Effect of Task-oriented Training with and without Trunk Restraint on Reaching Activity in Adult Hemiparetics

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ABSTRACT

The normal pattern for reaching to a target is not seen in hemiparesis, as patients are seen to use compensatory trunk movements to accomplish the same task. As much as this compensatory behavior allows them to accomplish the task regardless of the motor deficit, it however, may not be desirable for skill requisition. Past studies have shown that limiting these compensatory movements effectively improves reaching activity in adult hemiparetics. However in those studies, the investigators analyzed the effects of training for a very brief period. Thus in this study we are aiming to determine the effect of task-oriented training with trunk restraint on reaching activity in adult hemiparetics, where 20 adult hemiparetics over the age of 40 years were recruited and were randomly allocated to control (n=10) and experimental (n=10) groups. Participants of both groups were assigned a reaching task for 60 repetitions in a single session in 3 directions for 10 sessions within 2 weeks period. Trunk restraint was introduced to the experimental group while performing the reaching task. Pre and post –intervention scores of the Reaching Performance Scale (RPS) were analyzed. Participants of both the groups show significant ($p< 0.05$) change in RPS scores. Inter group post intervention RPS scores show a significant ($p<0.05$) differences. Additionally, when the mean values between the groups were compared, the post intervention RPS scores of the experimental groups were higher than the control group, implying better performance in the former.

Keywords: *Hemiparesis, Upper Extremity, Reaching Activity, Task Oriented Training, Trunk Restraint*

INTRODUCTION

The ability to reach is critical for virtually all activities of daily living (ADL) such as grooming, toileting, feeding and dressing.[1] A necessary requisite for controlled reaching is the coordination of the action of transporting the arm away from the body while activating appropriate muscles to stabilize trunk and scapula. The trunk is recruited before arm such that the trunk begins moving before the hand movement and can continue moving even after the hand has stopped.[2]

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Previous studies in hemiparetic patients have described excessive trunk or shoulder girdle movement in pointing and in reach to grasp movements for target placed close to the body.[3] Wanger et al (2006) showed that deficits in strength appear to be the most influential sensorimotor impairment associated with limiting reaching performance in subjects with acute hemiparesis.[4] Additionally elbow shoulder inter joint coordination is disrupted in hemiparetic patients. In contrast to healthy individuals, reaching in hemiparetic patients is characterized by a lack of smoothness as evidenced by both temporal and spatial segmentation.[5]

Therapist may approach the rehabilitation of reaching in several ways, eg. reflex based neurofacilitation approaches, that is acquisition of trunk and shoulder girdle stability must precede the retraining of arm movement. Unwanted movements and spasticity are inhibited and normal patterns are facilitated under the assumption that regaining voluntary control over key movements will transfer to functional improvements. However empirical evidences for this assumption are lacking.[6]

A recent meta-analysis also showed that more intensive therapy may at least improve the rate of ADL recovery, particularly if a direct functional approach is adopted.[7]

The rehabilitation of reaching has been based on a task-oriented approach in which movement is behaviorally driven and the interaction of the individual with the environment is stressed. It is seen, that excessive trunk movement in hemiparetics while reaching, limits the potential recovery of normal arm movement patterns. Reducing compensatory mechanisms by trunk restraint may encourage the return of the movement patterns typically seen in healthy individuals.[6]

Peurala et al showed various constraint induced movement therapy (CIT) doses which improved mobility of the affected upper extremity.[8] The Task related training (TRT) involved reaching to objects placed across the work –space. Progressive resistive exercises (PRE) involved whole- arm pulling against resistive therapeutic tubing in planes and distances similar to that in TRT.[5] Jeyaraman et al also demonstrated trunk restraint as a effective treatment for decreasing compensatory strategies.[9]

Post stroke therapeutic interventions leading to functional improvement emphasize intensive task – specific practice reported to facilitate training –induced plasticity and active –induced neuroplasticity where it is necessary to determine whether interventions result in the reappearance of premorbid movement patterns (recovery) or in substitution by novel movement patterns (compensations).[10]

This study aims to show short duration training on reaching activity with trunk restraint for Indian Population.

MATERIALS AND METHOD

After receiving clearance from the Institutional Human Research Ethics Committee for this randomized control trial, 20 subjects from both genders, over age of 40 years were taken.[11] Inclusion criteria for selecting subjects were non traumatic single unilateral stroke (not less than 1 month and not more than 6 months),[12] patients who have the ability to perform reach-to-grasp activity with the hemiparetic upper extremity (Brunstrom recovery stage 3 and above) and those who understand simple commands in English. Those who have severe cognitive impairment (Mini Mental State Exam score < 18), contractures/ deformities on the affected arm, shoulder- hand syndrome were excluded from this study.

Informed written consent was taken from all the subjects. Then all the subjects were randomly allocated into two groups, Group A (Control group, n=20) and Group B (Experimental group, n=20).

All the subjects in both groups were assessed using the Reaching Performance Scale (RPS) for pre and post intervention scoring. The subjects were seated in a chair with their feet in full floor contact. The length of the fully extended arm from medial aspect of the axilla to the distal crease of the wrist medially was measured. Then a target (A conical object with base of 7 cm diameter and height 17.5 cm, made from cardboard with a rough surface) was placed on the mid-sternal height at subject's full arm length. The subjects were asked to reach forward, grasp and return the cone to the mid chest region at a comfortable self paced speed and asked to repeat the same action through 20 repetitions, taking 2-3 minutes rest after the first 10 repetitions. A single session consisted of 60 repetitions of the reach-to-grasp task, where 20 repetitions done in each of the three directions; contralateral, ipsilateral and midline. The experimental group performed the same protocol with trunk restrained to the chair with a trunk restraint belt. The duration of the training was an overall of 10 sessions spread over a 2 week period, after which RPS assessment was done to get the post intervention scoring.

RESULT/ FINDINGS

Statistical analysis using paired t-test showed significant ($p< 0.05$) change in reaching activity of the subjects in both the groups (n=10) (Table 1 & 2). Unpaired t-test showed a significant ($p<0.05$) difference between the post intervention mean scores of the control group and the experimental group (Figure 1). Comparing means before and after intervention showed that participants from both groups improved their reaching activity after intervention. However, better improvement was seen in the experimental group.

DISCUSSION

Task-oriented training is effective in improving reaching activity of adult hemiparetics. Reaching activity is an important component for independent living. However, survivors of stroke often rely on compensatory movement strategies to accomplish reaching tasks.[9] Carr and Shepherd[13] suggest that compensatory strategies are the result of using available movements given the post stroke state of central nervous system, which leads to long term functional limitations. Without intervention, stroke survivors often use the uninvolved limb to accomplish functional goals, which results in learned disuse. In addition, failure to use the paretic limb can produce secondary changes in the effecter apparatus (muscle, connective tissue shortening) and lead to a stiff, immobile and sometimes painful upper limb.[5] To minimize these changes and as well to limit compensatory behavior in order to promote recovery, specific practice requiring the patient's active participation is suggested as being necessary.[14] This may therefore be the reason behind the improvement in reaching activity seen in this group of patients after training.

Quite a number of randomized control trials have shown that task oriented training improves upper extremity functions in hemiparetic patients.[15, 16] The mechanism behind this is the concept of specificity of training, which has been discussed in relation to able-bodied subjects and proposed as a means of rehabilitating the movement disabled.[14, 17, 18, 19] In this concept, it is emphasized that subjects improve on the actions which they practice.

The study also shows that task- oriented training with trunk restraint is effective in improving reaching activity in adult hemiparetics. The effects of trunk restraint indicate that hemiparetic patients did not use their potential joint range for free arm movements.[9] Hemiparetic patients could make isolated elbow flexion and extension movements by using reciprocal muscle activation pattern within available articular ranges. The increase in joint ranges with trunk restraint is partly due to an adaption involving anticipation of changed external load conditions.

Patients are forced to make movement out of synergy which probably involves a focused and greater effort on their part.[9] The adaptation of arm activity was triggered by somatosensory input from the trunk or shoulder caused by the trunk restraint. The strategy of constraining the unaffected arm to force the patient to make more use of the affected arm with the additional feature that reduction of compensatory movement patterns is also targeted. Physical trunk restraint can be considered similar to Manual Guidance in which spatial constraints are used to promote use of more optimal movement patterns.[20]

Comparison of post training RPS scores of the control group and the experimental group signifies that task oriented training with trunk restraint is better than task oriented training without trunk restraint on reaching activity in adult hemiparetics.

The reason behind this may be backed up by the study of Michaelson et al 2004,[20] in which a single session of repetitive reach to grasp training to objects within arm's reach during physical restriction of trunk compensatory movements led to greater gains in elbow extension, greater decreases in trunk involvement, and improved temporal inter joint coordination compared with instructed practice alone. It has been recognized by clinicians[14, 21] that once compensation has been learned, it is very difficult to modify. Indeed, prolonged use of compensatory trunk movements to reach targets placed with in arms length may result in the system learning not to use arm joints for reaching and grasping (learned nonuse) so that recovery of independent use of these joints would be discouraged. Physical trunk restraint can be considered similar to manual guidance in which spatial constraints are used to promote use of more optimal movement patterns justifying training induced plasticity, and activity induced neuro plasticity.[6, 20] In a study by Michaelson et al (2006) to determine how trunk restraint improves reaching ability in stroke patients , kinematic analysis revealed that decreased mean trunk displacement by 32.8 mm at post –test and 14.2 mm at follow-up , where as training without TR increased trunk displacement by 3.6 mm and 22.0 mm respectively.[10] This may further explain why more improvement was seen with trunk restrain as compared to training without trunk restraint.

Kwakkel G et al (2016) reviewed strong evidence that constraint-induced movement therapy has greater effects on motor function only when applied in the earlier stages post stroke, in which it is assumed that restitution of neurological functions is still possible, but that in the later phases constraint-induced movement therapy solely influences arm-hand activities by learning to use adaptation strategies (i.e., compensation) to improve upper limb performance in Activities of daily living.[22] In this study patients were selected not less than 1 month and not more than 6 months, and similarly also showed better movement pattern development in task oriented training with trunk restraint on reaching activity.

Results of this study have great implications for rehabilitation, demonstrating that stroke patients can improve their performance on seated reaching tasks with a task oriented training program that takes into account normative biomechanics of the upper extremity while minimizing unwanted compensatory movements. The findings directly challenge the assumption that improvement in function after stroke is due to spontaneous recovery only. In addition, the outcome is consistent with the increasing evidence that stroke patients can improve their performance of specific tasks if those tasks are included in training and practiced.

Trunk restraint may also be a useful technique to promote maximal arm motor recovery in the acute stage of stroke, when the potential for neuro plasticity may be greatest. Exercise is known to induce a cascade of molecular and cellular processes that support brain plasticity. Brain-derived neurotrophic factor (BDNF) is an essential neurotrophin that is also intimately connected with central and peripheral molecular processes of energy metabolism and homeostasis, and could play a crucial role in these induced mechanisms. An acute aerobic exercise unmistakably influences circulating BDNF concentration, although the effect is transient.[23]

So it is evident that the benefits of the simple reach training with physical trunk restraint employed in this study provide a strong argument for applying this training in clinical settings. The implication for therapy is that restriction of trunk use should be used even in patients with chronic hemiparetic to encourage maximal use of available degrees of freedom.

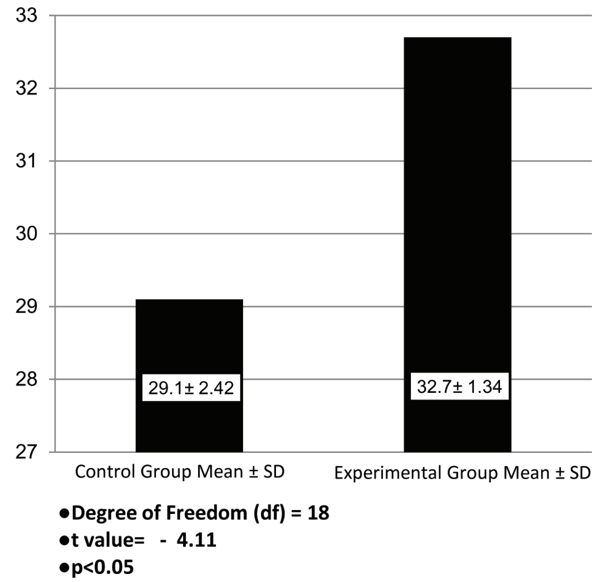

Figure 1: Comparison of post intervention RPS scores of Control and Experimental groups

Table 1: Comparison between the Pre and Post Intervention performance in the Control group (GroupA)

	Pre-score Mean±SD	**Post-score Mean±SD**	**t**	**Sig. (2-tailed)**
RPS score	23.1±4.01	29.1±2.42	-8.78	<0.05

Degree of freedom (df) = 9

Table 2: Comparison between the Pre and Post Intervention performance in the Control group (GroupA)

	Pre- Score Mean±SD	**Post- Score Mean±SD**	**t**	**Sig. (2-tailed)**
RPS score	22.6±3.95	32.7±1.34	-10.65	<0.05

Degree of Freedom (df) = 9

CONCLUSION

Task oriented training is an effective means of improving reaching activity in adult hemiparetics. However, task oriented training together with trunk restraint is a better method to improve reaching activity in adult hemiparetics.

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