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Original Research Article

EFFICACY OF SPECIALIZED TRUNK TRAINING PROGRAM IN IMPROVING THORAX CIRCUMFERENCE AND FUNCTIONAL REACHING SKILL IN QUADRIPARESIS CEREBRAL PALSIED CHILDREN

Ahmed M. Azam.

Department of physiotherapy for developmental disturbance and pediatric surgery, Faculty of physical therapy, Cairo University, Giza, Egypt.

ABSTRACT

Objectives: The aim of this work was to investigate the effect of specialized trunk training program in improving thorax circumference and functional reaching skill in quadriparesis cerebral palsied children.

Materials and Methods: 30 quadriparesis C.P. children were randomly selected into 2 groups; group A (specialized trunk training program plus physiotherapy program), and group B (physiotherapy program only). Functional Reach (FR) Test and thorax circumference were the measurement tools.

Results: The mean difference between pre and post-treatment results was significant in both groups in favor of the experimental group (p=0.0001) in both functional reach and thorax circumference variables.

Conclusion: According to the outcomes of this study, it can be terminated that the combined effect of physiotherapy training program plus specialized trunk training program can be recommended in improvement functional reaching skill and thorax circumference in quadriparesis cerebral palsied children.

KEY WORD: Trunk Training, Thorax Circumference, Functional Reaching Skill, Cerebral Palsy.

Address for correspondence: Prof. Dr. Ahmed M. Azam, Department of physiotherapy for developmental disturbance and pediatric surgery, Faculty of physical therapy, Cairo University, Giza, Egypt. **E-Mail:** prof.ahmedazzam@yahoo.com

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INTRODUCTION

Impaired motor control in C.P. children leads to desynchrony between abdominal muscles/diaphragm and rib cage muscles due to trunk flexors are hyperexitable subconsciously (spastic), whereas chest musculature act as an accessory. This means that when one group of muscles are working on inhaling, others may be working on exhaling. This result in uncoordinated respiratory mechanism lead to a flatter upper rib cage, depressed sternum, flaring of lower ribs and an overall smaller rib cage leading to decreased chest expansion [1].

C.P thorax circumference decreased due to many causes, as the secondary complications developed. The core muscles hyper-excitability result in thorax deformity as barrel chest with distal rib flaring as intercostals, diaphragm, and rectus abdominis lead to abnormal respiration associated with thorax improper movment during respiration and weakness of the rib cage muscles result in limitation of costovertebral joints leading to decrease of rib cage circumference [2].

The usual interaction between the trunk muscles and axial body parts and gravity results in the normal development of the thorax. However, impaired muscles motor control which produces a subnormal motor response despite a maximal activation of the muscle will not have the same ability to balance gravity influence so this incoordination between these two mechanisms leads to the delaying of the rib cage development leading to decrease proper inspiratory and expiratory mechanism [3].

Respiratory muscles cannot respond to continuous muscle stretch to save its muscle tone resulting in insufficient muscle contraction leading to thorax and head movement limitation. Cerebral palsy children suffering from loss of the main environmental stimulus that helps in maintaining stretch reflex leading to decrease of the rib cage circumference [4].

MATERIALS AND METHODS

Subject: Thirty children from both sexes with quadriparetic C.P. children were randomly selected for this study, aged 6 to10 years at the time of recruitment because the children in this age can understand the research instructions and rules. Body weight, height and hand dominance, Type of involvement, grade of spasticity according to modified Ashworth scale, level of ambulation were recorded for each subject. The children who had previous trunk surgery or had lower limb injection by botulinum toxin were excluded from the study.

Children randomized to the study group (A) received Specialized trunk training program plus physiotherapy program while children of the treatment group (B) subjected to physiotherapy program only. The individual-based Specialized trunk training program sessions of1hour to quarter to 1 hour were conducted three times weekly for 3 months in a physiotherapy treatment room after the physiotherapy program session which lasts for45 minutes for group (A) and the physiotherapy program session only for the group(B). In addition, all children were exposed to home routine program 3 hours daily for the 12 week treatment period.

Measurements

Evaluation

Modified Functional Reach (FR) Test: The child's arm put in 90-degree shoulder flexion with the hand put in fisted position. Third metacarpal head recorded on a yardstick at the starting then ask the child to reach as possible as he can and record the new position of the third metacarpal of the fisted hand. Assess the reach distance by subtracting the initial position from final positions [5].

Thorax circumference measurement: Thorax circumference was measured by calculating the subtraction between maximum voluntary inspiration and maximum voluntary expiration at 3 levels at axilla, 3fingers below xiphoid process and sub-costally by using tap measure in sitting position [6].

Procedure: For all children, the programs were conducted three times weekly, for 12 weeks. Each session lasted for 1 hour to quarter to 1 hour (Specialized trunk training program) plus 45 minutes (the physiotherapy program) for study group and 45 minutes(the physiotherapy program) for group B in a physical therapy room, plus to 3 hours of the home program, every day during the treatment period.

Both groups (A and B) received a physiotherapy program, as the following:

Moist heat application for preparation of stretch and gain muscle relaxation applied on the both wrist, elbow flexors, and hamstring, calf muscles, iliopsoas, rectus femoris and erector spinae for 10 minutes.

Facilitation of anti-spastic muscles (wrist extensors, elbow extensor, knee extensors and anterior tibial group): tapping followed by movement, quick stretch, triggering mass flexion, biofeedback, weight bearing, approximation, vibration, and ice application for brief time for 5 minutes.

Maintained stretch to gain relaxation(inhibition of spasticity) via approaches as (anti spastic positioning, static splint, inhibition of released abnormal pattern, NDT) for 5 minutes.

Passive stretching to tight muscles (wrist flexors elbow flexors, hamstring, calf muscles, hip adductors, iliopsoas and rectus femoris and erector spinae) to destruct adhesions in extra-fusal muscle fibers. It must be decent, gentle, gradual stretch not over stretch at all, lasting 20 seconds then relaxation 20-second 3-5 times per session then maintain the new range by using adjustable wrist and elbow splint, knee immobilizer and ankle-foot orthoses.(5minutes)

Walking training using orthoses in side walking, walking on one straight line followed by pass walking to stimulate protective reaction for the hand. (5minutes)

Faradic stimulation for wrist and elbow extensor and anterior tibial to modulate muscle tone. Mother was asked to support wrist in extension during NEMS and ankle maintained in dorsiflexion to prevent cross electricity to reach wrist flexors and calf due to these higher excitable tissues are more attractive to respond to electric stimulation than the less excitable. Faradic stimulation for ant-tibial group for triggering mass flexion of L.L aiming for modulating extensor tone spasticity for 15 minutes.

The study group (group A) received specialized trunk physiotherapy program as following:

The aim of this program is to enhance the motor control between pelvic, abdominal and chest muscles plus upper limb reaching.

It is contraindicated to use resistance strength program inC.P. children to avoid increase in hypertonia[7,8].

Trunk activation exercises of inhibited abdominal and oblique abdominal muscles with functional reaching training.

Myofascial Release was given to anterior chest wall: diaphragm, rectus abdominis, pectoralis major, intercostals and paraspinal muscles.

Passive stretching ex. For tight anterior chest, erector spinae and iliopsoas and rectus femoris muscles.

Hand function training as reaching in various directions as in sitting, upright position, kneeling, kneel sitting and sit to stand.

Breathing ex which stretches tight respiratory muscles plus increase chest joints range of movement.

PNF patterns training for upper extremity as flexion, abduction, and external rotation activate serratus anterior.

Functional activities such as swimming, swinging, bridging and unilateral bridging and sit to stand training also enhance trunk motor control and pulmonary functions.

Pelvic tilting reciprocal control via enhancement of gluteus maximus with hamstrings and trunk flexors with inhibition of hip flexors and low back extensors.

Abdominal breathing, and pursed-lip breathing. Enhance the primary and secondary respiratory muscles which result in increased thorax circumference and improve breath in.

Postural reaction training:

- Weight shift anteroposterior and lateral shifting within changing a width of the BOS

-Body perturbation from different position as sitting, quadruped, kneeling, half kneeling, standing with support and withhold on

-Movable surface producing perturbations in all planes

RESULTS

First table demonstrate the patients characteristics. There were 17 boys (56,66%) and 13 girls (43.33%). and in regarding to right-hand dominance reported in 14 patients (46,66%), and also16 patients (53.33%) were left-hand dominance. There was no expressive difference between the two groups in regarding to age (p=0.5488), in regarding to sex (p= 0.7240) and in regarding to hand dominance (p= 0.4814).

Table 1: Patients' characteristics.

Variables	Study group N=15	Control group N=15	P-value
Age	8±1.56	7.67±1.45	0.5488
% Sex N			0.7240
Boys	(60%)9	(53.33%)8	
Girls	(40%)6	(46.66%)7	
Hand dominance N %			0.4814
Right	(53.33)8	(40%)6	
Left	(46.66)7	(60%)9	

Changes in reach distance variable: Mean test scores and SD for all quadriplegic children are shown in table 2. The mean value of modified Functional reach variable in both groups (assessed by reach distance) at baseline measurement (pre-treatment) was insignificant (p>0.05).while study group had a an expressive enhancement in reach distance post-treatment(p<.05). The average improvement of reach distance variable move toward highly significant in the experimental group (1.4±0.51versus1.93±0.80, p=0.0013)while insignificant result in the treatment group (1.4±0.51versus 1.47±0.52, p=0.3343). The percentage of improvement of reach distance was (37.8%) in the experimental group and the improvement was(5%) in control group.

Table 2: The average test of reach distance variable in both groups.

Reach distance variable	Study group	Control group	P-value
	Mean±SD	Mean±SD	(within groups)
Pre-treatment	1.4±0.51	1.4±0.51	1
Post-treatment	1.93±0.80	1.47±0.52	0.0678
%Improvment	37.80%	5%	0.0158
P-value(within groups)	0.0013	0.3343	

Thorax circumference variables: Mean test scores and SD for all quadriplegic children are shown in table 3. The mean value of thorax circumference variables in all quadriplegic children (assessed by tape measurement) at baseline measurement (pre-treatment) was insignificant (p>0.05).while study group had a expressive enhancement in thorax circumference variables post-treatment(p<.05). The average improvement of thorax circumference variables move toward be highly significant in the experimental group (3.74±1.06versus4.47±1.30, p=0.0001)while insignificant result in the treatment group (3.67±1.40versus 3.73±1.22, p= 0.7921). The percentage of improvement of thorax circumference variable was (28.8%) in the experimental group while the improvement was (1.63%) in control group.

Table 3: The average test of thorax circumference variable in both groups.

Thorax circumference variable	Study group	Control group	P-value
	Mean±SD	Mean±SD	(within groups)
Pre-treatment	3.74±1.06	3.67±1.4	1.0000
Post-treatment	4.47±1.30	3.73±1.22	0.1230
%Improvment	28.80%	1.63%	0.4012
P- Value (With in groups)	0.0001	0.7921	

DISCUSSION

Loss of thorax muscle motor control leads to dependence mainly on the trunk flexors in respiration leading to limitation of the rib cage expansion [9,10]. Shallow and decreased volume of respiratory result in impaired of respiratory system elasticity leading to delay in respiratory system development leading to decreased in thorax circumference [11,12].

Spasticity, loss of reciprocal inhibition, incoordination, tightness of rib cage muscles and limitation of costovertebral joints may be the reasons of decreased thorax mobility. So the normal nervous system, respiratory muscles and costovertebral joints is a need for normal thorax mobility. Chest muscles in C.P. cannot developed enough increase and decrease of the thorax expansion leading to limitation of costovertebral joints leading to decrease of the rib cage circumference. Long run abnormal pattern of breathing lead to tight of rib cage muscles and limitation of costovertebral joints which lead to decrease of thorax circumference [13].

Loss of the elasticity in myofascial chains is a main reason to chest muscles tightness. There are links of MC between external oblique and pectoralis major plus serratus anterior muscle so any change in abdominal or chest muscles motor control can affect on each other leading to decrease of the rib cage circumference in cerebral palsy [14].

Excessive forward shifting of the pelvis due to the tightness of iliopsoas associated with weakness of gluteus maximus and hamestring and flexors of the trunk is a general mechanical problem producing femoral anteversion and shifting of the patella medially. Reciprocal treatment of pelvic muscles incoordination is the first choice to restore normal pelvic aligment [15].

Every 1 degree increase of ant-pelvic tilting due to tight of iliopsoas muscles associated with weakness of glueus maximus and hamestring and flexors of the trunk produce 2 degree increase of knee flexion.16 pelvis shifting to misalignment can be produced from incoordination between reciprocal forces between trunk and hip muscles produce pelvis shifting anterior when iliopsoas, rectus femoris muscles did not act with erector spinal muscles while pelvis shifting posterior when the gluteus maximus with hamstring did not act together with abdominal muscles [17].

The first choice of treatment to passive forward shifting of the pelvis in C.P. is the activation of normal co-contraction and reciprocal inhibition mechanisms between force couples by facilitation of gluteus maximus and hamestring and abdominal flexors in one side and inhibition and relaxation of iliopsoas and erector spinae [15,18].

Effect of pelvis deviation on the rib cage and upper extremity functions: The functional position of trunk and pelvis is mild anterior pelvic tilting, lumbar extension, and thoracic extension.

When reaching to a target anterior pelvic tilting, trunk extension occurs with pelvic girdle stability and shoulder girdle rotation. Ability to separate or isolate different body parts from each other is required for normal motor control [19].

Fig. 1: Effect of normal pelvic and trunk alignment on hand functions [19].

Functional alignment of trunk and pelvis
↓
Mild forward pelvic shifting
↓
Lumbar extension
↓
Thoracic extension
↓
Retraction of the scapula
↓
Humeral external rotation
↓
Forearm supination
The essential physical movement in ADL activities
↓
Facilitate hand functions and hand grip

Fig. 2: Effect of extreme anterior pelvic tilt on hand functions in C.P1.

In cerebral palsy children
↓
Spasticity is the main problem lead to extremely ant. pelvic tilting due to the tightness of iliopsoas associated with weakness of flexors of the trunk and gluteus maximus and hamstring
↓
Extreme forward pelvic shifting
↓
Abdominal contents did not support or assist diaphragm
↓
Inadequate expiration
↓
Extend of the ribs laterally and winging of the ribs bottom
↓
Decrease of the thorax expansion
↓
Thoracolumbar flexion
↓
Scapular abduction
↓
Shoulder internal rotation
↓
Forearm pronation (loss of the essential physical movement in ADL
↓
Thumb and finger facing downward
↓
Inhibit the hand function and grip

Fig. 3: Effect of extreme posterior pelvic tilt on hand functions in C.P1.

Tightness of hamstring and weakness of erector spinae
↓
Extreme backward shifting of the pelvis
↓
Abdominal content push up into the thorax
↓
Insufficient lung tissue extensibility
↓
Insufficient deep breath
↓
Increase demand for energy on respiratory muscles
↓
Chest muscle weakness
↓
With extreme posterior tilting
↓
Lumbar flexion
↓
Thoracic flexion
↓
Scapular abduction
↓
Humerus internal rotation
↓
Forearm Pronation
↓
Thumb and fingers facing downward
↓
Impaired of fine motor skills and hand grip [1]

In cerebral palsy children, the weight bearing is more on the thenar muscles more than hypothenar muscles leading to flexion of an elbow with scapular pulling upward with a shifting of the lower angle outward. This is associated with thoracolumbar collapse due to the shifting of the pelvis anterior [20].

Activation of trunk and shoulder muscle produce improvement of fine motor skills .such as activation of pectoralis major and latissimus dorsi which affect on arm forces and its relations to thorax plus fixation of the scapula to the thorax which acted by serratus anterior and rhomboid [20].

CONCLUSION

According to the results of this study, it can be concluded that the combined effect of physiotherapy training program in addition to specialized trunk training program can be recommended in improvement functional reaching skill and thorax circumference in quadriparesis cerebral palsied children

Conflicts of interest: None

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