Effect of progression from hydrotherapy to land-based exercise on balance in children with hemiparetic cerebral palsy

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Abstract

Background: Cerebral palsy (CP) is a disorder of movement and posture caused by damage to the motor cortex, Hemiplegic cerebral palsy is a type of cerebral palsy that results from damage to the part (hemisphere) of the brain that controls muscle movements. The consequences of chronic muscle imbalance and the resultant deformities may be leading to increasing disability with age, that also characterized by abnormalities of motor activity, posture and balance. In CP children, voluntary movement that should be complex, coordinated, and varied is instead uncoordinated, stereotypic, and limited. Simple actions that are performed unconsciously by unaffected individuals require marked effort and concentration and often fail in patients with CP. **Aim of the study**: This study designed to study the effect ofprogression from hydrotherapy to land based exercises program on balance in hemipareticcerebral palsy children. **Subjects and Methods:** Thirty children with hemiparetic cerebral palsy from both sexes (16 boys and 14 girls). Their ages ranged between 5-10 years, were assigned into two equal groups: progression from under water to land based intervention group and land based exercises group. Balance was assessed by Biodex Balance System while Gross Motor Function Scale used to assess patient motor functional improvement. Treatment program was conducted for 3 successive months/3 sessions /week. Evaluation for each child in both groups was done before, intermediate and after the conduction of treatment program. **Results**: Significant difference was recorded between post treatment mean values of the two groups after treatment in favor of underwater intervention group. **Conclusion**: The obtained results suggested that progression from underwater exercises therapy to land based exercise therapy is effective to improve balance in children with hemiparetic cerebral palsy.

Key words: Cerebral palsy –Hydrotherapy– Balance.

Introduction

Cerebral palsy is the most common childhood-onset physical disability with varied impact on daily activities and participation, that may occur before, during or shortly after birth resulting in delaying in normal activates and weak balance(1).

In disabled children's, an attempted voluntary movement may evoke a primitive reflex, co-contraction of agonist and antagonist muscles, and mass movements [(2)]. Hemiplegic cerebral palsy children characterized by stiffness and weakness in muscles on one side of the body, difficulty with walking and balance, delay in reaching expected developmental milestones such as rolling over, sitting up, crawling or walking [(3)]. Balance recovery limitation in hemiplegic children contributing to delayed responses of ankle muscles, inappropriate sequencing; and increased co activation of agonists/antagonists. Proper muscle response organization and reduced co-contraction of after training help to improve balance recovery [(4)]. Hydrotherapy can refer to pool therapy or exercise in warm water, which usually called hydrotherapy [(5)]. Water offers a unique medium in which reduced gravity, hydrodynamic forces and the viscous properties act on the exercising body [(6)].

Therefore, the purpose of this study was to compare between the balance improvement in both progressions from underwater to land based treatment program and land based treatment program.

Subjects, Materials and Methods

Thirty hemiparetic cerebral palsy children aged from 5 to 10 years participated in this study. They were selected from the outpatient clinic of National Institute of Neuromotor System in the period from March 2016 to November 2016. Children were assigned to either study or control group by opening an opaque envelop prepared by an independent subject with random number generation.

Subject'sparents signed a written consent form approved by Ethics Committee of the Faculty of Physical Therapy, Cairo University, before the children participated in the study.

A-inclusion criteria:

Children's age was ranged from 5 to 10 years, their height was at least one meter, they were able to stand and walk alone, they were only grade 1 or 1+ spasticity, they were medically and clinically stable, they were able to understand and follow instructions.

Exclusion criteria:

Children who suffers from any problem that may affect results at the end of the study were excluded from the study, problems: Cardiac diseases, Mental retardation, Autistic children, Open wounds, visual or hearing defect, Fractures, hypermobile or painful joints., Convulsions and any contraindications for aquatic therapy.

Under water group included 15 children (7 boys and 8 girls), Land–based exercises group included 15 children (9 boys and 6 girls). Children in both groups participated in the study for 3 months/ 3 sessions/week, and each session lasted for one hour

Instrumentation

For patient's selection Modified Ashworth scale was used to evaluate the degree of spasticity (grade 1 or 1+) and Weight and Height scale (at least 1 meter) while balance was assessed usingBiodex Balance System(all children assessed at level 8) and Gross Motor Function Scale was used to assess motor functional improvement.

- For treatment

- Swimming pool, water balance board, underwater plinth,life jackets, floating toys, ball, different sizes of mats, wedges, rolls, foamboard, stand bar, movable chair, landbalance board.

Procedures

- For treatment: Study group:

Children in this group were received 2 months of hydrotherapy exercise followed by 1 month of land based exercise.Hydro therapy program for two months as the following:

A: Strengthening exercise for weak muscle (15 min).

B: Stretching exercise for shortening muscle (15 min).

C: Balance training program (30 min).

1- Warming up exercise including (Breathing exercises, Range of motion exercises for affectedsideand Floatingexercises).

2- Training program [7]:

- Balance training from sitting (counter reaction),
- Balance training from standing (Single limb weight bearing, distribution of balance duringstanding, bendsideway, turn to right, turn to left).
- Balance training from static positions (Quadruped position, kneeling position, half kneeling position).
- Balance training during walking (Walking forward, walkingsideward, walking backward).
- Strengthening exercise (Squat to stand, get to stand from kneel sitting, stepup, stepdown, Push leg side way).
- Stretching exercise of shortening muscles.
- Upper limb training exercise.
- Cooling down: prepare for come out of pool.
- Graduation of difficulty through:Change level of immersion(by increase body immersed in water exercise come easier),move from using water from assistance to free to resistance, decrease base of support, change in speed of movement (the slower the easier of movement)[8].

Fig (1) underwater exercise from quadruped position

- After 2 months patient progressed to land based exercise (the same training program but in land) for 1 month.

Control group:

Children in this group were received the same program but in land for 3 months.

Results

Data were statistically analyzed using SPSS program (version 20) and applied the following tests:

1- Analysis of variance (ANOVA Test) to compare within each group among pre-treatment, intermediate treatment and post treatment.
2- Independent t-test to compare between two groups before and after treatment.
3- Significance level at 0.05 was used throughout all statistical tests within this study.

C.1. Overall stability index:

Table (1): $\bar{X} \pm SD$ Values of stability index in study group.

Items	Stability index		
	Pre	Intermediate	Post
Mean ± SD	2.26 ±0.44	1.69 ±0.43	1.48 ±0.48
Minimum to Maximum	1.30 – 2.90	1.10 – 2.60	0.90 – 2.40
Mean difference	———	-0.57	-0.78
Improvement %	———	-25.22%	-34.51%
F-value	10.409		
P-value	0.0001		
Significance (P<0.05)	HS		

Table (2): $\bar{X} \pm SD$ Values of stability index in control group.

Items	Stability index		
	Pre	Intermediate	Post
Mean ± SD	2.06 ±0.43	1.64 ± 0.46	1.52 ±0.46
Minimum to Maximum	1.40 – 2.70	1.30 – 2.40	1.10 – 2.70
Mean difference	———	-0.42	-0.12
Improvement %	———	-20.39%	-26.21%
F-value	4.620		
P-value	0.017		
Significance (P<0.05)	S		

Table (3): Comparison between overall stability index in study group and control group.

Items	Stability index		
	Pre	Intermediate	Post
Study group	2.26 ±0.44	1.69 ±0.43	1.48 ±0.48
Control group	2.06 ±0.43	1.64 ± 0.46	1.52 ±0.46
t-value	1.153	0.237	0.210
P-value	0.261	0.815	0.836
Significance (P<0.05)	NS	NS	NS
Study group improvement %	———	-25.22%	-34.51%
Control groupimprovement %	———	-20.39%	-26.21%

Growth Motor Function scale:

Table (4): $\bar{X} \pm SD$ Values of GMFCs in study group.

Items	GMFCs		
	Pre	Intermediate	Post
Mean ± SD	81.92 ±3.85	84.04 ±3.80	85.15 ±4.08
Minimum to Maximum	75.00 – 87.00	76.00 – 88.00	76.50 – 91.00
Mean difference	———	2.12	1.11
Improvement %	———	2.59%	3.94%
F-value	3.284		
P-value	0.011		
Significance (P<0.05)	S		

Table (8): $\bar{X} \pm SD$Values of GMFCs in control group.

Items	GMFCs		
	Pre	Intermediate	Post
Mean ± SD	80.83 ±3.77	80.21 ±7.75	84.63 ±3.57
Minimum to Maximum	75.00 – 86.00	58.5 – 88.00	78.5 – 89.5
Mean difference	———	-0.62	3.80
Improvement %	———	-0.64%	4.70%
F-value	3.356		
P-value	0.0174		
Significance (P<0.05)	S		

Table (15): Comparison between GMFCs in study group and control group.

Items	GMFCs		
	Pre	Intermediate	Post
Study group	81.92 ±3.85	84.04 ±3.80	85.15 ±4.08
Control group	80.83 ±3.77	80.21 ±7.75	84.63 ±3.57
t-value	0.713	1.587	0.343
P-value	0.483	0.126	0.735
Significance (P<0.05)	NS	NS	NS
Study group improvement %	———	2.59%	3.94%
Control groupimprovement %	———	0.64%	4.70%

DISCUSSION

This study conducted in agree with the **fletcher**[9] who said the ability to maintain static and dynamic balance increased after aquatic and land-based training, but the results of comparing aquatic training with land-based were inconsistent. Choosing the sample suffering from hemi paretic cerebral palsy and assessment of their balance come in agreement with**flodmark**[10]who stated that child with hemiparetic cerebral palsy difficulty with walking and balance also they have a shorter step length on the affected side and more stiffness when compared with normal child in the same age .

There is no significance difference was reported when comparing the pre-treatment mean values of measuring variables of both study and control group in bothbiobex results or GMFCS this was due to the same criteria in the patient selection and confirm the homogeneity of all groups member.

The results of the present study after the period of treatment showed significant improvement in the measuring variables of both study and control group comparing with their pre and intermediate and post treatment mean values but the more improvement noticed in the study group who received hydrotherapy.

Results of biodex balance system showed significant improvement in stability index mainly in children who receive the hydrotherapy also there is significant improvement in stability index and Medio lateral index and anteroposterior index in children who receive the land based program.

Results ofGross motor function scale showed therewas significant improvement in both groups mainly in study group

Results come in agree with **Lorena and Xavi**[11]who said that resistance offered by water is greater than that experienced on dry land and this greater resistance of water compared with that of air is due not only to its density, but also to its dynamic viscosity. He also added that exercising in water produces an increase in cardiac output, in the blood flow to muscles, and in the diffusion of metabolic waste products from muscle to blood, as well as a reduction in the time it takes to transport oxygen, nutrients, and hormones to fatigued muscles.

This results come in agree with **O'Connor**[12] that found that the buoyancy of water decreases the influence of gravity and provides increased postural support and these characteristics may allow children with CP to exercise in water with more freedom than on land while the resistive forces of buoyancy and viscous drag permit a variety of aerobic and strengthening activities that can be easily modified to accommodate the wide range of motor abilities of children with CP.

Asimenia et al[13]showed that 6-week balance training programs improved all balance performance indicators including total stability index, anteriorposterior index, medial-lateral index, and targets in both aquatic and land groups, but there was no significant group by time interaction.

There is significance improvement of gross motor in both group but it more improved in group that receive hydrotherapy that also may be due to the properties of water that come in agree with **wallcott**[14].

Conclusion:

Based on our findings, both underwater and land based exercises may be useful for children with hemiparetic cerebral palsy for improving balance. progression from Underwater exercises to land based exercise is an amazing form of exercises for children with hemiparetic cerebral palsy because it has a unique properties of water that reduces pain, assist movement, train weak muscle, represent playing activities, and enhance physiological output and psychological mood for children.

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