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Research Article

EFFECT OF PASSIVE ELONGATION OF SCAPULA RETRACTORS ON NECK CONTROL IN CHILDREN WITH SPASTIC CEREBRAL PALSY

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ABSTRACT

INTRODUCTION: Neck hyperextension is a powerful strategy that may hinder the normal motor development resulting in abnormal quality of muscle tone and movement. This leads to abnormal developmental pattern which hinders the midline orientation of the head. Inhibition of this pattern along with facilitation of normal development pattern may have a positive effect on neck control. The aim of this study was to evaluate the effect of passive elongation of scapula retractors on neck control in children with spastic cerebral palsy.
MATERIALS AND METHODS: 30 children with a mean age 18.47 ± 6.34(months) were randomized into two groups. All children underwent an initial baseline assessment of Clinical rating Scale for Head Control and GMFM-66 (Dimension-A). All the two groups received conventional exercises. The experimental group in addition received passive elongation of scapula retractors. The intervention period was of 6 weeks duration, 5 days/week. Follow-up was assessed at 6 weeks.
RESULTS: The overall results of the study showed improvement in the head control, in both clinical rating scale (CRS) for head control and Gross Motor Function Measure (GMFM-66) dimension-A at the end of 6 weeks of treatment in both groups. However, the experimental group showed a significant more improvement.
CONCLUSION: The study demonstrates that conventional treatment combined with passive elongation of scapula retractors is superior to conventional treatment alone in improving the neck control in children with spastic cerebral palsy.

INTRODUCTION

Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurr in the developing fetal or infant brain. Spastic CP is the most common type, accounting for up to 75% of cases (Jan *et al*., 2006). Head control is the first movement that a baby achieves, and is necessary to attain other movement skills such as sitting, crawling, and walking (Illingworth, 1983). Development of head control is very important as the head position of a child significantly impacts their ability to access and function within the environment and in meeting their educational needs (Doherty and Robdau, 1998). Development of neck control has been found to develop by providing activities in supine, prone and sitting (Snell, 1997), stroking of cheek muscles (Rood, 1954), visual and auditory stimulation (Carol *et al*., 1981), and feedback (Wooldridge and Russell, 1976). Children without neck control demands long term care, which can greatly exceed the normal requirements associated with the early stages of child development. This excessive responsibility may adversely affect the physical and psychological health of caregivers (Brehaut *et al*., 2009; Tucket *et al*., 2009), affecting their social, cultural and professional lives (Grootenhuis & Bronner, 2009) and possibly reducing their quality of life (Davis *et al*., 2010). Head control requires strength and coordination of the muscles which flex and extend the neck. Normal movement is built upon the development of righting, equilibrium, and protective responses (Miranda *et al*., 1977). In normal motor development of child, head extension is the first antigravity component to be expressed. Antigravity flexion in the same proximal areas seems to appear several months after the extension. At 4 month of age head extension is reinforced by bilateral scapular adduction.

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Scapular adduction reinforcing spinal extension is a common occurrence during the developmental process. Fortunately, this strong extension is being balanced by equal antigravity flexor activity. In abnormal motor development, the antigravity flexion component does not develop sufficiently to counter balance the extension. Most children with developmental delays or movement disturbances seem to start out with abnormal quality of extensor muscle activity. Subsequently, the child is left with an abnormal quality of muscle tone and movement. When the antigravity flexor activity does not balance the antigravity extensor activity, the baby has difficulty in stabilizing one part of his body so that another part can move. As the child cannot stabilize himself normally, he "learns", subcortically, to hold himself artificially, and learns to "fix". Fixing prevents further movement of that segment. As fixing is used more frequently and becomes stronger, it "blocks" the normal process of development (Bly, 1983). As the baby lacks normal head control, he compensates by elevating his shoulders to stabilize his head. Though the shoulder elevation stabilizes the head, it prevents normal head/neck movements and exaggerates the hyperextension, blocking the normal mobility of the scapula. Further the lack of scapular stability prevents the development of independent, dissociated humeral movements: external rotation, flexion and horizontal adduction. Therefore, the muscles between the scapula and humerus are not elongated and shoulder girdle control does not develop.

This abnormal development leads to scapular instability and tightness of the muscles between the scapula and humerus (Willard *et al*., 1983). Despite the availability of various therapeutic interventions, stretching remains as the mainstay of treatment of tightness. Stretching focuses on changing the muscle's viscoelastic, structural and excitability properties (Magnusson *et al*., 2000). Recent evidence suggests that muscles and tendon also act viscoelastically in response to stretch (Sullivan 2007). Therefore, stretching a muscle or group of muscles seems to induce muscle relaxation via either the inverse stretch reflex or the inherent viscoelastic property of the muscle From the neurophysiologic perspective, during stretching the GTO, which monitors the tension created by stretch of a muscle-tendon unit, may override any facilitative impulses from the primary afferents of the muscles spindle (Ia afferent fibers) and subsequently may inhibit tension in the contractile units of the muscle being stretch (Nielson *et al*., 2000). However no previous study has worked on specifically reducing the tightness of scapular adductors. The focus of this study therefore was to evaluate the effectiveness of manual scapular retractors stretching on neck control and upper limb function in children with spastic CP.

MATEIALS AND METHODS

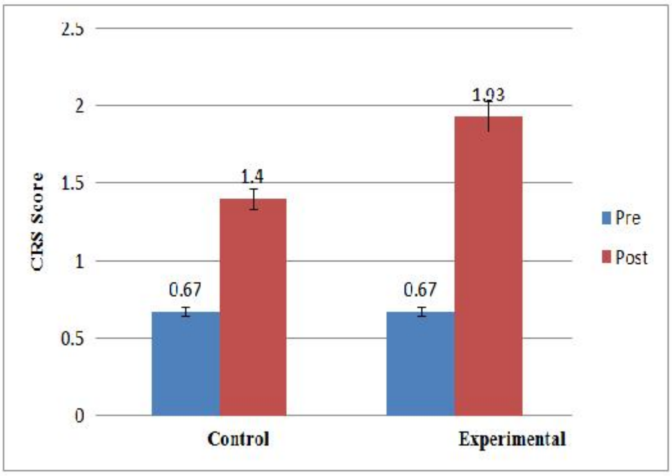
30 children with a mean age 18.47 ± 6.34(months) were randomized into two groups with 15 subjects each in experimental group (mean age 18.13 ± 5.59) and control group (mean age 18.8 ± 7.19). All children underwent an initial baseline assessment of Clinical rating Scale for Head Control and GMFM-66 (Dimension-A). All the two groups received conventional exercises which include facilitation of weak neck flexors, prone on elbow, rolling, maintain supported sitting with hip-knee in 90 degree of flexion and upper extremity in midline. The experimental group in addition received passive elongation of scapula retractors. The intervention period was of 6 weeks duration, 5 days/week. Follow-up was assessed at 6 weeks.

STATISTICAL ANALYSIS

Cohen's kappa statistics was used to find out the interrater reliability of clinical rating scale for head control. Data was analysed using non parametric Mann Whitney U test to know the between group difference in change score. The change score was taken as post score minus pre score for both the groups. Wilcoxon Signed Rank test was used to know the difference within the groups, as Clinical Rating Scale (CRS) for head control and Gross Motor Function Measure (GMFM) had ordinal score, 0.05 level of significance was used for hypothesis testing. Analysis was performed using SPSS versions 16.0 package.

RESULTS

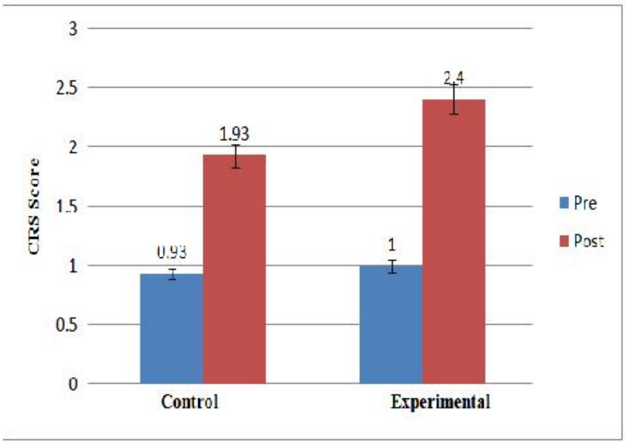
The kappa (k) values for the three test dimensions i.e. supine, prone & supported sitting showed very good agreement between the two therapists. The kappa value obtained with supine dimension was the highest (k= 0.94) than supported sitting (k= 0.89) and prone (k= 0.82).



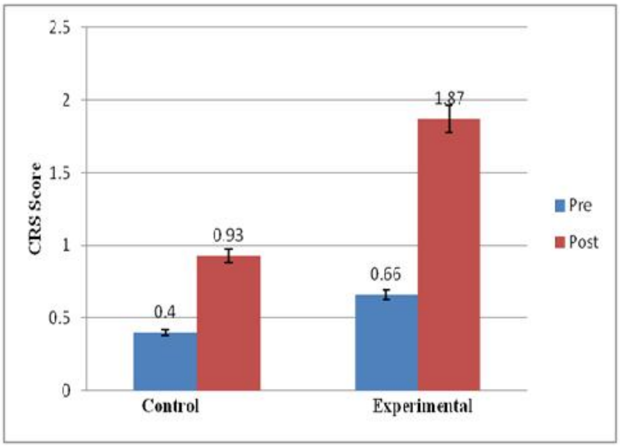
Graph 1. Pre to Post changes in CRS for Head Control in Supine

The graph- 1 shows there was a significant change from pre to post score in clinical rating sale in supine dimension in both groups, but experimental group showing significantly more change as compared to control group. As shown in graph-2 there was a significant change from pre to post score in clinical rating sale in prone dimension in both groups, but experimental group showed significantly more change as compared to control group.

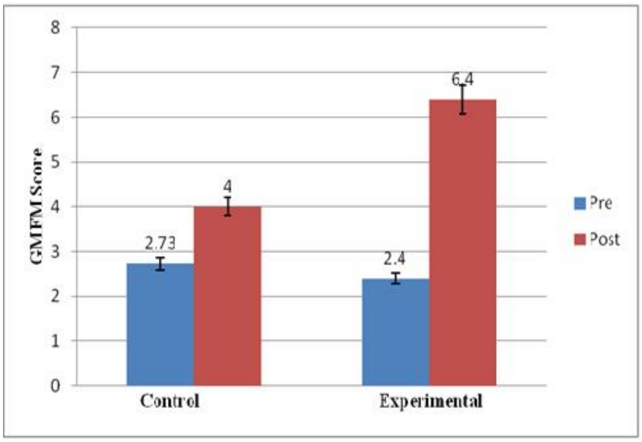
There was a significant change from pre to post score in clinical rating sale in supported sitting dimension in both groups, but experimental group showing significantly more change as compared to control group. Graph 3. As shown in there was a significant change from pre to post score in GMFM-66 (dimension-A) in both groups, but experimental group showed significantly more change compared to control group.



Graph 2. Pre to Post change in CRS for Head Control in Prone



Graph 3. Pre to Post change in CRS for Head Control in Supported Sitting



Graph 4. Pre to Post changes in GMFM (Dimension-A) Score

DISCUSSION

The overall results of the study showed improvement in the head control, in both clinical rating scale (CRS) for head control in prone, supine & supported sitting dimensions and Gross Motor Function Measure (GMFM-66) dimension-A i.e. rolling and supine at the end of 6 weeks of treatment in both, experimental & control groups, however, the experimental group showed a significant improvement in both Clinical Rating Scale (CRS) for head control and Gross Motor Function Measurement (GMFM -66) dimension A.

Clinical Rating Scale for head control

There was improvement in clinical rating scale in all the three dimensions i.e. supine, prone, supported sitting in both the groups, but the experimental group improved with a significant difference than the control group. The result of the study showed more significant improvement in supine and supported sitting compared to prone. We hypothesize this to the motor responses that are easier for the former in prone dimension. The improvement in Clinical Rating Scale for head control in the control group may be attributed to the facilitation of weak neck flexors-by prone on elbow, rolling, supported sitting with hip-knee in 90 degree of flexion and upper extremity in midline interventions that were used to treat the study participants.

During the intervention, neck flexors were facilitated by applying tactile sensory stimulation to the anterior aspect of neck in supine positions. This mechanism of action may be explained by the reflex and system theory and reciprocal innervation mechanisms. The tactile sensory stimulation is received by cutaneous receptors of the neck resulting in contraction of neck muscles. Rood used a light stroking of the skin to activate the superficial mobilizing muscles, which activates low threshold hair end organs and free nerve endings. The stimuli send impulses to A delta and C fibres to the higher centers through the spinothalamic and spinoreticular tracts, and fine touch ascends along the leminiscal (dorsal) column. As a result, light moving touch causes reciprocal innervation, which is clinically seen as phasic withdrawal response (Rood, 1954; Stockmayer, 1967)**.** Recent study using vibrotactile stimulation on spastic cerebral children showed better postural trunk stability, facilitation of rotations and greater selectivity of movements, a result supported by other authors (Antropol, 2011; Czarkowska-Bauch, 1996;Blake *et al*.,1997).

In the study we progressed the exercises from static muscle contraction to eccentric and concentric contractions. This approach was chosen as the physiological cost of eccentric muscle work is low as compared to concentric muscle work (Gardiner 2005). We hypothesize such an approach will facilitate the weak muscle initially. As the control over neck increased, we prescribed exercises that was better coped up by children. In forearm weight bearing, the participants started demonstrating the first coordinated action of extensors and flexors working together to achieve a purposeful movement. This exercise was justified as the proprioceptive feedback it provides to the shoulder and neck will subsequently influence the development of stability (Bly, 1983)**.** Placing the children on prone on elbow position helps in respiratory expansion by facilitating thoracic extension. This allows rib mobility and a mobile rib cage for the abdominal musculature to work leading to greater trunk stability. Though not directly related to outcomes, this position also allows for better oral-motor desensitizing helping with good suck/swallow/breathe pattern, upper quadrant function including shoulder complex mobility, strength, and control.

The prone-on-elbows position has an added advantage of improving depth perception, orientation in space, and prepares the child for protective reactions of arms. Strength of spine and hip musculature are also improved as the hip muscles must be able to support the entire weight of the body in extended positions for extended periods of time. In the prone position, the glutei muscles are strengthened against gravity; which assists in forming a 'stable' hip joint. Another advantage of placing the child in weight-bearing postures is that it promotes dynamic stability. The children recruited for the study had difficulties in rolling due to the presence of abnormal tone. Spasticity leads to stiffness through the trunk, interfering with coordinated rolling movement (Fraiberg 1971). Further the ability to roll smoothly from back to stomach, or stomach to back requires some degree of head control, and a rotation movement that occurs along the trunk of the body, between the hips and the shoulders (Caplan, 1978). When a baby is physically unable to roll, the therapist can help him roll to enable the child experience this pattern of movement (Fraiberg 1971). We hypothesized that rolling will stimulate some amount of neck control in children with cerebral palsy.

The children were treated in 90-90-90 sitting position as children with CP are known to have deficits in head stability during dynamic tasks and to have deficits in postural control during sitting (Saavedra *et al*., 2010). In 90-90-90 sitting position maximum symmetry between left and right sides of the body is achieved with no pelvic obliquity, rotation and posterior pelvic tilt. This also promotes proximal stability which in turn fosters distal control (Lange, 2001). Kangas suggested that 90-90-90 position can passively and temporarily reduce tone (Kangas, 2002). Studies have been shown that children with CP have deficits in head stability even during quiet sitting and were able to hold their head by external postural support and vision. Holding a trunk in upright position assist in head holding even when toys and food are introduced from different sides (Saavedra *et al*., 2010) and also improve upper extremity function (Nwaobi, 1987) **.**

The greater improvement in experimental group may be attributed to the added advantage of passive elongation of scapula retractors along with conventional exercises. Possible explanation could be attributed to the stretching of muscles seems to induce relaxation in scapula retractors via either the inverse stretch reflex or the inherent viscoelastic property of the muscle reducing tension in the muscle/tendon. From the neurophysiologic perspective, stretching the GTO, which monitors tension created by stretch of a muscle-tendon unit, may override any facilitative impulses from the primary afferents of the muscles spindle (Ia affrent fibers) and subsequently may inhibit tension in the contractile units of the muscle being stretched (Magnusson et al., 2000). Passive elongation of scapula retractors provide optimal length tension relationship that might facilitated the neck flexors.

Gross motor function measure (GMFM-66) Dimension-A

GMFM-66 dimension-A (lying & rolling) include components like bringing hands to midline, reaches out with right arm then with left arm by crossing midline and in prone lifts head upright. Experimental group showed significant improvement in all the components of GMFM-66 dimension-A. Possible reason for this may be the fact that treatment was aimed to improve the scapular stability and scapulohumeral mobility by elongating the head and neck extensors while activating the flexors. This would decrease shoulder elevation and increase the shoulder girdle mobility and control. Active flexion and active midline orientation of head and neck could result in symmetrical use of upper extremity (Lois, 1983). It may be also because of passive elongation of scapula retractors which was given to the experimental group only, which might have induce relaxation to the retractors which in turn facilitate the protraction along with flexion of the shoulder. The little improvement which was seen in control group may be because of the improvement in last component of GMFM-66 dimension-A which include "lift head upright" in prone which may be attributed to the "prone on elbow" positioning that might have resulted in better lifting of head in prone.

Conclusion

The study demonstrates that conventional treatment combined with passive elongation of scapula retractors is superior to conventional treatment alone in improving the neck control in children with spastic cerebral palsy.

Conflict of Interest

The authors report no conflict of interest.

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Ethical Clearance

Ethical clearance was obtained by the institutional ethical committee, SVNIRTAR.

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