Thera suit Versus Universal Exercise Unit on Muscle Strength and Functional Mobility in Children with Spastic Cerebral Palsy

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ABSTRACT

Background: Impaired muscle strength and functional mobility are common problems facing children with cerebral palsy. Purpose: The purpose of this comparative study was to compare between the effect of universal exercise unit and Thera suit on improving muscle strength and functional mobility in children with diplegic cerebral palsy.**Methods:** Fifty-three children with spastic diplegic cerebral palsy of both sexes aged from five to eight years participated in this study. They were randomly classified into two study groups; A and B. Group A included 27 children received therapeutic exercise program with Thera suit while, group B involved 26 children received the same exercise program in universal exercise unit to improve muscle strength and functional mobility. treatment protocols were conducted Muscle strength of quadriceps and hamstring and functional mobility were assessed before and after treatment by hand-held dynamometer and mobility questionnaire. **Results:** a statistically insignificant differences in quadriceps and hamstring force and mobility questionnaire score between both groups ($p > 0.05$). Conclusion: Both Thera suit and universal exercise unit has the same effect on muscle strength and functional mobility in children with diplegic cerebral palsy.

Key words: cerebral palsy, diplegia, Thera suit, universal unit.

INTRODUCTION

Cerebral palsy (CP) is characterized by the inability to control motor functions, and it has the potential to influence the development of a child by affecting his/her ability to explore, speak, learn, and become independent (1). Spastic diplegia is the most prevalent type of CP. in diplegic CP, spasticity is predominant in the legs and less severely affecting the arms, they can use their upper limbs functionally even with difficulty but spasticity and tightness in certain lower limb muscles namely the hip flexors, hip adductors, knee flexors and ankle planter flexors make the child walks in abnormal crouch pattern with scissoring of the legs (4). Muscle weakness in children with CP is due to reduced central drive, possible abnormal neural maturation, insufficient and disorganized motor recruitment, impaired voluntary control, impaired reciprocal inhibition, altered setting of muscle spindles, and reinforcement of abnormal neural circuits (5).

The universal exercise unit (spider) was developed as an answer to the missing link in rehabilitation. It is used to improve various diseases of mobility and physical deficits caused by disorders of the central nervous system (CNS). Spider helps the child to overcome the gravitational effect on their static and dynamic patterns (6). The spider allows postural stability while promoting independence with security which significantly improves balance and coordination of the body and the performance of the vestibule system. Also, it allows more full use of the patient's strength and abilities (7).

Suit therapy serves as an external skeletal support for children with CP, its major goals are to improve proprioception and to restore proper patterns of movement and posture (8). The studies that compare between the effect of Thera suit and universal exercise unit on muscle strength and functional mobility are still limited. Therefore, the main purpose of this work was to compare between the effect of Thera suit and universal exercise unit on muscle strength and functional mobility in children with diplegic CP.

MATERIALS AND METHODS

Participants: A sample of Fifty-three children diagnosed as diplegic CP that was obtained from their medical records and confirmed by radiological examination and neurologist from both sexes and ranged in age between five to eight years were selected from Outpatient Clinic of Hadaek Helwan hospital participated in this study, Their inclusion criteria included: The degree of spasticity of lower limb muscles ranged from 1 to 1+ according to Modified Ashworth Scale (9). The children were at level III on Gross Motor Function Classification System (GMFCS) (10) and they were able to understand and follow instructions of evaluation and treatment procedures. Participated children were excluded if they had any of the following; fixed deformities in lower extremities, spinal or postural deformities, previous orthopedic operations or botulinum toxin injection in leg muscles within 6 months prior to program,visual or auditory defect that affect performance of children or mental retardation.. Approval by the Ethical Committee of the Faculty of Physical Therapy, Cairo University (P.T.REC/012/001464) at (6/12/2016) and written consent forms from parents of children, were obtained before the beginning of the study.

Sample size

The sample-size calculation showed that 53 subjects was needed in this study at an alpha level of 0.05 with 80% power and large effect size. Sample size calculation was performed pri

or to the study using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany).

Study Design, Randomization and blinding

This study was a comparative study that was conducted from January 2017 to December 2017. Sixty diplegic children were screened for participation in the current study. Five children were excluded as they didn’t fit the inclusion criteria and parents of two children refused to participate in the study. The remaining fifty-three children were randomly allocated into two groups; group A who received a designed physical therapy program while using Thera suit and group B who received the same designed program while using universal exercise unit rather than thera suit. Flow of participants was demonstrated through a flow chart which based on Consolidated Standards of Reporting Trials (CONSORT) (Figure 1).

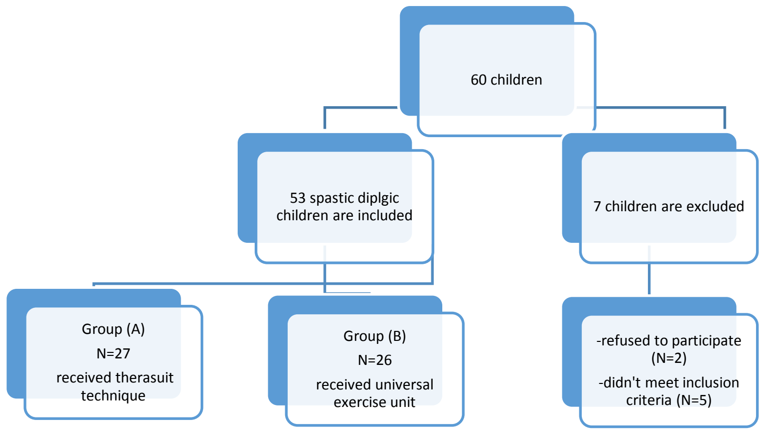

Figure 1. Flow chart for the selection of participants.

Procedures

Measurement Procedures:

1-Measurment of muscle strength:

Using Handheld dynamometer was used for measuring muscle strength. of quadriceps and hamstring muscles as follows :

- For quadriceps muscle:

Child was asked to sit on a chair with flexed knee 90 degree and to extend his/her knee putting handheld dynamometer against his leg anteriorly and the average of three measurements were taken (12).

- Hamstring muscle:

Child was lying prone with leg straight with extended hip and knee then he /she was asked to bend his/her knee while putting handheld dynamometer against his/her leg posteriorly on calf muscle and the average of three measurements were taken

2-Measurment of functional mobility:

Evaluation of functional mobility was performed by using Mobility Questionnaire (Mob Quest 28), it consists of a rating scale on which the parents score the amount of difficulty their child experiences in the execution of mobility activities.. The advantage of this questionnaire over existing mobility measures for this population is that information is provided about the functional mobility of the child in his/her own home environment. The Mobility Questionnaire showed good reliability and content and construct validity (13).

B) Treatment procedures:

For group A:

The children received a designed physical therapy program while wearing Thera suit. It was individualized, according to the child's abilities and conducted for three times per week over twelve consecutive weeks. The treatment program involved the following sets of exercises (getting to high kneeling position from prone lying position, getting to half kneeling position from high kneeling position, standing holding on with both hands from half kneeling, standing from half kneeling without support , stoops and recovery, standing weight shift and stepping) (14). Each exercise was done for 10 minutes Thera suit is consisted of a vest, shorts, knee pieces, and special shoes with hooks to attach cords. This suit also, used bungee cords, which were designed to produce gentle tension like the tension produced by elongation and shortening in human muscles. Thera suit was designed in way that the placement of the bungee cords can assist weak muscles or strengthen weak muscles. The bungee cords placement can also correct abnormal body positions or movement patterns from non-structural sources) (15).

For group B:

Children in this group received the same program as group A in universal exercise unit. The treatment program was conducted at frequency of three times per week over twelve consecutive weeks. Universal exercise unit consists of several elastic cords of different elasticity attached to three points on each side attached to patient's waist belt at one end and to the different points on the surrounding construction on the other one. It allows independency and controlled movement also; it improves the strength of affected parts of the body (16). The patient was suspended in the middle of the cage with unique support received through the elastic cords. This type of support was extremely dynamic and provided just the right amount of support needed. This allowed the patient to perform any movement or functional skill virtually "independent".

Data analysis

All statistical analyses were performed using IBM SPSS statistical package version 25 for Windows (IBM SPSS, Chicago, IL, USA). Mean, standard deviation and frequencies were calculated for descriptive statistics. Statistical significance was defined as P < 0.05. Subject characteristics were compared between groups using t-test and Chi-squared test was used for comparison of sex distribution. Shapiro-Wilk test was used to check the normal distribution of data and Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Within and between group comparison were carried through mixed design MANOVA. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison.

- Subject characteristics: Subject characteristics of both groups were summarized in table 1. There was no significant difference in the mean age, weight and height between both groups (p > 0.05). Also, there was no significant difference in sex distribution between groups (p = 0.32).

Table 1. demographic data for patients in both groups between group A and B.

	Group A	Group B			
	x̄±SD	**x̄±SD**	**MD**	**t- value**	**p- value**
Age (years)	6.92 ± 1.17	6.65 ± 1.23	0.27	0.82	0.41
Weight (kg)	21.18 ± 3.36	20.88 ± 3.7	0.3	0.31	0.75
Height (cm)	112.33 ± 13.96	111.73 ± 16.48	0.6	0.14	0.88
Boys/girls	14/13	10/16		($\chi2$ = 0.95)	0.32

x̄, **Mean; SD, Standard deviation; MD, Mean difference; χ^2, Chi squared value; p value,**

Probability value

<u>Effect of treatment on quadriceps force, hamstring force and MobQuest score:</u>

Mixed MANOVA revealed that there was non-significant interaction of treatment and time (Wilks' Lambda = 0.92; F (3,49) = 1.25, p = 0.3). There was a significant main effect of time (Wilks' Lambda = 0.07; F (3,49) = 193.61, p = 0.001). There was no significant main effect of treatment (Wilks' Lambda = 0.96; F (3,49) = 0.57, p = 0.63). Table 2 showed descriptive statistics of quadriceps force, hamstring force and MobQuest score as well as the significant level of comparison between groups and the significant level of comparison between pre and post treatment in each group.

- Within group comparison:

There was a significant increase in quadriceps force, hamstring force and MobQuest score post treatment compared with that pretreatment in the group A and B (p < 0.001). The percent of increase in Quadriceps force, hamstring force and MobQuest score in the group A were 33.61, 26.17 and 19.11% respectively, while that in the group B were 29.77, 30.08 and 15.78% for Quadriceps force, hamstring force and MobQuest score respectively. (table 2).

- Between groups comparison:

There was no significant difference in quadriceps force, hamstring force and MobQuest score between both groups pre-treatment (p > 0.05). Comparison between both groups post treatment revealed a non-significant difference in quadriceps force, hamstring force and MobQuest between groups (p > 0.05). (table 2).

Table 2. Mean quadriceps force, hamstring force and MobQuest score pre and post treatment in group A and B.

	Group A	**Group B**		
	$\bar{x}$ ± SD	**$\bar{x}$ ± SD**	**MD**	**p value**
Quadriceps force (lb)				
Pre treatment	19.4 ± 2.83	18.88 ± 3.5	0.52	0.55
Post treatment	25.92 ± 2.96	24.5 ± 3.6	1.42	0.12
MD	-6.52	-5.62		
% of change	33.61	29.77		
	p = 0.001*	***p = 0.001****		
Hamstring				

force (lb)				
Pre treatment	16.7 ± 2.74	15.96 ± 3.2	0.74	0.36
Post treatment	21.07 ± 2.78	20.76 ± 3.53	0.31	0.72
MD	-4.37	-4.8		
% of change	26.17	30.08		
	p = 0.001*	***p = 0.001****		
MobQuest score				
Pre treatment	68.03 ± 8.81	67.57 ± 10.28	0.46	0.86
Post treatment	81.03 ± 10.6	78.23 ± 11.95	2.8	0.37
MD	-13	-10.66		
% of change	19.11	15.78		
	p = 0.001*	***p = 0.001****		

$\bar{x}$, mean; SD, standard deviation; MD, mean difference; p-value, probability value; *, significant

DISCUSSION

The aim of this study was to The current study was conducted to compare between the effect of Thera suit and universal exercise unit on muscle strength and functional mobility in children with spastic diplegic CP.

The current result showed that there was a significant improvement in quadriceps and hamstring force and functional mobility post treatment compared with that pretreatment in the group A and B. While, there were non-significant differences in quadriceps and hamstring force and functional mobility between both groups.

The significance improvement in all measured outcomes in group A maybe due to the effect of Thera suit on improving muscle strength via facilitating strong afferent proprioceptive input which in turn improve muscle strength and functional mobility.This come in agreement with Alagesan (17) who demonstrate that Thera suit is highly effective in improving muscle strength and gross motor function of children with spastic diplegic CP.

Suit therapy provides external stabilization, aligns the body to as close to normal as possible, normalizing gait pattern, providing tactile stimulation, supports weak muscles, providing resistance to strong muscles to further enhance strength, helping to decrease contractures and improving coordination (18).

The significant improvement in muscle strength and functional mobility in group B is due to effect of universal exercise unit. It improve muscle strength and range of motion by elimination effect of gravity on their static and dynamic patterns and improves coordination of movement by overcoming the gravitational effect since this treatment gives postural stability while promoting independence with security which significantly allows more full use of the patients strength and abilities(19).

The current results regarding universal exercise unit are supported by the opinion of Johnson and Bonner (20) who demonstrate that universal exercise unit is used to obtain measurable gains in muscle strength and flexibility.

The universal exercise unit enables independent and controlled movement as well as strengthening of the affected part of the body (21).

The current study has some limitations such as; the absence of follow-up for participants which may restrict the application of our results only on the short term effect of Thera suit or universal exercise unit modalities. Additionally, the children who participated in this study were restricted to one type of CP with the age group from five to eight years and level three of GMFCS. So, similar studies are needed on other types of CP with different levels on GMFCS.

CONCLUSION

Both Thera suit and universal exercise unit can be used as an effective modality to improve muscle strength and functional mobility in children with spastic diplegic CP.

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