

Research

The Effect of Hydrotherapy- Halliwick Concept on the Respiratory System of Children with Cerebral Palsy

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Abstract

Aim

The aim of this study is to investigate the effect of Hydrotherapy on the respiratory system of children with cerebral palsy (CP). The effect of Hydrotherapy on both the myoskeletal system of children with cerebral palsy and the respiratory system of children with a variety of issues (cystic fibrosis, asthma, myopathy, scoliosis) has been extensively investigated. However, not many studies have investigated the effect of Hydrotherapy on the respiratory system of children with C.P.

Method

In this study 10 children were used. The participants, aging from 5 to 15 years of age, had a diagnosis of C.P. and participated in a Hydrotherapy program one time per week for 45 minutes, for two months. The respiratory function was measured with a spirometer, a flow-meter and a pulse oximeter. Moreover, the adjusted to Greek assessment form Swim with Independent Measure (SWIM) of the International Halliwick Association, was completed, assessing the child's progress in controlling their respiration under water. In addition, the adjusted to Greek assessment forms Water Orientation Test Alyn 1 (WOTA1) and Water Orientation Test Alyn 2 (WOTA2) were used. The measurements and forms were conducted 2 times during the time of this study, once in the beginning (pre-test) and once after the completion (post-test)of the program.

Results

9 out of the 10 children concluded the study and only one subject were excluded due to an allergic reaction. All statistical analysis was performed using SPSS v. 16. The results indicated a statistically significant difference between the assessments forms used.

Conclusions

The results of this study showed that Hydrotherapy exhibits a positive effect on the respiratory system of children with CP. Further investigation is advised in order to investigate the effect in a longer period of time.

Keywords: Cerebral Palsy; Respiratory Function; Hydrotherapy; Therapeutic Swimming; Lung Diseases; Halliwick; Swim Test; WOTA1; WOTA2

Introduction

CerebralPalsy

Definition

Blair and Stanley mentioned a progressive developmental disability of posture and movement which is attributed to the injury “of the immature brain [1]. CP is a persistent but not unchanging disorder of movement and posture due to a non-progressive disorder of the

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brain”[2]. In 1990, Bax talked about a general definition that includes a group of ever-changing conditions [3]. According to Panteliadis and Syrigou-Papavassiliou, CP is one of the most common congenital or acquired neurological disorders [4].

History and Frequency of Appearance

CP was already known since the 4th-5th century B.C., when Hippocrates first mentioned the causes of the disorder. Later, Freud talked about the term “brain diplegia” and categorized the causes in congenital, intrapartum and postpartum, while he, also, described in detail the motor disorders in children [5]. The frequency of appearance for the disorder has been identified at 2.0- 2.5/1000 living neonates and has been associated to the weight of the new-born [6]. Crothers and Paine created a model of classification based on the functional characteristics of the American Academy for Cerebral Palsy and Developmental Medicine that classified CP in two groups: 1) pyramidal (spastic) and 2) extrapyramidal (non-spastic) [7].

Therapeutic Swimming and Hydrotherapy

The term Hydrotherapy refers to the use of water as a means of therapy and rehabilitation [8]. Hydrotherapy is used on children with neurodevelopment disorders such as: CP, Prader-Willy syndrome, Spinal Muscular Atrophy, Developmental retardation, juvenile rheumatoid arthritis, Rett syndrome, Autistic spectrum disorders, Asperger’s syndrome [9].

Hydrotherapy is a type of Physiotherapy and includes the submersion of the whole or part of the body underwater in order for the movements to be conducted either passively via thermal, mechanistic or chemical pressure of the water or actively via therapeutic exercises (hydrokinesiotherapy) [8].

The Therapeutic Exercises Include

1. Strengthening exercises
2. Stretching exercises
3. Respiratory/Ventilating exercises
4. Control of posture and balance exercises
5. Walking training
6. Relaxation exercises [8].

Therapeutic swimming and Hydrokinesiotherapy are distinct terms.

Therapeutic swimming is not a form of physiotherapy but rather a method of swimming training. Hydrokinesiotherapy is a physical education program which promotes autonomy, movement, physical and psychological well-being, entertainment, sociability, general health and swimming performance [8].

The Benefits of Hydrotherapy on CP Include

1. Increases the heart and respiratory $\epsilon\nu\theta\rho\alpha\nu\psi\epsilon$
2. Facilitates the breathing control
3. Increases strength
4. Improves coordination
5. Improves swimming competences
6. Offers support without burdening the unstable joints
7. Enables the usage of muscles that are restricted by gravity
8. Improves self-esteem and self-aware [10].

Halliwick

James and Phyl McMillan, in 1949 developed a teaching method in order to teach swimming to a group of disabled girls, called the Halliwick Penguins. Although, the Halliwick philosophy was first used as a teaching method for swimming it was later adjusted in order to be used as a therapeutic method for improving motor and cognitive abilities as well as for the rehabilitation of adults and children [11].

The Basis of the Halliwick Philosophy is a 10 Point Program

1. Mental adjustment in water
2. Disengagement
3. Transversal Rotation Control
4. Sagittal Rotation Control
5. Longitudinal Rotation Control
6. Combined Rotation Control
7. Upthrust or Mental Inversion
8. Balance in Stillness

9. Turbulent Gliding

10. Simple Progression and Basic Swimming Movement [11].

The Therapy within the Halliwick Program Can Be Classified In 3 Stages

1. Preparation stage

2. Balance Control

3. Movement stage [8].

Through the Halliwick Method 7 Aims can Bbe Achieved

1. Muscle strengthening

2. Increase the confort zone of movements

3. The facilitation of posture and balance

4. The improvement of the general well-being

5. The decrease of pain

6. The decrease of spasm movements

7. The improvement of the mental adjustment in water and exercise

The Activities within the Halliwick Program can be Classified in 8 Groups

1. Entrance and exit from water

2. Respiration control

3. Orientation while moving in water

4. Sagittal rotation control

5. Transversal rotation control

6. Combined rotation control

7. Turbulence

8. Submersion [11].

Respiratory Problems in CP

In CP the respiratory system is directly affected while the pulmonary function is indirectly affected. The neuromuscular disorder of the disease can cause pulmonary dysfunction. The deformation of the thoracic wall (due to the spasms of CP) leads to limited airway cleaning and limited respiratory reservoir [12]. The patients with CP often exhibit respiratory problems including pneumonia, atelectasis, bronchiectasis and chronic respiratory problems [13].

Methods

Participants

Children participated in this study, aging from 5 to 15 years old, with a diagnosis of CP. 3 of the 10 subjects had a diagnosis of spastic quadriplegia, 1 child had hypotonia, 2 children had hemiplegia and the rest (4) had spastic diplegia. 5 out of 10 subjects were transporting with the support of their parents or with a wheelchair in the instances of long outdoor distances. 9 out of the 10 subjects have been on Halliwick Hydrotherapy programs for over 2 years and were being instructed by highly qualified personnel. Only one subject started the program this year for the first time. Parents were present during the course of the treatment and measurements and they signed a consent form supplied by the researcher. (Table 1.)

Sex	Age	Diagnosis	Hydrotherapy	Others therapies
Male	7	Spastic Quadriplegia	1 a week	3 times a week Physical Therapy 2 times a Week Occupational Therapy 2 times a week Speech Therapy
Female	10	Spastic Diplegia	1 a week	3 times a week Physical Therapy
Male	6	Hypotonia	2 a week	2 times a week Physical Therapy 2 timew a week Occupational Therapy 2 times a week Speech Therapy 1 a week Therapeutic Horseriding
Female	9,5	Spastic Diplegia	1 a week	No
Male	5	Spastic Quadriplegia	1 a week	2 times a week Physical Therapy 2 times a week Occupational Therapy
Female	6	Spastic Hemiplegia	1 a week	2 times a week Physical Therapy 2 times a week Occupational Therapy 2 times a week Speech Therapy
Male	15	Spastic Quadriplegia	1 a week	Unknown
Male	5	Spastic Diplegia	1 a week	2 times a week Physical Therapy 2 times a week Speech Therapy
Male	6	Spastic Hemiplegia	1 a week	1 a week Physical Therapy 1 a week Occupational Therapy
Female	6	Spastic Hemiplegia	1 a week	2 times a week Physical Therapy 1 a week Occupational Therapy

Table 1

Design of Study

The selection criteria for this study included children with CP, aging 5 to 18 that were taking part in Hydrotherapy sessions. The children that had surgery scheduled and would miss a substantial part of their therapeutic program were excluded. Children missing a lot of sessions for other reasons were excluded as well on the same principle. Finally, children that continued their Hydrotherapy program during the summer were also excluded because in order for the measurements of the study to be submissable, a minimum period of 1 month absence from Hydrotherapy was needed.

The subjects of the study participated in Hydrotherapy programs once per week for 45 minutes for one month and were individually instructed by Halliwick qualified personnel. The children were familiar with their therapists from the beginning of the program sessions.

Hristara et al says that evaluation of the assessment of pulmonary function is made for better control of treatment through special examinations like:

1. MRIs
2. SaO2

3. Sallow Assessment
4. Measurment FEV1
5. Measurment PEFR [14].

In this study, the respiratory function was measured with a spirometer, a cardiovascular blood flow-meter and a pulse oximeter. More specifically, the volume of air exhaled at the end of the first second of forced expiration (FEV1) and its percent was measured with a Carefusion Pulmolife spirometer. Subsequently, the saturation of oxygen (SPO2) and the heart rate (HR) were measured with a GIMAOXY- 4oximeter. Finally, with the Carefusion MicroPeak flow meter, the peak expiratory flow rate (PEFR) was measured.

Moreover, the SWIM assessment report form from the International Halliwick Association was completed which assesses the improvement on the child's respiratory control under water. The Water Orientation Test Alyn 1 (WOTA1) and Water Orientation Test Alyn 2 (WOTA2) forms were completed, as well. The above mentioned forms were based on the Halliwick philosophy and were used on swimmers with functional and cognitive limitations. These forms have been translated and adjusted to the Greek population [15]. The measurement and the completion of the assessment reports were conducted twice during this study, once in the beginning (pre-test) and once in the end (post-test) of the therapeutic program, one month later.

Results

The statistical analysis of the measurements that was done by the pairedt- test on SPSS v. 16 showed a statistically significant result of Hydrotherapy on the respiratory condition of the subjects of this study. In the final statistical analysis only the measurements of the 8 out of the 10 children of the intervention were used.

Before the intervention it was shown that the mean heart rate was 93,87 (HRpre= 93,87), the mean oxygen saturation was 93,25 (SPO2pre= 93,25), the mean peak expiratory flow rate was 103,75 (PEFRpre=103,75), the mean air volume exhaled at the end of the first second of forced expiration was 22,75 (FEV1pre= 22,75) while the mean percent of exhale volume was 0,86 (FEV1Ppre= 0,86). (Table 2.1)

After the intervention the mean heart rate was found 120,25 (HRpost= 120,25), the mean oxygen saturation was 97,12 (SPO2post= 97,12), the mean peak expiratory flow rate was 131,25 (PEFRpost= 131,25), the mean air volume exhaled at the end of the first second of forced expiration was 24,75 (FEV1post= 24,75) and the mean percent of exhale volume was 0,96 (FEV1Ppost= 0,96). The statistical analysis showed that the heart rate and the oxygen saturation exhibit statistically non-significant weak correlation for the pre and post intervention measurements. On the other hand, the peak expiratory flow rate (PEFR), the volume exhaled after forced expiration (FEV1) and its percent (FEV1%) exhibit a strong positive statistically significant correlation between the pre and post intervention measurements. (Table 2.2)

Moreover, it was shown that the intervention had a positive statistically significant effect on the respiratory system of the subjects in this study. More specifically, the mean heart rate (HR) with $t(7) = 3,550$ ($p < 0,05$), the mean oxygen saturation (SPO2) with $t(7) = 2,832$ ($p < 0,05$), the mean percent of volume air exhaled after forced expiration (FEV1%) with $t(7) = 2,427$ ($p < 0,05$) and the mean peak expiratory flow rate (PEFR) with $t(7) = 4,158$ ($p < 0,05$) were significantly increased. The mean of volume exhaled after forced expiration (FEV1) does not seem to have changed significantly with $t(7) = 2,075$ ($p = 0,77$). (Table 2.3)

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	HRpre	93,8750	8	24,58477	8,69203
	HRpost	120,2500	8	13,54094	4,78745
Pair 2	SPO2pre	93,2500	8	3,84522	1,35949
	SPO2post	97,1250	8	1,35620	,47949
Pair 3	PEFRpre	103,7500	8	45,09910	15,94494
	PEFRpost	131,2500	8	60,75419	21,47985
Pair 4	FEV1pre	22,7500	8	15,10676	5,34105
	FEV1post	24,7500	8	14,20010	5,02049
Pair 5	FEV1Ppre	,8675	8	,53240	,18823
	FEV1Ppost	,9688	8	,56032	,19810

Table 2.1. Paired Samples Statistics

		N	Correlation	Sig.
Pair 1	HRpre & HRpost	8	,520	,187
Pair 2	SPO2pre & SPO2post	8	,158	,710
Pair 3	PEFRpre & PEFRpost	8	,981	,000
Pair 4	FEV1pre & FEV1post	8	,985	,000
Pair 5	FEV1Ppre & FEV1Ppost	8	,978	,000

Table 2.2: Paired Samples Correlations

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	HRpre - HRpost	-26,37500	21,01658	7,43048	-43,94530	-8,80470	-3,550	7	,009
Pair 2	SPO2pre - SPO2post	-3,87500	3,87068	1,36849	-7,11097	-,63903	-2,832	7	,025
Pair 3	PEFRpre - PEFRpost	-27,50000	18,70829	6,61438	-43,14052	-11,85948	-4,158	7	,004
Pair 4	FEV1pre - FEV1post	-2,00000	2,72554	,96362	-4,27861	,27861	-2,075	7	,077
Pair 5	FEV1Ppre - FEV1Ppost	-,10125	,11801	,04172	-,19991	-,00259	-2,427	7	,046

Table 2.3

Regarding to the International Halliwick Association SWIM assessment form, there were no changes in the control of children’s breathing in the water during two months of the intervention program. Also, WOTA1 and WOTA2 forms did not saw any changes too. It is worth noting that heavily infantile children have scored less in the above forms as they have had difficulty coordinating their breathing (inhale-exhale). Finally, all children in the research found it difficult to get rhythmic breathing.

Discussion

Measurements of the 8 out of the 10 children of the study were able to be included in the statistical analysis. 2 children were excluded from the study as one child developed an allergic reaction from the water and the cooperation with the second one was difficult and ineffective. The results showed statistically significant results for the heart rate (HR), the oxygen saturation (SPO2), the peak expiratory flow rate (PEFR) and the percent of the volume after forced expiration per second (FEV1 %). The results for the volume after forced expiration per second (FEV1) were not found statistically significant. Consequently, Hydrotherapy may have positive effects on the respiratory system of children with CP, in companion to physiotherapy.

Hutzler and his colleagues in 1998 studied the effects of motion and swimming on the vital capacity and swimming skills of children with CP. They concluded that exercise and bathing programs had better respiratory performance than traditional intervention programs in children with CP.

Also, Pikham-Fragala Maria and her associates in 2008 studied the effect of aerobic exercise on water in children with difficulties and concluded that significant improvement in heart rate and cardiac resistance

A year later, in 2009, Retarekar and his colleagues studied the effects of Hydrotherapy in children with CP. They talked about a case study. A girl aged 5 years and diagnosed with spastic diplegia and level 3 on the GMFCS scale participated in the study.

The results showed that the strength and speed of the girl increased significantly.

Dragos Adrian and his colleagues in 2013 conducted a study to research the effect of hydrotherapy on vital capacity, quality of life and physical activity in children with CP. After the 6-month intervention, an increase in vital capacity was observed by 56, 7% of the original prices.

So it seems from the limited research studies that exist, the researchers agree with our own research, that the aquatic environment significantly affects the respiratory function in relation to the classical Physiotherapy.

In conclusion, Hydrotherapy can have positive effects on the respiratory system of children with cerebral palsy in combination with classical physiotherapy.

Future Proposals

Based on the above it is proposed:

- Recommendation of including Hydrotherapy in the program of children with CP.
- Regular and often measurement of the cardio-respiratory indications of children with CP.
- Inform the scientific therapeutic group about the possible benefits of the Hydrotherapy on the respiratory system of children with CP.

Finally, it is recommended that the scientific community takes the lead in conducting more studies with a larger sample group and for longer periods of time. It should be noted that Hydrotherapy should be instructed by highly qualified therapists and that there should be cooperation within the community for the optimal therapy outcomes.

References

1. Blair Eve, Stanley Fiona (1997) Issues in the Classification and Epidemiology of Cerebral Palsy. Article in *Mental retardation and developmental disabilities reviews*. 1-2.
2. Rosenbaum L Peter, Jacobson Bo, Domino Diane (2005) Proposed definition and classification of cerebral palsy, April 2005. *Developmental Medicine and Child Neurology* 47(8): 571-576.
3. Bax Martin, Brown Keith (2009) *The Spectrum of Disorders Pertaining to Cerebral Palsy, Treatment of Kinetic Disorders in Children With Cerebral Palsy*. Scientific Publications Parisianos 9-14.
4. Panteliadis P Hristos, Syrigou- Papavassiliou Antigone (2010) *Definition, Cerebral Palsy Neurological-Orthopedic-Psychosocial Approach*. 3rd Edition, Thessaloniki: 9-10
5. Pavlidou Efterpi, Panteliadis P Hristos (2010) *The History of Cerebral Palsy from Antiquity to Today, Cerebral Palsy Neurological-Orthopedic-Psychosocial Approach*. 3rd Edition Thessaloniki: 11-15.
6. Panteliadis P Hristos (2010) *Frequency-Epidemiology, Cerebral Palsy Neurological-Orthopedic-Psychosocial Approach* 3rd Edition Thessaloniki: 16-18.
7. Panteliadis P Hristos, Pavlou Evangelos, Syrigou- Papavassiliou Antigone (2010) *Escorts Problems of the CP, Neurological-Orthopedic-Psychosocial Approach*. 3rd Edition Thessaloniki: 79-93.
8. Skoutelis Ch Vasilis (2014) *The evolution of Halliwick's philosophy in the bathing method in a hydrophysiotherapeutic approach: Effects on the kinetic function of disabled children (Part 1 and 2), Physical Therapy of National Recognition, published by the Panhellenic Association of Physiotherapy* 17 (2): 15-23.
9. Frazen Kathleen, Tryniszewski Priscilla (2013) *Effectiveness of Aquatic Therapy for Children with Neurodevelopmental Disorders: A Systematic Review of Current Literature*. 1-22.
10. Jorgic Bojan, Dimitrijevic Lidija, Lambeck Johan, Aleksandrovic Marko, Okicic Tomislav et al. (2012) *Effects of aquatic programs in children and adolescents with cerebral palsy: Systematic review*. *Sport science* 5(2): 49-56.
11. Grosse J Susan (2010) *Water Freedom for All: The Halliwick Method*, International Journal of Aquatic Research And Education, Halliwick Association of Greece Ελληνικό Σωματείο Halliwick Therapy. (www.halliwick.org.gr, 2016)
12. Ersoz Murat, SelcukBarin, GunduzRamazan Kurtaran Aydan, AkyzMufit (2006) *Decreased Chest Mobility in Children with Spastic Cerebral Palsy*. *The Turkish Journal of Pediatrics* 48(4): 344-350.
13. Park SookEun, Park Hyun Jung, RhaWook Dong, Park IL Chang, Park Woo (2006) *Comparison Of The Ratio Of Upper To Lower Chest Wall In Children With Spastic Quadriplegic Cerebral Palsy And Normally Development Children*. *Yonsei Medical Journal* 47(2): 237-242.
14. Hristara -Papadopoulou Alexandra, Georgiadou Athina, Papadopoulou Ourania (2014) *Laboratory Examinations*. *Physiotherapy in Pediatrics Thessaloniki*: 103.
15. Chandolias Konstantinos, Tsiokanos Athanasios, Konstantinidou Elisavet – Andriana (2016) *Translation, validity, reliability and inter-rater reliability of Wota 1 & 2, water assessment tests based on the Halliwick concept in children with cerebral palsy*, 53th Pan-Hellenic Pediatric Congress 29-31 Makedonia Palace, Thessaloniki.
16. Dragos Adrian, Emese Agnes, Beng Ileana (2013) *Effects Of An Aquatic Therapy Program On Vital Capacity, Quality Of Life And Physical Activity Index In Children With Cerebral Palsy*. *Human And Veterinary Medicine* 5(3): 117-124.
17. Hutzler Yeshayahu, Chacham Anat, Bergman Uri (1998) *Effects of a movement and swimming program on vital capacity and water orientation skills of children with cerebral palsy*. *Neurodevelopmental Medicine and Child Neurology* 40(3): 176-181.
18. Pickham- Fragala Maria, Haley M Stephen, O'Neil E Margaret (2008) *Group Aquatic Aerobic Exercise For Children With Disabilities*. *Developmental Medicine And Child Neurology* 50(11): 822-827.
19. Retarekar Runzun, Pinkham- Fragala A Maria, Townsend E Elise (2009) *Effects of Aquatic Aerobic Exercise for a Child with Cerebral Palsy: Single- Subject Design*. *Pediatrics of The American Physical Therapy Association* 21(4): 336-344.