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Original Research Article

The effect of hydrotherapy according to Halliwick concept on children with cerebral palsy and the evaluation of their balance: a randomised clinical trial

Konstantinos Chandolias[1]*, Evangelia Zarra[2], Anna Chalkia[2], Alexandra Hristara[2]

[1]Department of Physiotherapy, University of Thessaly, Lamia, Greece
[2]Department of Physiotherapy International Hellenic University, Thessaloniki, Greece

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***Correspondence:**
Dr. Konstantinos Chandolias,
E-mail: konchand@uth.gr

ABSTRACT

Background: Hydrotherapy according to Halliwick concept is a physiotherapeutic intervention technique for disabled patients and for children with neurodevelopmental disorders. Assessing the balance in children with cerebral palsy (CP) is an extremely complex process and more difficult to evaluate the results of some therapeutic interventions in these patients. The purpose of this study is to investigate the effect of Halliwick based Hydrotherapy on the support base in children with CP. Several studies have proven the beneficial effects of hydrotherapy in the respiratory system of children, but few are studies that report the effect on the balance of children with CP.
Methods: The study involved 16 children diagnosed with CP. The 10 children were following a Halliwick Concept hydrotherapy program and the 6 children classical physiotherapy program for 3 months. Their balance was assessed with the Berg, GMFM, and footprint plate. The assessment was performed at the start of the program (pre-test) and after 3 months (post-test).
Results: There is a statistically significant change between the 1st and 2nd measurement with the BERG and GMFM tools and better for the water intervention group. The change in the support base between the 1st and 2nd measurement was better in the water intervention group but not statistically significant.
Conclusions: The results of the study showed that hydrotherapy according to Halliwick has positive effects on gross mobility and the balance of children with CP. It also appears to have a positive effect on changing the support base compared to classical physiotherapy.

Keywords: CP, Hydrotherapy, Halliwick concept, Balance, Therapeutic swimming

INTRODUCTION

Cerebral palsy (CP) is the most common neuromuscular disorder in children.[1] Little CP or disease has been defined to describe a group of non-progressive movement or posture disorders due to an immature brain injury.[1] Although the damage to the brain is neither progressive nor curable, the changes in the body are many and change the motor development of the child, which develops normally over time.[2]

Many attempts have been made to define CP over the years. Mac Keith and Polani defined CP as a "persistent but not unchanged movement and posture disorder that occurs in the early years of life due to in a non-progressive brain disorder".

CP occurs with a frequency of 1.0-2.5/1000 live births. Thus, it is estimated in Greece about 25,000 people suffering from CP, while 300 children are born each year. Those statistics are relatively old (1980), at a time when

obstetrics and gynecology did not have the current technological capabilities. Thus, one would expect the incidence of this disease to have decreased internationally and the incidence to be much milder. However, an international statistical study has been published which reports a frequency of 2.12-2.45 cases per 1000 live births in six countries.

Hydrotherapy is an intervention treatment for children with neurodevelopmental disorders such as: CP, Prader-Willy syndrome, spinal muscular atrophy, developmental disorder, developmental delay, juvenile rheumatoid arthritis.[3,4]

The benefits of hydrotherapy are many because water offers anti-gravity forces and children can float without their weight. There are reduced compressive forces on the joints resulting in the most "fluid" movement in children who are unable to perform these activities on land. Hydrotherapy can reduce spasticity, improve children's tolerance to multisensory stimuli and finally can increase blood pressure because of hydrostatic pressure.[5]

Compared to the activities that take place on the ground, the activities in the water facilitate the functional movements due to the reduced load, therefore we have less load on the joints.[6] Aquatic therapy programs have incorporated many ground exercises such as stretching, resistance exercises, aerobic endurance exercises and motor skills. Aquatic activities also incorporate water adaptation, functional independence, water movement control, rotational movements, swimming skills and breathing exercises.[7,8] Both in water and on land, treatments are in the form of play, which is a very popular practice in the field of pediatric rehabilitation.[7]

Through swimming, children can make uncontrollable movements and use restrained muscles against gravity. For this reason, swimming and any other relevant water sports are suitable for children with CP and other motor difficulties.[8]

Also, when a child with a physical disability learns to move and swim without the help of others, his self-esteem and self-awareness seem to improve. Water is in fact a means by which anyone can take part in recreational and therapeutic activities, regardless of their age.

Swimming and aquatic intervention have been recognized as part of an overall physical activity program for people with CP.[25] In particular, the benefits of hydrotherapy programs for children with disabilities include: 1. The buoyancy of water, allowing movement to begin, even when the neuromuscular system is unable to move against gravity. 2. The high viscosity of water, providing gradual resistance throughout the range of motion. 3. Significantly greater heat transfer to water than to air reduces spasticity and other involuntary movements.[10] 4. Hydrostatic pressure provides extensive stimulation as well as increased pressure on the lungs and other internal organs as well as the respiratory muscles. This, in turn, improves coordination, respiration, and related functions such as diet and speech.[17]

The Halliwick concept was developed in 1949 by James and Phyl Mc Millan to teach swimming to people with disabilities. James McMillan was an engineer, swimming instructor and coach. He was able to understand the problems of balance and motion in water through the principles of the hydrostatic and hydrodynamic theory. James and Phyl worked at Halliwick school in North London with girls with disabilities. There they developed the method and so the school got its name from the Halliwick method. In 1950 the first swimming club "the Penguins of Halliwick" was founded. This group accepted people with various forms of disability (motor, mental, sensory). This group was voluntary, and the volunteers (relatives, parents, friends) were trained as trainers or assistants. In 1952 the therapeutic swimming organization was founded which was later renamed the Halliwick therapeutic swimming organization.[33] Halliwick philosophy spread throughout Britain but also in Mainland Europe.

There are certain principles that govern Halliwick's concept In Halliwick there is a one-to-one philosophy. The Halliwick philosophy is applied by an educator working with a learner. Each trainer is always in the water with his trainee until the trainee is completely independent in the water.[8] Through this philosophy the trainee participates in group therapy but has the constant supervision of the therapist. Also, through the toys that exist in the treatment, the children are informed and become familiar with the properties and behavior of water. Finally, through the games, the trainee exercises his balance. The Halliwick technique pays special attention to the therapist who provides the right support and through it the trainee can get the sense of movement that he / she most likely has never felt on land. When the trainee becomes familiar with water and has learned to control and balance his body then the therapist slowly begins to take his hands out and the trainee acquires complete freedom in the water.[6] Finally, the trainee must maintain a safe breathing position, must learn to change position in the water, learn how to control exhalation when their face is in the water, rotate and stop rotating when he wants.[7]

McMillan argues that the basis of the method is the 10-point program. A swimmer must master all ten stages to be considered truly capable in the water. 1. Mental adaptation to water, 2. Release, 3. Anteroposterior rotation control, 4. Side rotation control, 5. Longitudinal rotation control, 6. Combined rotation control, 7. Buoyancy, 8. Balance at rest, 9. Slipping into turmoil and 10. Simple progress and learning basic swimming moves

The main problem of children with CP it is not so much the disturbed muscle tone as the lack of control of the

posture of the body. Attenuation of the postural tone is a frequent accompanying phenomenon of many forms of brain damage. All signs of motor behavior are affected by the state of tone in the body, even the amount of movement that takes place. The abnormal tone greatly influences reflex response expression.[36] Spasticity, for example, seems to be associated with abnormal extrapyramidal conditions, especially of the striatum, when the beneficial effects are impaired, resulting in an increase in muscle tone manifested by increased reflex activity and thus reflex responses. coarse and out of sync. This has detrimental effects on static and dynamic equilibrium.[36]

The posture tone may change as the baby develops. In CP, it is quite common for a hypotonic infant to become spastic and initial hypertension to eventually appear as a malformation.[4,5,15] It is also often the case that the tone abnormality is not evenly distributed in the body. A sluggish torso may be associated with stiffness. In addition, the tone is quite different from the child's condition and unfortunately, the increased voluntary effort has the opposite effect, especially in hypertension. It is unfortunate that knowledge of the mechanisms that control the maintenance of posture tone in normal individuals is so limited and understanding of abnormal tone is greatly hindered by this. Lack of understanding of all the parameters of tone abnormality in CP for example is a major obstacle at all levels. It makes understanding these hypotheses very difficult, it limits the prediction in terms of probabilities, and, most importantly, the efforts to handle the tone abnormality remain at an instinctive level. However, although the mechanisms involved in maintaining posture tone and the importance of primordial reflexes are not fully understood, it is known that some abnormality significantly impairs the balance of children with CP.

Electromyographic studies show that in spastic CP. Balance problems can be classified as: a) defective use of motor units, referred to as paralysis or weakness, b) abnormal, gradual increase in stimulus intensity caused by muscle tension, which is called spastic pattern16, c) selective activation of muscle antagonists with loss of the normal reciprocal inhibitory pattern, called the contraction pattern, and d) problems associated with musculoskeletal limitations due to changes in the mechanical properties of the muscle.[36] A patient profile will reflect a combination of the factors mentioned above. Thus, each individual with CP will present a slightly different pattern of motor behavior.[36]

Sensory disturbances can cause problems in addition to lack of information and movement feedback, in addition to the development of abnormal motor strategies. Lack of sensory supply does not allow children to modify the way they feel and move to control posture and balance.[4,24] We conclude, therefore, that the balancing and motor behavior of children with CP is not only a result of neurological damage but also the efforts of different systems to compensate for the loss and remain functional.[36]

Balance in normal children develops even after 13 years.[14,32,40] In children with CP the development of the brain is stopped or disturbed resulting in the incomplete or delayed development of the synergistic structures or neuromuscular synergies used to maintain balance.[14,22] In addition, the incomplete development of the sensory systems results in the absence of sensory and motor strategies that allow children to modify the way they feel and move to control posture and balance.[5,24]

The abnormal muscle tone of people with CP contributes significantly to the abnormal control of balance during posture and movement.[22] The type and severity of muscle tone problems depend on the location and extent of the injury. Spasticity is the most common manifestation of abnormal muscle tone found in people with CP.[34] It manifests itself with excessive muscle activation which limits the ability of people with CP to move freely and quickly.[34]

Also, in people with CP there is a pattern of simultaneous activation of agonists and muscle competitors around a joint called a pattern of muscle antagonist contraction.[11] This pattern in combination with muscle spasticity makes the joints of individuals with CP stiff while significantly reducing the strength of muscle fighters.[11,39] Although the contraction of muscle competitors is a normal motor control strategy when the individual wants to stabilize a joint, in people with CP the degree of simultaneous activation of muscle competitors is considered excessive, significantly impeding movement in their joints.[39]

Purpose

The purpose of this study is to study the effects of Halliwick on the balance of children with CP. The aim of the research is to strengthen the position and contribution of the intervention in water and the Halliwick concept - hydrotherapy intervention in the balance of children with CP and to investigate its contribution to an integrated therapeutic approach of these children.

In recent years, parallel therapeutic approaches are gaining ground, which in combination with physiotherapy treatment contribute to the increase of therapeutic results in early and post-intervention for children with CP.

Several studies have been done from time to time, which have proven the beneficial effects of hydrotherapy on children's respiratory system[7], but few studies report the effect of hydrotherapy on children's balance. Through this research we will be able to focus more on the benefits of hydrotherapy on the balance of children with CP and have a clearer picture of the results of the activity in the water.[35]

METHODS

The study type was a randomized clinical trial between September 2021 and November 2021. The study involved 16 children diagnosed with cerebral palsy (GMFCS 1-2). Selection criteria were diagnosed children with CP, GMFCS level 1-2, without accompanying seizures, without recent surgery or alantic toxin injection, and able to understand basic instructions. The 16 children randomly were divided into 2 intervention groups. The 10 children attended a Hydrotherapy program according to the Halliwick philosophy by specially trained method therapists. The 6 children attended treatment with the methods of classical physiotherapy (Figure 1).

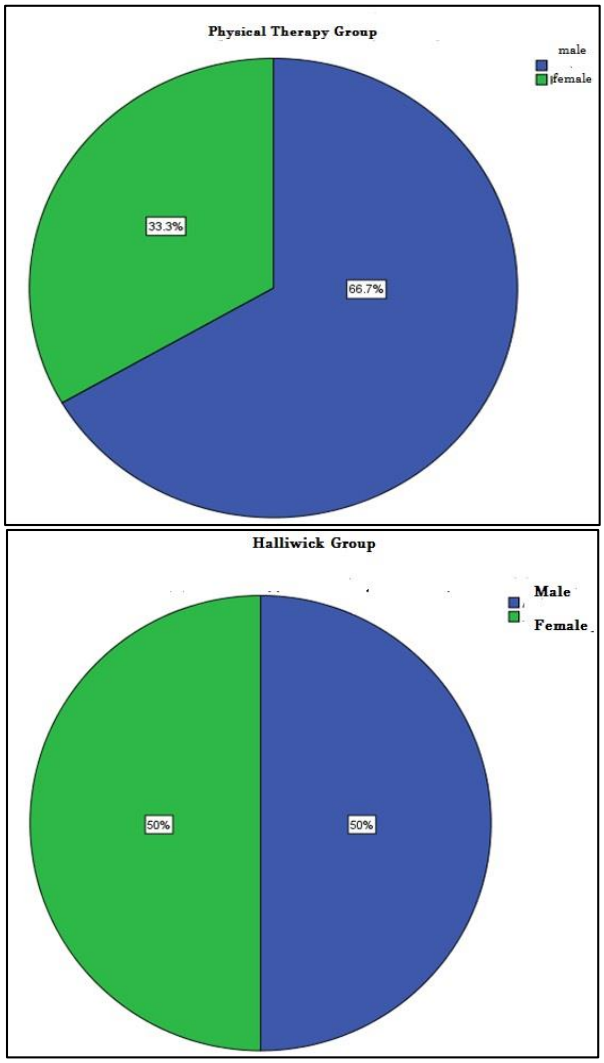

Figure 1: Percentages of the sex by group.

The parents were present during the treatment and the measurements while they signed the researcher's consent form. All assessments were carried out in the same place, in the same room, with the required equipment. Emphasis was placed on child was dressed in as little clothing as possible so that the execution of the skills is not difficult, and the effort could be assessed in the best possible way.

The intervention in the water took place in the same indoor heated pool for all children, 6 meters long, 4 meters wide and same depth to 1.20 m. The water temperature was 32-33°C. No flotation aid was used. The children were dressed in their bathing suits, except for those with poor bowel control who also used a special water diaper or a special bathing suit.

Permission was required from the bioethics and ethics committee of the physical therapy department of the international Hellenic university, which was issued under protocol number XXX. The research was also registered in the records of clinical trials with ID XXX.

Statistical analysis

In the analysis of the questions, statistical frequency tables, bar charts, and pie charts were used for the graphical representation of the findings. Descriptive statistical measures such as mean, median, maximum, minimum values, and standard deviation were also used.[27] Parametric and non-parametric control methods were used to test statistical hypotheses of mean value equality, depending on the data.

The statistical analysis was performed with the statistical package SPSS version.[22]

The following variables' tables show 16 valid observations and 0 missing. There are no incomplete observations in the sample, so these two columns are identical. The significance level is set at 5%. Thus, the Intervention itself is analyzed below, and then, depending on the intervention or control group, gender, age, GMFM scale scores, BERG scale score[9], and footprint values are analyzed.

Design

Admission criteria were children with CP aged 3-16 years with GMFM score 1 to 2. The children who missed several more than 2 sessions during the study were excluded from the research process.

The ten children in the study participated in a hydrotherapy program twice a week for 45 minutes for three months and received hydrotherapy from specially trained Halliwick therapists, one therapist for each child. The other six children participated to a classical physical therapy program 2 times per week. The children who participated in the study knew their therapists from the beginning of the program.

For the needs of the research, the balance of the children was evaluated with the assessment tools Berg, GMFM, and footprint plate. Measurement and assessment were done at the beginning of the program (pre-test) and measurement and assessment (post-test) were done after the end of the treatment program.

Assessment tools

The Berg balance scale (BBS) includes fourteen (14) tests that correspond to the child's daily activities.[2] Balancing ability is a prerequisite for performing individual tests of the test. Each test is scored on a five-point scale, with values starting at 0 (inability to perform and up to 4 (full capacity). Then, the scores of all individual tests are added up and the total score of the test is calculated.

The gross motor function measure (GMFM) test was designed to quantify changes in gross mobility in children with CP at different times.[30] No age limits are stated but the test can be performed with 100% success by a five-year-old child with normal motor ability. and movement to knees, standing posture and finally walking, running, and jumping. Effort to shorten the time required to perform this test, as well as to prioritize its subtests based on the difficulty of performing them by children with CP, led Russel and her colleagues to select 66 subtests, which were arranged in order of their degree of difficulty and not grouped in 5 areas of gross mobility control. This new test was named GMFM-66 and its authors claim that it better detects changes in gross mobility in children with very severe/ very mild motor impairment.

Footprint pate (Pelmatografima-elite) was also used. The footprint plate is a test that analyzes the distribution of pressures during posture and gait, digitally capturing the morphology of the sole. It is a device with thousands of sensors, which record the pressures exerted on each point of the foot when it is in contact with its surface. A computer is connected to the device, which collects, processes, and analyzes specific information.

RESULTS

GMFM

1st measurement

Table 1 shows the number of measurements (N) which is 10, the maximum and the minimum value, 97.4 and 35.8 respectively. The mean value is 74.16 and the standard deviation is 20.47 for the Halliwick group and the number of measurements (N) which is 6, the maximum and the minimum value, 91.4 and 55.6 respectively, the mean value (Mean) and the standard deviation, 76.3 and 13.03 respectively for the physical therapy group.

2nd measurement

Table 2 shows information on number of measurements (N) which is 10, the maximum and the minimum value, 97.4 and 7.7 respectively, the mean value (Mean) and the standard deviation, 75.69 and 27.62 respectively for Halliwick group and measurements (N) which is 6, the maximum and the minimum value, 92.6 and 59.2 respectively, mean value (Mean) and standard deviation, 75.8 and 13.01 respectively for physical therapy group.

BERG

1st measurement

Table 3 gives the number of measurements (N) which is 10; the maximum and the minimum values, 55 and 8, respectively; the mean value (Mean) and the standard deviation, 40.7 and 16.2 respectively. Physical therapy group in table 5 above gives the number of measurements (N), which are 6, the maximum and the minimum value, 55 and 28, respectively, the mean value (Mean) and the standard deviation, 42.83 and 8.99 respectively.

2nd measurement

Table 4 gives the number of measurements (N) which are 10, the maximum, and the minimum value, 56 and 10, respectively. The average value (Mean) is 44.6, while the standard deviation is 17.28. Physical therapy group in the table above informs us about the number of measurements (N), which is 6, the maximum, and the minimum value, 56 and 29, respectively. The mean value is 44, while the standard deviation is 8.87.

Footprint

Footprint plate measurements are in percentages.

1st measurement

Table 5 shows the number of measurements in the Halliwick intervention group for each leg (N) which is 10. From the same table it appears that for the left and the right leg the maximum and the minimum value are 66.4 and 33.6 respectively. The mean value (Mean) for the left foot is 56.4 with standard deviation 9.82 while for the right the average value is 43.5 with standard deviation 9.82 for Halliwick group and the number of measurements for each leg (N) in the classical physiotherapy intervention group which is 6. From the same table it appears that for the left leg the maximum and the minimum value is 66.6 and 54 respectively while for the right 46 and 33.4 respectively. The mean value (Mean) for the left foot is 61.03 with standard deviation 5.068 while for the right the average value is 38.96 with standard deviation 5.068 for physical therapy group.

2nd measurement

Table 6 shows the number of measurements in the Halliwick intervention group for each foot (N) which is 10. From this table it appears that for the left and the right foot the maximum and the minimum value are 62.4 and 31.8 respectively. The mean value (Mean) for the left foot is 51.59 with standard deviation 8.7 while for the right the average value is 48.42 with standard deviation 8.69 for Halliwick group and the number of measurements for each leg (N) in the classical physiotherapy intervention group which is 6. From the same table, we see that for the left leg the maximum and the minimum value is 67.2. 6 and 54.2 respectively while

for the right 45.8 and 32.8 respectively. The average value (Mean) for the left foot is 59.92 with a standard deviation of 5.62 while for the right the average value is 40.08 with a standard deviation of 5.62 for physical therapy group.

Table 1: Descriptive statistics Halliwick and physical therapy group before intervention.

Descriptive statistics	N	Minimum	Maximum	Mean	Std. Deviation
Halliwick therapy group					
GMFM pre-test	10	35.8	97.4	74.160	20.4707
Physical therapy group					
GMFM pre-test	6	55.6	91.4	76.300	13.0338

Table 2: Descriptive statistics Halliwick and physical therapy group after intervention.

Descriptive statistics	N	Minimum	Maximum	Mean	Std. Deviation
Halliwick therapy group					
GMFM post- test	10	7.7	97.4	75.699	27.6705
Physical therapy group					
GMFM post- test	6	59.2	92.6	75.800	13.0120

Table 3: Descriptive statistics Halliwick and physical therapy group before intervention.

Descriptive statistics	N	Minimum	Maximum	Mean	Std. Deviation
Halliwick therapy group					
BERG pre-test	10	8	55	40.70	16.200
Physical therapy group					
BERG pre-test	6	28	55	42.83	8.998

Table 4: Descriptive statistics Halliwick and physical therapy group after intervention.

Descriptive statistics	N	Minimum	Maximum	Mean	Std. Deviation
Halliwick therapy group					
BERG post-test	10	10	56	44.60	17.283
Physical therapy group					
BERG post-test	6	29	56	44.00	8.877

Table 5: Descriptive statistics for Halliwick and physical therapy group before intervention.

Descriptive statistics[a]	N	Minimum	Maximum	Mean	Std. Deviation
Halliwick therapy group					
Left foot pre-test	10	33.6	66.4	56.490	9.8262
Right foot pre-test	10	33.6	66.4	43.510	9.8262
Physical therapy group					
Left foot pre-test	6	54.0	66.6	61.033	5.0686
Right foot pre-test	6	33.4	46.0	38.967	5.0686

Table 6: Descriptive statistics for Halliwick and physical therapy group after intervention.

Descriptive statistics	N	Minimum	Maximum	Mean	Std. Deviation
Halliwick therapy group					
Left foot post-test	10	31.8	62.4	51.590	8.7009
Right foot post-test	10	37.6	68.2	48.420	8.6943
Physical therapy group					
Left foot post-test	6	54.2	67.2	59.917	5.6286
Right foot post-test	6	32.8	45.8	40.083	5.6286

DISCUSSION

In the present study, 16 children participated in the statistical analysis. The 10 children underwent hydrotherapy according to Halliwick philosophy. The 6 children performed a program according to the methods of classical physiotherapy.

The results according to Halliwick concept showed statistically significant effects on changing the child support base and improving balance 6. The results of our research seem to agree with other researchers as a reference to the effect of hydrotherapy on the balance of children with CP, as shown in the international literature.

Thorpe and colleagues in 2005 studied the effects of hydrotherapy in walking children with spastic CP through a 45-minute program, 3 times a week for 10 weeks, and concluded that gait, running, and exercise were significantly improved. jumping.

McManus and Kotelchuc in a controlled non-fatalized study observed that hydrotherapy, lasting 30 minutes once a week for 9 months, as an adjunct to early home therapy improves gross motor function in infants and young adults with neurodevelopmental disorders.

Two years later, Retarekar and his colleagues, through a case-study in a girl with spastic diplegic CP, concluded that there were significant changes in gross movement, speed and walking distance, as well as energy expenditure during walking.[23]

Researchers Fragala and Pinkham in based on a description of 4 clinical cases, reported that the implementation of a hydrotherapy program, 45-60 minutes, 1-2 times a week for 6 months significantly contributes to an increasing range of motion and muscle strength, reducing of pain, as well as in the improvement of movement and motor skills, in children with neurodevelopmental disorders.[12]

The results of the above study were reinforced by Ballaz and colleagues in 2011, who in a pre-and post-trial study without a control group observed that a supplemental therapeutic bath program, 10 weeks, twice a week for 45 minutes improves gait performance in walking children with spastic CP.

Finally, Jorgic and colleagues conducted a pilot study in 2012. They demonstrated that a 45-minute, twice-weekly, 6-week hydrotherapy supplement, according to Halliwick, developed the ability to walk, run, jump, and the overall gross motor function of walking children with spastic CP. The children also showed an improvement in water familiarity and the ability to move and swim.[18]

In conclusion, the results of hydrotherapy can be positive in improving the balance of children with CP in combination with conventional physiotherapy.

Clinical messages

Based on the above results it is proposed: Inclusion of children with CP in parallel with a hydrotherapy program. Assessing the balance of children with CP with more tools and with a treatment period of more than 2 months. Informing the scientific treatment team about the usefulness of water rehabilitation in improving the balance of children with CP.

It is proposed for the scientific community more research with a larger sample population and for a longer period of time. It is emphasized that hydrotherapy should be done by properly trained therapists and the whole scientific team should work together for the best treatment.

The present research comes to fill an absence in the databases related to the effect of hydrotherapy on the support base of children with CP. Future research should focus researchers' attention on the complex evaluation of the parameters of the individual factors of functional balance evaluation by investigating their variation by gender, age, GMFCS level, in the short and long term.

Limitations

There are a few limitations to this study. First, the sample size is relatively small, which may have limited the power to detect some significant differences. Second, the study did not include a control group, so it is impossible to determine whether the observed improvements were due to the hydrotherapy program or other factors such as natural recovery or maturation. Third, the study did not assess long-term outcomes, so it is not known whether the improvements seen at follow-up were maintained over time. Finally, the study did not assess the impact of the hydrotherapy program on functional outcomes, so it is not known whether the observed improvements in motor and cognitive skills translated into improvements in daily functioning.

CONCLUSIONS

Hydrotherapy according to Halliwick concept is one of the most important physiotherapy practices. The results obtained from this research were remarkable. In the second group, the control group, which included children who followed a classical physiotherapy program, there was no statistically significant change in support base and balance. In the first group, the intervention group according to the Halliwick philosophy, there was an improvement in balance.

More specifically, the evaluation of the Berg scale and the GMFM showed a change in the support base and an improvement in the balance in the intervention group according to the Halliwick philosophy. As for the pedometer, there was a change in the support base in the intervention group, it was just not statistically large.

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