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Balance Training versus Rebounding Exercises Program on Motor control of Knee Joint in Spastic Diplegic Cerebral Palsied Children

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KEYWORDS

*Balance training ;
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A B S T R A C T

To investigate the effect of balance training versus rebounding exercise program on motor control of knee joint controlling in spastic diplegic cerebral palsied children. Thirty children were enrolled in this study and randomly assigned into two groups of equal number. Group A include 15 spastic diplegic cerebral palsied children who received a course of balance training program that include static and dynamic postural stability training-plus traditional physiotherapy program- Group B include 15 spastic diplegic cerebral palsied children who received rebounding exercises in addition to the same traditional physiotherapy program in group (A) 3 days a week for 3 moths, Standard plastic goniometr was used to detect and follow knee extension from the point of flexion deformity, flexibility tests was used to detect hamstring, gastrocnemius and gracillis muscles flexibility in addition 10 tape measurement was used alternatively to measure distance between the heel to buttock at the point of extension limitation. These measure means were taken before initial treatment and after 12 weeks of treatment. Revealed statistically significant improvement in the measuring variables of both groups when comparing their pre and post treatment mean values. Significant differences in the measured variables were also obtained in favor of the group (A) when compared with that of group (B).The use of balance exercise program are superior to rebounding training for all measurement that include knee mobility and hamstring, gastrocnemius and gracillis flexibility after 12 weeks follow up.

Introduction

SPASTIC dipiepic cerebral palsy caused by brain damage in the outer layer of the

and the cerebral cortex. Spastic dipiepic cerebral palsy affects nearly 35 percent

of C.P. children and is the most common form of cerebral palsy. Spastic diplegic cerebral palsy symptoms include increased tone or tension in a muscle, tightness of muscles and released pathological reflexes. All four limbs are affected both legs as well as mild affects in the arms are present. Proper treatment can correct toe walking and flexed knees deformity which are common attributes of spastic diplegia (Pharoah et al., 2006; Steult et al., 2004). The spastic diplegia was known as Little's disease for several years. Gradually, researchers determined that Little's disease was spastic diplegia just one of the forms cerebral palsy can take. Diplegia means that both sides of body are affected by a form of paralysis; di is from the Greek for two and plegia is derived from the Greek for some form of paralysis. The term diparesis, which means mild affection in motor disorder (Arnould et al., 2007; Bobath B. and Bobath 1975). The most effective and efficient treatments will focus first on physical problems with the greatest impact on function and address more than one problem at a time. Training balance on an unstable surface contributes not only to use of visual and vestibular inputs but also (to the use of hip strategy, to increase lower extremity strength and to increase motor control on that type of surface) (Ashwal et al., 2004; Klingels et al., 2010). Proprioceptive input to central nervous system is very important for conscious awareness of joint position sense and motion so clinicians need to evaluate kinesthetic deficits and to design exercise programs to improve kinesthetic awareness. (Van et al., 2004). A rebounding is an exercise that exercises every cell in the body at once by helping the body increase its resistive load via trampoline rebounding. The use of rebound therapy with children with both

physical and learning disabilities is expanding.. The spastic diplegic children when they want to walk they need some flexion of hips and knees. Therefore they start walking with both hips and knees in some degree of flexion, adduction and internal rotation. The weight is then taken on the medial border of the feet which results in a valgus deformity of their feet. He moves further forward by bending his trunk over his hips, his legs then follow, toes down first to prevent him falling forwards. Spastic diplegic patients start walking with both hips and knees in some degree of flexion, adduction, internal rotation, the weight is then taken on the medial border of the feet which results in valgus deformity of the feet (Groch S and Judit'i L 2007). Hamstring muscle is functionally important hip extensors. Tightness of hamstring cause inability to perform hip extension lead to tightness of hip flexors lead to anterior pelvic tilting lead to hyper lordosis and forward trunk walking. Tightness of gastrocnemius and gracilis with hamstring lead to knee flexion deformity.

Subjects, Instrumentations and Methods

Subjects

Thirty children from both sexes with spastic diplegic were enrolled for this study .

Inclusion criteria

(1) age range of seven to eleven years, (2) The degree of spasticity was determined according to the modified Ashworth's scale to be within the range of 1 and 1+ grades, (3) They had tightness in both hamstring and limitation in knee extension(4) They were able to understand any command

given to them, with an IQ level within (4) They have to have the ability to stand with support, walk with assistance in flexion hip and knee and valgus of the foot.

Exclusion criteria (1) shorting or contracture (2) cardiovascular diseases, (3) surgery within the previous 24 months, (4) sensory defensiveness, and (5) Post operative released of hamstring were excluded. The study sample was divided randomly into two groups of equal number (A and B). Group A includes 15 spastic diplegic C.P. children who received a course of balance training program that include static and dynamic postural stability training plus traditional physiotherapy program. Group B; Includes 15 spastic diplegic C.P. children who received rebounding exercises plus the same traditional physiotherapy program in group (A).

Instrumentations

I-For evaluation: 1-Guymon goniometer (LAFAYETTE type), (model 01129), USA. It is a digital bi-dimensional goniometer that can measure any joint angle or range of motion quickly and accurately .

II - For treatment 1- Mini trampoline: 40 inches in diameter and about 12 inches high for a model with six legs, also have 40 inches long bar at the trampoline side which fixed with the trampoline by 3 longitudinal bars with 24 inches in height that gives child something to hold onto if child is at risk for falling due to disturbance of the balance.

- 2- Biodex stability system which produce perturbation in all directions, medical ball ,balance board , wedges and rolls

Procedure

For Evaluation

All spastic diplegic children From supine lying position the untested limb put in flexion position, tested limb put in flexion hip 90, flexion knee 90, then perform gradual knee extension to detect flexibility of hamstring. The tightness detected from (limitation in knee extension, resistance in knee extension and facial expression). Then perform to the other limb.

- From supine lying position, untested limb is extended and supported to physiotherapist chest, other limb is flexed in hip 90, knee 90, sole of the foot support on the chest and by gradual dragging of the heel of the tested limb on therapist chest performing gradual stretch on hamstring to show the limitation, resistance, facial expression. To increase stretch gradually therapist lean the trunk forward till tightness appears.
- From supine lying position the tested limb taken passively from extended knee to abduction hip (to test gracillis muscle), pillow under knee and from extended knee perform dorsiflexion (to test gastrocnemius muscle).
- By using standard plastic goniometer used to detect and follow passive range of knee extension from the point of flexion deformity. The child was placed in supine with thorax firmly strapped to the table to prevent body shift. Normally the knee extension is the starting position (zero de gree) by using goniometer therapist measure improvement in knee flexion deformity pre and post treatment.
- Another method to detect limitation

in extension, alternatively measure the heel to buttock distance in the point of extension limitation pre and post treatment. This can be a very accurate way of detecting small alterations in range and is useful for follow-up of knee flexion deformity and checking progress in treatment.

For treatment

The children were treated 3 times per week, each treatment session lasted 1 hour. The treatment program includes:

A- Traditional physiotherapy program which includes the following

- Faradic stimulation for anterior tibial group to triggering the mass flexion of lower limb so inhibit the extensor spasticity with support ankle in dorsi-flexion to prevent cross electricity to reach calf muscles because these spastic muscles are more sensitive to electric stimulation than ankle dorsiflexor.
- Prolonged stretch to spastic muscles to gain relaxation via; at first quick stretch occur lead to stimulate gamma fibers lead to stimulate contractile part of intrafusal muscle fiber lead to stimulate non contractile part which include stretch receptors sending afferent signals to PHC. Then to AHC then to alpha motor neuron causing contraction of extra-fusal muscle fibers. At second step just one contraction or repeated contraction occurred stimulate GTO sending Ib afferent to PHC then to Ib inter neuron which reverse the stimulated signals into inhibitory signals inhibiting AHC (alpha motor neuron) then relax the extrafusal muscle fibers. Techniques used as prolonged stretch (positioning, night splint, reflex inhibiting pattern, Bobath technique) (Groch S and Judit'i L 2007).
- Facilitation of anti-spastic muscles (lapping followed by movement, quick stretch, triggering mass flexion, biofeedback, weight bearing, clenching to toes, compression on bony prominence, rapping the muscle, approximation, TVR, irradiation to weak muscles by strong muscles, ice application for brief time) (Strauss et al., 2005; Nieu et al., 2009).
- Passive stretching to tight muscles (most common tight muscles are; tendo-acchihis muscles, ham string, hip flexor and hip adductor). Concentration focused on hamstring, gastrocnemius and gracillis muscles because their tightness responsible on knee flexion deformity. It must be decent gentle gradual stretch not over stretch at all (Groch S and Judit'i L 2007).
- Graduated active exercise for trunk muscles (abdominal, para-spinal, lateral flexors).
- Gait training using aids in closed environment using obstacles, side walking then by pass walking)
- Hot packs to improve circulation and relax muscle tension. Quadribed disturbance forward, backward, side- way then by raising one limb then disturbance as above then others, then both one upper limb and opposite lower limb with disturbance.
- Kneeling and half kneeling in

addition to disturbance in all directions sudden raising of one upper limb then release and other limb then both upper limbs. Standing against wall, ball, stand bar, corner, manual support standing with disturbance in all direction then by narrowing BOS then disturbance then by shifting of one lower limb then disturbance then decrease the support by remove one hand from support then disturbance then by taking forward step then disturbance, then ask the child to push me and sudden release in all direction.

- Changing positions, stooping and recovery exercises to facilitate balance training. The child backed to me in standing then by lowering foot of one limb below plinth ask the child to raise, ask him to do stoop and recovery, using of abdominal belt to perform change of position training.

Group A- Balance training program

This program was introduced to study group only which includes:

Static balance training

- Ability to maintain posture in different position about 20 second.
- Maintain quadruped position, kneeling, half kneeling, standing; standing with step forward, with large BOS then narrow BOS, shifting to one limb.

Dynamic balance training

Ability to control the body when the support surface is moving or when the

body is moving on a stable surface. Medical ball to train automatic postural reactions (righting reaction training via sitting on ball and make tilting to body then the child right his head and thorax-Equilibrium reaction training via different positioning as prone on ball, supine on all, quadruped on balance board, sitting on ball, kneeling with disturbance, half kneeling with disturbance, standing with disturbance, standing with step forward with disturbance, narrow BOS with disturbance, shifting with disturbance) all these produced motor response as raised side of body have equilibrium reaction and lowering side on the other side have protective reaction, axial parts have righting reactions,

Group B: engaged to extra exercise" rebounding on the mini trampoline". Rebound therapy should be used as part of a therapy program adding to existing therapies and not in isolation the treatment program was conducted three times / week over a period of three months. we start bouncing slowly (warming up) while the therapist control and guide the bouncing rate in short blocks of 2 to 5 minutes, gradually increase the workout time as the endurance increases to reach target heart rate 50-70% of maximum heart rate, Then gradually decrease the intensity near the session end (cooling down).

Result and Discussion

Data analysis was available on 30 spastic diplegic C.P. children. were randomized to Group A include 15 spastic diplegic cerebral palsied children who received a course of balance training program that include static and dynamic postural stability training-plus traditional physiotherapy program-

Group B include 15 spastic diplegic cerebral palsied children who received rebounding exercises in addition to the same traditional physiotherapy program in group (A) Demographic data in (Table 4) revealed that p -value <0.05 for some variables, this means that has affected on the study at 5% level of significant. But, p -value >0.05 for age, group and sex, this means that all of them have not affected on the study at 5% level of significant.

Knee flexion

A comparison of the pre and post treatment for the right lower limbs in both groups as shown in (Table 1) revealed that there is highly statistical significant difference ($p<0.01$) for the (Rt) knee flexion pre and post treatment of the study .group (A) also statistically significant difference ($p<0.05$) to the right lower limb in group (B) (Table 1) and Fig. (1). On the other hand there is a highly statistical significant difference of the (Lt) knee flexion pre and post treatment in, the study group ($p<0.01$) but non significant difference to the (Lt) knee flexion in the control group ($p>0.05$). The percentage of decreasing in. knee flexion in the group A was -7.5% on. Rt and -7% on the Lt in study group and -1.43% on Rt and -2.1% on Lt in group B as shown in (Table 3).

A course of traditional physiotherapy program plus balance training were significantly more effective than rebounding exercise plus traditional physiotherapy alone. Knee flexion was decreased by -7.5%, -7% in study group in comparison with control group which decreased by -1.43%, -2.1% and increase of the distances between buttock and heel by 16.95%-13.72% in group A while group B increased by 1.62-2.36%.

Underlying mechanism of balance training: Balance control requires the interaction of the nervous and musculoskeletal systems and contextual effects.

The nervous system provide the following

- 1-Sensory processing for perception of body orientation in space provided by visual, vestibular, and somato-sensory systems.
- 2- Sensori-motor integration essential for linking sensation to motor responses (centrally programmed postural adjustments that precede voluntary movement).
- 3- Motor strategies for planning, programming and executing balance response. Information from peripheral receptors including visual, vestibular, and somato-sensory. (proprioceptive including conscious which are joint receptors, unconscious proprioceptors which are muscle spindle and GTO in addition to cutaneous receptors) to the cord and brain stem then be sensitized by the thalamus then localized by post central gyrus (sensory areas) to make three functions (perception of sensation, cognition, formation of sensory strategies) then reach to cerebellum and basal ganglion to prevent excessive activity, smoothening of information then to the precentral gyrus which perform permanent changes lead to motor strategies and long term memory of this skill this means increase of anatomical (numbers) and physiological (efficiency) of synapses this means formation new neurological circuit which means learning of balance skill then

Table.1 The mean values of Knee flexion in degree

Data	Group A				Group B			
	Pre-rt	Post-rt	Pre-lt	Post-lt	Pre-rt	Post-rt	Pre-lt	Post-lt
Mean	45.07	41.67	44.27	41.13	45.4	44.73	44.46	43.46
Standard deviation	3.24	3.13	3.08	2.8	4.3	4.1	3.9	3.6
Difference mean	3.45		3.13		0.66		1	
p-value	<0.01		<0.01		<0.05		>0.05	

Table.2 The mean values of distance between buttock and heel in cm

Data	Group A		Group B		Group A		Group B	
	Pre-rt	Post-rt	Pre-lt	Post-lt	Pre-rt	Post-rt	Pre-lt	Post-lt
Mean	27.86	32.5	28.26	32	27.33	27.8	29.06	29.73
Standard deviation	1.68	1.72	1.67	2.9	1.79	2.27	2.05	2.01
Difference mean	4.67		3.86		0.46		0.67	
p-value	<0.01	<0.01	<0.05	<0.05	<0.01		>0.05	

Table.3 Percentage of improvement of variables

Side	Knee flexion		Distance between buttock and heel	
	A	B	A	B
	Rt	-7.5 %	-1.43%	16.95%
Li	- 7 %	- 2.1%	13.72%	2.36%

Table.4 Demographic data (ANOVA)

Source	df	ss	Adj ss	Adj ms	f	p-vaue	Test
Variables	1	12499.3	12499.3	12499.3	1076.8	0.0	Sig.
Age	1	2.8	5.2	5.2	0.49	0.484	No. sig.
Sex	3	42.9	43.8	14.46	1.37	0.252	No. sig.
Group	1	1.5	1.5	1.5	0.14	0.707	No. sig.
Error	233	2474.8	2474.8	10.6			
Total	239	15021.2					

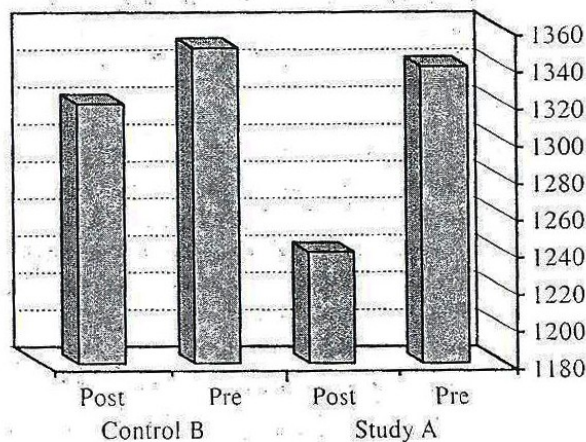


Fig.1 Values of knee flexion pre and post treatment for group A and B in degree

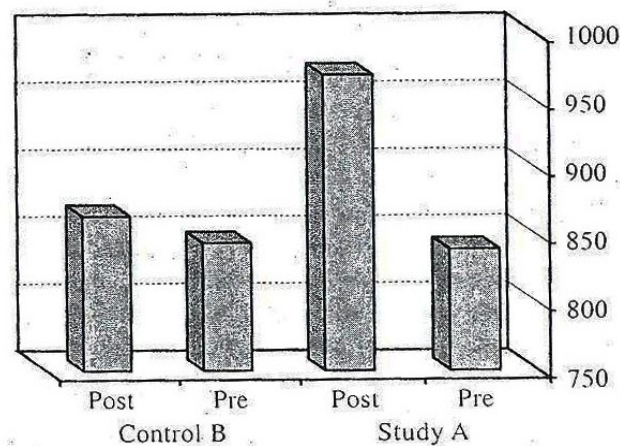


Fig.2 Values of distance between buttock and heel pre and post treatment for group A and B in cm

formation of motor command via tracts to final common pathway (alpha and gamma MN) which provides two motor response (Pharoah 2007).

Internal responses

- Reflexly response via stretch reflex comprises the first response to external perturbation producing contraction of antigravity muscles to regain balance.
- Voluntary response produces highly variable motor output by reaching to nearby stable surface.

- Automatic postural reactions produce prevention from fallen down.

External responses

Ankle strategies produced by small disturbance (forward movement produce forward body sway shifting line of gravity backward produces contraction of paraspinal muscles, hamstring, calf muscles, backward movement produces backward body sway shifting line of gravity anterior produce contraction of abdominal, quadriceps, ant-tibial group.

- *Weight shift strategies:* This moves COG in a lateral plane primarily through activation of hip abductor and adductor muscles,
- *Hip strategy:* Produced by large and fast disturbance. Large rapid forward movement of board lead to backward sway shifting of line of gravity anterior leads to contraction of abdominal, quadriceps and ant-tibial muscles. Large backward movement leads to forward body sway shifting of COG backward produces contraction paraspinal, hamstring and calf muscles.
- *Step strategy:* Produced by large force perturbation leads to forward or backward step to increase BOS to regain balance control. In addition to the effect of balance training on motor control and strengthen of weak muscles, vestibular stimulation will trigger vestibule-spinal tract which affects on alpha motor neuron producing modulation of muscle tone, stimulates also the co-ordination of different parts of the body parts to learn the difficult and new situation to overcome it after that. Heitkamp et al., (2000) studied the gain in strength and muscular balance after balance training which was performed on instability training devices as rolling board and large rubber ball. Strength gain was similar for the flexors and extensors. Affected limbs improve after balance training greater than increase over the strength training group. The results indicate that balance training be effective for gain in muscle strength, equalization of muscular imbalances which may be achieved after balance training.

Goddard et al., (2001) studied the effect of force platform feedback for standing balance training after stroke. There are no significant effects on laboratory

postural sway indicators and clinical measure of functions at follow-up assessment. Force platform feedback improves stance symmetry but not sway in standing, clinical balance outcomes.

Conclusion

Balance training with traditional physiotherapy program should be considered in tightness of muscles and limitation of ROM. The use of balance training program plus traditional physiotherapy program are superior to rebounding exercise plus traditional physiotherapy alone for all measurements that include knee mobility and muscles flexibility after 12 weeks follow-up.

References

- Arnould C., Penta-M. and Thonnard J.: Hand impairments and their relationship with manual ability in children with cerebral palsy. *J. Rehabil. Med.*, 2007 11.39 (9): 708-714. 2007.
- Ashwal S., Russman B.S., Blasco P.A., et al.: "Practice parameter: Diagnostic assessment of the child with cerebral palsy: Report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. *Neurology*, 62 (6): 851-63, 2004.
- Bobath B. and Bobath K.: Motor development in the different types of cerebral palsy. Heinemann medical books, London pp: 12-14, 1975.
- Goddard R., Hain T., Ramasvamy R. and Hilman M: Force platform feedback for standing balance 4, pp:

- 465-498, 2004 training alter stroke. Coherency. Data base. Syst. Rev. 4, pp: 465-498, 2004.
- Groch S and Judit'i L "Medical News: Cerebral Palsy Rates Decline in Very Low Birth weight Children-in Neurology, Genera! Neurology from MedPa»c Today" Med. Page Today, 12-08. 2007.
- Heitkamp H., Horstman T Mayer K and Dick- Ljth L.: Gain in strength and muscular balance after balance training. International J. Sport-Md, May. Vol. 22, pp: 480-4S7, 2001.
- Horak F. and Shupert C.: Role of the vestibular system in postural control. Vestibular rehabilitation. 2nd ed., pp: 98-113, 2000.
- Kllngels K., Cock P., Molenaers G., Desloo- Verb K., Huenaerts C, Jaspers E, et al.: Upper limb motor and sensory impairments m children with hemiplegic cerebral palsy. Can they be measured reliably'. Disabil. Rehabil. 03. 32 (5): 409-416, 2010.
- Mark L. and Latash S.: Neurophysiological basis of movement. Pp.: 59-62, 1996.
- Nieu W.C., Donke R.M., Nieu W.W., Stam ILL and Roebroek M.E.: Experienced problems of young adults with cerebral palsy: Targets fur rehabilitation care. Arch. Phys Med. Rehabil. 11,90(11): 1891-1897, 2009
- Pharoah P.O.: "Prevalence and pathogenesis of congenital anomalies in cerebral Palsy". Arch. Dis. Child. Fetal. Neonatal. Ed., 92 (6): F 489-93, 2007.
- Pharoah P.O: "Risk of cerebral palsy in multiple pregnancies". Clin. Pcnittol, 33 (2): 301-13.2006.
- Steult E., Dekker J., Bouter L.M. and Lam-bregts B.: Occupational therapy for children with cerebral palsy: A systematic review. Clin. Rchabil. 02.18(1): 1-14, 2004.
- Strauss D., Brooks J., Rosen B.R. and Shave- Lle R.: "Life Expectancy in cerebral palsy: An updale". Developmental Medicine & Child. Neurology, 50: 487-93, 2005.
- Van Z.. Miller M. Russo R., Viurch L. and Crotty M: Joint receptor contributions to reflexive and kinesthetic responses. Phys ther; 62(1): 22-29. Noda, R., Maeda, Y., & Yoshino, A. (2004). Therapeutic time window for musicokinetic therapy in a persistent vegetative state after severe brain damage. Brain Injury; 18 (5): 509-515.1961;42:101-105.
- White H., Jen K., Neace W.P., Tylko W.C. and Walker J.: " Original technique for the treatment of ligament-related genu recurvatum: preliminary results. Knee Surg Sports Traumatol Arthrosc; (10): 260-264.