Neural Repair*. 2012;26:231-238.
- [31] Karthikbabu S, Nayak A, Vijaykumar K, et al. Comparison of physio ball and plinth trunk exercises regimes on trunk control and functional balance in patients with acute stroke: a pilot randomized controlled trial. *Clin Rehabil*. 2011;25:709-719.
- [32] Karthikbabu S, Rao BK, Manikandan N, et al. Role of trunk rehabilitation on trunk control, balance and gait in patients with chronic stroke. A pre-post design. *Neurosci Med*. 2011;2:61-67.

(Edited by Meng R, Lin YC, Zhao LJ/Song LP)