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Research Article

Effect of Strength and Endurance Training of Upper Limbs by arm Ergometer on Trunk Conventional of Children with Cerebral Palsy

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Abstract

Objective: To evaluate the effect of arm training by arm ergometer without specific balance conventional training on the trunk conventional of the children with spastic diplegic and quadriplegic CP.

Method: Thirty children with spastic diplegic and quadriplegic cerebral palsy were fulfilling the inclusion criteria were taken into the study and assigned into two groups; Group A, and Group B with 15 subjects in each group. All the subjects underwent an initial baseline assessment of GMFM: B (Sitting component) and TCMS. The children included in the study ranged from 4-13 years with mean range of 7.26 years. Both groups received conventional exercises like trunk stabilization exercises for the trunk in various positions, i.e. prone, supine, kneeling and sitting. All the exercises were performed till hold of 10 seconds for 2 minutes each. The experimental group in addition received arm training with the RECK MOTO med viva-2 ergo meter.

Statistical Analysis: Data was analyzed using between groups difference for GMFM and TCMS was done by using Mann Whitney U test and within group difference analysis was done using Wilcoxon signed Rank test. An alpha level of 0.05 of significance was set. Analysis was performed by using SPSS package 16 version.

Results: There were improvements in GMFM: B and TCMS score in both the groups from pre treatment measurement to post treatment measurement for a period of 6 weeks. However more significant improvements were found in the experimental group (Group-A) after 6 weeks of intervention.

Conclusion: Arm training by arm ergometer along with trunk stabilization exercises bring about more trunk conventional, arm function and overall function than trunk stabilization exercises.

Keywords: CP-Cerebral palsy; TD-Typically developed; APA-Anticipatory postural adjustment; GMFCS-Gross motor function classification system; TCMS-Trunk conventional measurement scale

Introduction

One of the key features of children with cerebral palsy is deficient postural conventional [1,2]. During sitting and standing humans voluntarily move their arms; the postural muscles of the lower limbs and trunk conventional posture are activated in advance of the focal muscles that move the arm voluntarily [3-5]. This type of postural conventional, known as Anticipatory Postural Adjustment (APA), is believed to reduce the effects of forthcoming perturbations caused by voluntary movement on posture and equilibrium [6-8]. APAs thus probably play an important role in adequately performing various voluntary movements while standing [4,9]. This 'anticipatory' contraction of the abdominal muscles is thought to contribute to preparatory stabilization of the spine against reactive forces resulting from the limb movement [5,6,10]. Shoulder and elbow functional movements result in trunk muscle activation which includes trunk flexors, extensors along with quadriceps, gastrocnemius and tibialis anterior. Through repetition, the infant acquires and refines the coordination or movement patterns necessary to achieve the functional action goal. Arm ergometry or arm cycling involves sitting upright in a seat and "pedaling" with the arms. An important advantage of ergometer training over conventional physiotherapy is that patients who are motivated to continue training, can do so themselves, which is an alternative to hand-to-hand therapy, often limited by budget constraints. Though Arm Ergometry is one of the means of upper limb movement no study has been done on the effect of arm ergometry on the trunk conventional of children with cerebral palsy yet.

Muscle activities of the trunk during upper limb movements are thought to be important for maintaining postural stability. Hence, upper limb movement training should be carried out in the context of the task demands (alternate arm movements) and may be essential for the implicit engagement of the underlying neural conventional networks for integration of the different mechanical, sensory, motor and goal oriented systems that contribute to arm function and

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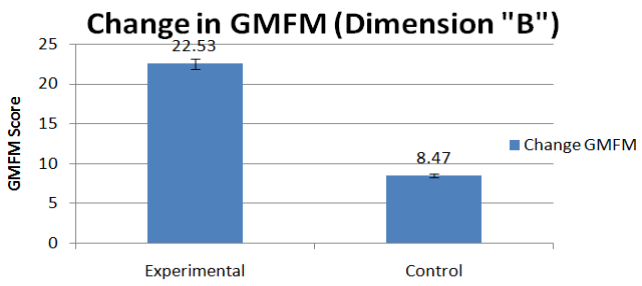
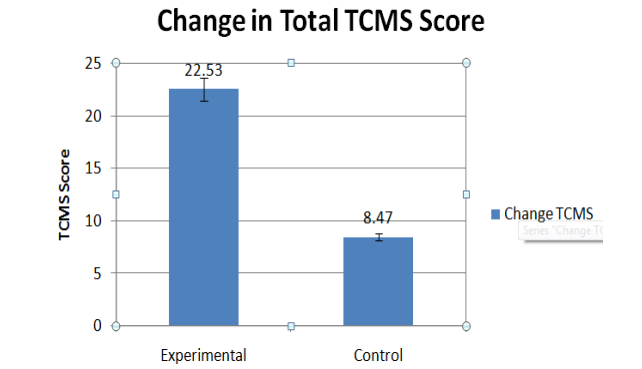


Graph 1: GMFM: B (Sitting).
The graph 1 shows the change in GMFM: B from pre to post is more in experimental group than conventional group. Mann Whitney U test showed that Z-score is -4.422, value of test is 7.000 with p< 0.000 indicating a significant difference in change of score between groups.



Graph 2: Total tcm score.
The graph 2 shows the change in total TCM score from pre to post is more in experimental group than conventional group. Mann Whitney U test showed that Z-score is -4.405, value of test is 7.000 with p<0.000 indicating a significant differences in change of score between groups.

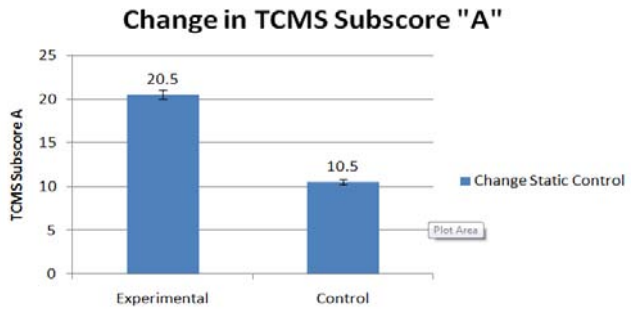
postural regulation. Combining both arm function as well as postural conventional, however, would constitute a dual task situation that individuals with cerebral palsy would find quite difficult. Till date there is no such study which defines the postural conventional improvement by using arm function by ergometry which includes pulling and pushing activities in cyclic manner in children with cerebral palsy. So the objective of the study is to see the effects of arm training by using arm ergometry on trunk conventional of children with cerebral palsy in sitting.

Methodology

30 children diagnosed as spastic diplegic or spastic quadriplegic cerebral palsy from the Pediatric unit of Dept. of Physiotherapy, SVNIRTAR fulfilling the inclusion criteria were randomly allotted in two groups. All the subjects underwent an initial baseline assessment of GMFM: B (sitting) and TCMS (Graph 1). The children included in the study ranged from 4-13 years with mean range of 7.26 years. The mean age of children in group 1 was 6.93 years and there were 4 girls and 11 boys in the group. The mean age of the children in group-2 was 7.6 years and there were 5 girls and 10 boys in the group (Graph 2).

Procedure

All children with spastic diplegic and quadriplegic cerebral palsy



Graph 3: TCMS: A (Static Sitting Balance).
The graph 3 shows the change in TCM: A score from pre to post is more in experimental group than conventional group. Mann Whitney U test showed that Z-score is -3.168, value of test is 37.500 with p<0.001 indicating a significant difference in change of score between groups.

underwent an initial baseline assessment of TCMS and GMFM-66 (Dimension-B). GMFM, a standardized observational instrument, valid and reliable to be used for measuring change in gross motor function abilities in cerebral palsy children. Trunk Conventional Measure Scale (TCMS), a recent observational scale developed to measure the static as well as dynamic trunk conventional in spastic cerebral palsy children. The children who met the inclusion, exclusion criteria were randomly distributed into 2 groups. Both groups received conventional exercises like trunk stabilization exercises for the trunk in various positions, i.e. prone, supine, kneeling and sitting. All the exercises were performed till hold of 10 seconds for 2 minutes each. The experimental group in addition received arm training with the RECK MOTO med viva-2 ergometer.

Exercise protocol for the arm training group

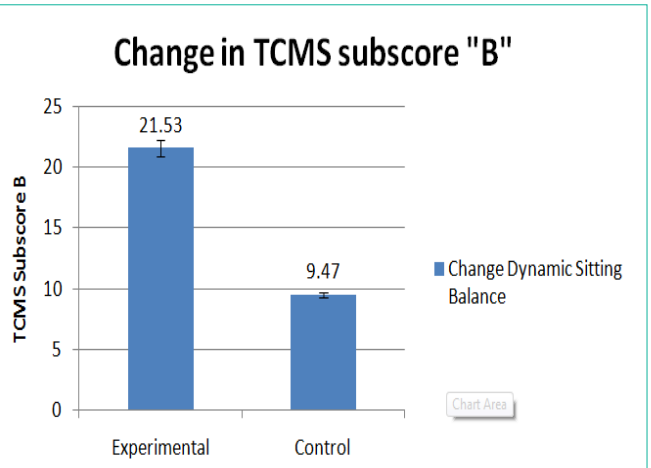
Children were seated on a stool without a back or arm supports with 90 degree of flexion in hips and 90 knees. Training focused on task completion with no explicit instructions provided for postural alignment, weight shift or balance strategy. The strength-endurance protocol were selected in the ergometer for 30 minutes and children were instructed to hold the cranks of the arm ergometer and perform the assisted pulling and pushing in cyclic manner as directed by the ergometer. Gear was increased gradually in each week. The intervention period was of 6 weeks duration, 5days/week. Follow-up was assessed at 6 weeks.

Data collection and data analysis

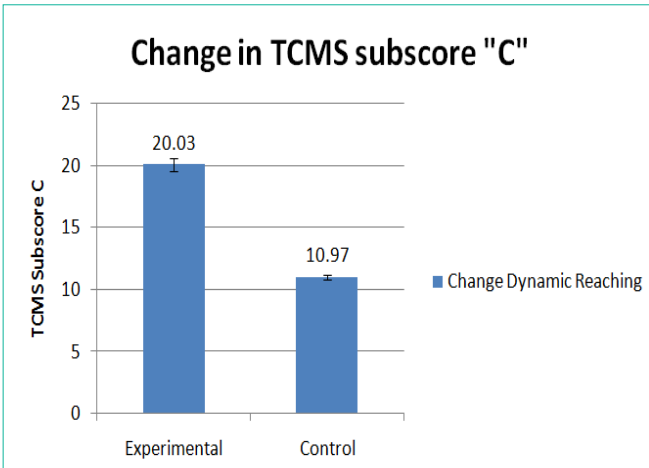
Pre-test GMFM and TCMS scores were recorded prior to the intervention and post-test scores after completion of 6 weeks intervention. Wilcox on Signed Rank test was used to know the difference within the groups, 0.05 level of significance was used for hypothesis testing. Analysis was performed using SPSS versions 16.0 package.

Results

The overall results of the study showed improvement in the TCMS for trunk postural conventional and GMFM-66 dimension-B i.e. sitting at the end of 6 weeks of treatment in both experimental and conventional groups. However, the experimental group showed a significant improvement in both TCMS and GMFM-66 dimension-B.



Graph 4: TCMS: B (Dynamic Sitting Balance).
The graph 4 shows the change in TCM: B score from pre to post is more in experimental group than conventional group. Mann Whitney U test showed the Z-score is -3.848, value of test is 22.000 with p<0.000 indicating a significant difference in change of score between groups.



Graph 5: TCMS: C (Dynamic Reaching).
The graph 5 shows the change in TCM: C score from pre to post is more in experimental group than conventional group. Mann Whitney U test showed the z-score is -2.941, value of test is 44.500 with p<0.004 indicating a significant difference.

Discussion

Trunk conventional measurement scale (TCMS)

The overall result showed that the improvement in TCMS & GMFM: B between two groups is significantly different. The mean rank shows more improvement in the experimental group. The improvement obtained in the post treatment mean values of TCMS variables of the conventional group may be attributed to the effect of conventional physical therapy program, which consisted of trunk stabilization exercises for the trunk in the various positions, i.e. prone, supine, quadruped, kneeling and sitting directed toward facilitating normal patterns of postural conventional (righting and equilibrium reactions) and developing a greater variety of normal movement patterns, particularly in the trunk and lower extremities. This improvement in TCMS score in conventional group can be attributed to the performance of trunk conventional exercises in variety of positions i.e. supine, prone, quadruped, kneeling and sitting, which could have improved core muscle recruitment. In prone position exercises like coming prone on hand, followed by altering arm lift and altering leg lifts were performed that may have provided a stretch to the anterior chest wall and stabilized lower ribs, thus diaphragm over activity is reduced in this position so that other accessory muscles of ventilation, like scapular retractors start functioning [11]. As these exercises were progressed, upper lumbar extensors and gluteal muscles are challenged that prevents the pelvis from posterior tilting (Sanders). The activities performed in quadruped position i.e., attaining quadruped position, alternating arm –leg lifts, achieving superman position, increased the activity of contra lateral oblique and ipsilateral external oblique (Callaghan, Stevens). In kneeling, attaining, maintaining and coming back to kneel sitting from kneeling was practiced. Progression was done by adding onto bilateral arm lifting, followed by exercises in sitting position including sitting without support, lifting both arms up, cross leg sitting, leaning in anterior, posterior and lateral directions and reaching in all 3 planes.

The experimental group showed 62.5% of improvement. The extra 49.453% of improvement in experimental group than the conventional group may be attributed to the motor learning and postural conventional development associated with feed forward training. Facilitation of the core stabilizer due to concurrent resisted arm training was given in addition to trunk postural conventional exercises and that the TCMS items measured all 3 aspect of postural conventional [12] i.e. Proactive or Postural orientation [13], Postural stability or steady state balance; Reactive Postural Adjustment or Equilibrium Reaction [14].

The improvement in the TCMS: A (static sitting) (Graph 3) may be supported by the continuous diaphragm activity while performing arm ergometry. Kolar et al. have shown that the diaphragm is an important muscle for postural stabilization by intra-abdominal pressure modulation and by playing an important role in spinal stability and also it is under voluntary conventional and can perform its respiratory function and postural tasks simultaneously [11].

The improvement in the Dynamic Sitting Balance subscale of TCMS: B (Graph 4) in the experimental group could be attributed by the result of a study on Effects of type and mode of propulsion on hand-cycling biomechanics in non-disabled subjects by Faupin et al. [15], who found significant flexion/extension of the trunk in the arm trunk power mode and greater lateral flexion and rotation of the trunk in asynchronous mode of the arm ergometry. Tanaka et al. performed a quantitative analysis of the head and trunk posture, and concluded that repeated head and upper limb movements may stimulate the vestibule-cochlear system to facilitate the equilibrium reactions in cerebral palsy [16].

Gross motor function classification system (GMFM)

Both the experimental and the conventional groups showed improvement in GMFM-B score. The improvement in experimental group was significantly more than the conventional group.

The performance of core stabilization exercise to improve the trunk conventional as evident by the improvement in TCMS scores with time, so it can be postulated that improve trunk conventional

could be responsible for an improvement in GMFM score.

The components of GMFM-B consist of the activities which require trunk conventional. As the TCMS result showed improvement in the conventional group it may attribute to the improvement in the GMFM: B in the conventional group.

The improvement in the GMFM score in the conventional group can also be supported by the result obtained from the study of Akbari et al. [17]. Their results demonstrated that, functional physical therapy improves motor abilities of children with cerebral palsy. All dimensions of gross motor function including lying and rolling, sitting, crawling and kneeling, standing, and walking, running, and jumping, measured by the GMFM were significantly improved following functional physical therapy (Graph 5).

The dimension B i.e. sitting were used to measure the improvement in function. The dimension of B requires the child to pull self to sitting with head conventional, rolls to either sides and attain sitting, supported sitting with head lifting, lean forward to touch the toy and re-erect without arm propping, maintain sitting with arm free, attain 4 point over either sides, attain sit on small bench, attain sit on small bench from the floor, attains it on large bench from the floor etc. The fact supported by Snider 2007, showing a level 2a evidence for effectiveness of hippo therapy for treating trunk and hip muscle asymmetry and therefore leading to a better gross motor function. This improved trunk conventional could be one factor which improved GMFM [18].

The improvement in trunk stabilization by performing trunk exercises leads to (a) improved length tension relationship of the upper and lower limb muscle which originate from the girdle which in turn are linked to spine, (b) improved phasic contraction of spinal muscle, (c) decrease freezing and improved degree of freedom leading to smoother and more appropriate and purposeful movements [19]. The trunk exercises were progressed by addition of upper and lower limb movement which could have caused strengthening of trunk and limb muscles while body weight acting and resistance.

Another factor responsible for improvement in GMFM score could be the practice of functional activities like reaching in various directions while sitting upright, kneel sitting to kneeling, sit to stand with support, etc. have the potential to train aspects of muscle performance such as coordination, strength, endurance, physical conditioning [20] as well as motor learning as all of these tasks resembled the items of GMFM scale. Studies of Curtis et al. suggest strong association of improvement in gross motor function, and mobility and segmental level of trunk conventional [21]. Bigongiari et al. found that CP children showed stronger single and agonist/ antagonist muscle activations comparing to normal children [22]. This was obvious in our study from the results that dynamic items of sitting domains of GMFM scale were significantly improved by the dynamic activity of performing arm ergometry in sitting posture.

In the experimental group, the result showed improvement in the trunk conventional measure scale which may attribute to the improvement in GMFM: B. The improvement in the improvement in the GMFM score in the experimental group than the conventional group could be supported by the study done by Khan et al. in which they got a significant increase in GMFM score in the experimental group than the conventional group by the intervention of resisted elastic band training for the upper limbs in children with spastic diplegic cerebral palsy [23].

Experimental group has shown a significantly better improvement in function than conventional group possibly due to forceful movements of upper extremities while performing arm ergometry facilitates trunk stability due to increased in intra-abdominal pressure, flexion/ extension of the trunk, lateral flexion and rotation of the trunk which are necessary for the execution of the activities of daily living or playing activities.

Conclusion

Clinician may consider using arm training by arm ergometer without explicit instruction in the improvement of trunk conventional in children with spastic diplegic and quadriplegic cerebral palsy. It is a simple exercise which can be used in institutional setup to improve trunk conventional and gross motor function.

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