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Effect of hydrotherapy on muscle strength in children with brain tumor

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I.INTRODUCTION

Most pediatric brain and spine tumors are primary tumors, meaning they originated in the brain or spine. The most common types of brain tumors in children are astrocytoma, medulloblastoma and ependymoma**(Terri et al., 2015)**.

Medulloblastoma is a rapidly-growing tumor of the cerebellum – the lower, rear portion of the brain. This area controls complex motor functions such as finer hand movements**(American Brain Tumor Association, 2015)**.

Cancer-related fatigue (CRF) is mainly characterized by tiredness to exhaustion that is not precipitated by activity. It can also occur after activity if it is out of proportion to the level of exertion and is not relieved by or in fact may be worsened with rest. A moderate to high level of CRF is associated with reduced quality of life in these patients and is perceived as a barrier to include exercise in their lifestyle, justifying the need to seek different methods of treatment for these patients**(Berger et al., 2012)**.

Previous research has investigated the effects of exercise as a nonpharmacological treatment for CRF with clinical impact ranging from small to moderate effect sizes on CRF; these studies have mainly focused on land-based exercise programs, although many benefits can be obtained in an aquatic environment. Different properties of water could increase potential benefits of exercise, such as buoyancy, which significantly decreases stress on weight-bearing joints, bones, and muscles, thereby reducing pain. Exercise can reduce depression, anxiety, and improve mood state in brain cancer survivors. Aquatic group exercise interventions have also been shown to improve psychological state in several conditions **(Waller et al., 2009)**.

Because movement in the aquatic medium is easier than movement on land, with the weight reduction associated with immersion in water, it is easier to sustain movement and build cardiorespiratory fitness. Working against the resistance of the water helps build strength. Many times low physical fitness is a deterrent to land-based exercise training. Activity in water can help build fitness, while also facilitating balance and gait **(Grosse, 2011)**.

So, this study was conducted to investigate the impact of pool therapy on muscle strength of Rt. and Lt.shoulder flexors, shoulder abductors, elbow flexors, wrist extensors, hip flexors, hip extensors, knee extensors and ankle dorsiflexors in children with brain tumor.

II. SUBJECTS, MATERIALS AND METHODS

Subjects:

Twenty-six children of both gender participated in this study. They were selected from Children's Cancer Hospital Foundation 57357, Cairo. Their ages between 5-12 years old, they have affection of motor function and muscle weakness of upper and lower limbs (Rt. and Lt.shoulder flexors, shoulder abductors, elbow flexors, wrist extensors, hip flexors, hip extensors, knee extensors and ankle dorsiflexors), Time elapsed since the start of treatment more than 1 month in order to be in maintenance phase.

Children who cannot follow orders or instructions, with a genetic disorder or mental retardation, with a chronic lung disease, Sever cardiomyopathy, with a neuromuscular disease not related to tumor, with zero muscle power were excluded from the study.

Materials:

The Lafayette Manual Muscle Tester (MMT) Model Number 01163 combines precision and accuracy with a new ergonomic design to provide accurate, objective and reliable results. The three interchangeable padded stirrups were used to employ established protocols with efficiency and confidence while ensuring patient comfort **(Lafayette instrument evaluation, 2015)**.

The Lafayette MMT features innovations not employed by any other manual muscle test system. The interactive menus allow the user to select a wide range of options, such as, data storage, test times (1-10 seconds) and also offers the choice of high and low threshold settings (to accommodate large muscles or digits). The large, easy to read LCD screen displays all information clearly, reducing the possibility of reading errors or selecting unwanted options **(Lafayette instrument evaluation, 2015)**.

The pool's size is 3m (length) 2m (width), large enough for underwater exercises, with 1.5m depth. The water temperature was adjusted by a thermometer between 34-37°c and the room temperature was between 20-25°c. The water level was at the shoulder level while the child is sitting and at the hip level while the child is standing**(Irene et al., 2013)**.

Methods:

The test is performed with the clinician applying force to the limb of a patient. The objective of the test is for the clinician to overcome or “break” the patient’s resistance. The MMT records the peak force and the time required to achieve the “break” providing reliable, accurate, and stable muscle strength readings that conform to most manual muscle testing protocols. The Lafayette MMT allows force measurement in pounds or kilograms (user selectable). It was used to measure isometric muscle strength of both upper and lower limbs (Rt. and Lt.shoulder flexors, shoulder abductors, elbow flexors, wrist extensors, hip flexors, hip extensors, knee extensors and ankle dorsiflexors) in kilograms (Kg)**(Lafayette instrument evaluation, 2015)**.

Children were randomizely assigned by closed envelopes into two groups, group A received land-based exercise program for such cases, and group B received pool therapy in addition to the land-based exercise program, the program took 30 minutes (5 minutes each with 1 minute rest in between), mild to moderate aerobic training according to the child‘s ability, at least 10 rep. for 2 sets, 3 sessions per week, for 6 weeks**(Schmitz et al., 2010)**.

The designedpool therapy program was in the form of:Sitting while strengthening shoulder horizontal adductors by using weights, Sitting while pushing down by using weights, Sitting while strengthening elbow extensors by using weights, Sitting while holding weights for a while, Standing on uneven surface, Pushing downs by legs, Sitting balance, Sitting with pushing by hands while making legs as glue, Sitting with kicking by legs while fixing hands, Standing and throwing a ball, Weight shifting and recovery while initiating single limb support**(Irene et al.,2013)**.

The protocol of this study was approved by the ethics committee, Faculty of Physical Therapy, Cairo University. It was also approved by SMAC (Scientific and Medical Advisory Committee),Children's Cancer Hospital Foundation 57357,Cairo in 12 October 2016. It was also approved by IRP ethical committee. Following an explanation of the experimental protocol and written consents were obtained from all participants and their parents or families.

Statistical Analysis:

- Descriptive statistics for patients' characteristics reported as means and standard deviations for muscle strength.
- Paired and unpaired t-tests were used to compare the mean and standard deviation within and between groups respectively with significant level at alpha <0.05.

III.RESULTS

The present study was conducted to investigate the effect of pool therapy on muscle strength in children with brain tumor.

There were two independent variables, the first one was the (tested groups); between subjects factor which had two groups (Group A received the regular therapeutic exercise program given for such cases while Group B received the same regular therapeutic exercise program given to such cases in addition to pool therapy program); within subject factor which had two levels (pre, post). In addition, this test involved one dependent variable which is muscle strength measured in kilograms (Kg).

Data is presented in table (1) and table (2) and illustrated in figure (1)

Table 1: Pre and post treatment mean values of muscle strength of upper limbs within both groups (A and B):

Muscle Tested	Group	Mean (Kg) ±SD Pre test	Mean (Kg) ± SD Post test	MD	% of Change	P value
Rt. Shoulder flexors	Group A	3.86 ± 0.98	4.55 ±0.96	0.69	17.88 %	0.0007*
	Group B	4.51 ±2.05	6.19 ± 1.86	1.68	37.25 %	0.0001*
Lt. Shoulder flexors	Group A	3.65 ± 1.01	4.19 ± 0.97	0.54	14.79 %	0.0001*
	Group B	4.3 ± 2.05	6 ± 1.93	1.7	39.53 %	0.0001*
Rt. Shoulder abductors	Group A	4.78 ± 1.07	5.29 ± 1.08	0.51	10.67 %	0.0001*
	Group B	5.26 ± 2	7.05 ± 1.81	1.79	34.03 %	0.0001*
Lt. Shoulder abductors	Group A	4.62 ± 1.08	5.12 ± 1.09	0.5	10.82 %	0.0001*
	Group B	5.19 ± 2.13	6.86 ± 1.89	1.67	32.18 %	0.0001*
Rt. Elbow flexors	Group A	3.12 ± 1.04	3.6 ± 1.01	0.48	15.38 %	0.0001*
	Group B	3.94 ± 2.52	5.71 ± 2.16	1.77	44.92 %	0.0001*
Lt. Elbow flexors	Group A	3.07 ± 1.1	3.58 ± 1.09	0.51	16.61 %	0.0001*
	Group B	3.82 ± 2.01	5.59 ± 2.02	1.77	46.34 %	0.0001*
Rt. Wrist extensors	Group A	2.47 ± 0.7	3.08 ± 0.65	0.61	24.7 %	0.0001*
	Group B	2.78 ± 1.38	4.31 ± 1.35	1.53	55.04 %	0.0001*

Lt. Wrist extensors	Group A	2.35 + 0.86	2.92 + 0.81	0.57	24.26 %	0.0001*
	Group B	2.61 + 1.22	4.22 + 1.2	1.61	61.69 %	0.0001*

*Significant level is set at alpha level <0.05.

Table 2: Pre and post treatment mean values of muscle strength of lower limbs within both groups (A and B):

Muscle Tested	Group	Mean (Kg) + SD	Mean (Kg) + SD	MD	% of Change	P value
		Pre test	Post test			
Rt. Hip flexors	Group A	3.75 + 1.07	4.25 + 1.04	0.5	13.33 %	0.0001*
	Group B	4.52 + 1.72	6.19 + 1.71	1.67	36.95 %	0.0001*
Lt. Hip flexors	Group A	3.44 + 0.94	3.9 + 0.94	0.46	13.37 %	0.0001*
	Group B	4.01 + 1.76	5.75 + 1.8	1.74	43.39 %	0.0001*
Rt. Hip extensors	Group A	1.7 + 0.72	2.23 + 0.7	0.53	31.18 %	0.0001*
	Group B	2.56 + 1.9	3.92 + 1.98	1.36	53.13 %	0.0001*
Lt. Hip extensors	Group A	1.52 + 0.68	2.05 + 0.69	0.53	34.87 %	0.0001*
	Group B	2.35 + 1.81	3.65 + 1.88	1.3	55.32 %	0.0001*
Rt. Knee extensors	Group A	3.48 + 0.7	3.98 + 0.73	0.5	14.37 %	0.0001*
	Group B	4.6 + 1.74	6.12 + 1.78	1.52	33.04 %	0.0001*
Lt. Knee extensors	Group A	3.16 + 0.83	3.65 + 0.82	0.49	15.51 %	0.0001*
	Group B	4.19 + 1.99	5.95 + 2.13	1.76	42 %	0.0001*
Rt. Ankle dorsiflexors	Group A	2.75 + 0.61	3.31 +0.58	0.56	20.36 %	0.0001*
	Group B	3.6 + 1.14	4.84 + 1.37	1.24	34.44 %	0.0001*
Lt. Ankle dorsiflexors	Group A	2.47 + 0.57	2.98 + 0.56	0.51	20.65 %	0.0001*
	Group B	3.09 + 1.14	4.33 + 1.33	1.24	40.13 %	0.0001*

*Significant level is set at alpha level <0.05.

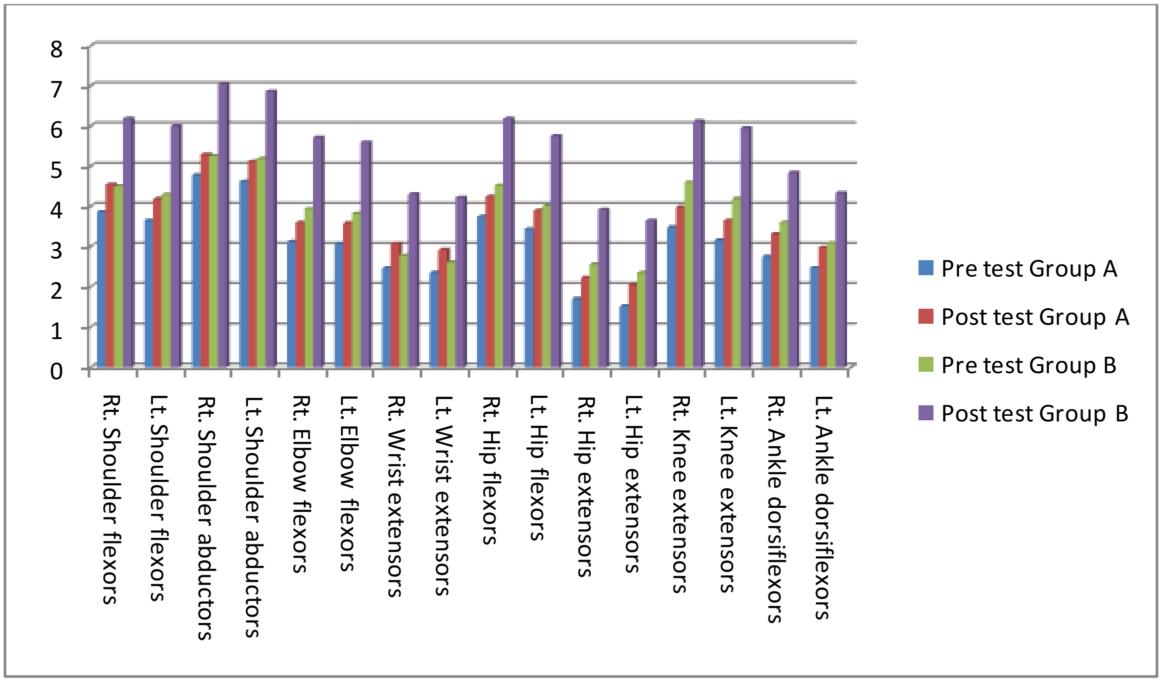

Fig. 1: Pre and post treatment mean values of muscle strength within both groups (A and B).

Data presented in table (3) and table (4) and illustrated in figure (2) compares the pre-and post-treatment mean values between both groups (A and B)

Table3: Pre and post treatment mean values of muscle strength of upper limbs between both groups (A and B):

Muscle Tested	Examination Time	Group (Mean ±SD)		MD	% of Change	P value
		A	B			
Rt. Shoulder flexors	Pre test	3.86 ± 0.98	4.51±2.05	0.65		0.3157
	Post test	4.55 ±0.96	6.19±1.86	1.64	36.04 %	0.0091*
Lt. Shoulder flexors	Pre test	3.65 ± 1.01	4.3 ± 2.05	0.65		0.3194
	Post test	4.19 ± 0.97	6 ± 1.93	1.81	43.2 %	0.0059*
Rt. Shoulder abductors	Pre test	4.78 ± 1.07	5.26± 2	0.48		0.4554
	Post test	5.29 ± 1.08	7.05±1.81	1.76	33.27 %	0.0063*

Lt. Shoulder abductors	Pre test	4.62 ± 1.08	5.19±2.13	0.57		0.3929
	Post test	5.12 ± 1.09	6.86±1.89	1.74	33.98 %	0.0083*
Rt. Elbow flexors	Pre test	3.12 ± 1.04	3.94±2.52	0.82		0.2869
	Post test	3.6 ± 1.01	5.71±2.16	2.11	58.61 %	0.0039*
Lt. Elbow flexors	Pre test	3.07 ± 1.1	3.82±2.01	0.75		0.2511
	Post test	3.58 ± 1.09	5.59±2.02	2.01	56.15 %	0.0042*
Rt. Wrist extensors	Pre test	2.47 ± 0.7	2.78±1.38	0.31		0.4701
	Post test	3.08 ± 0.65	4.31±1.35	1.23	39.94 %	0.0072*
Lt. Wrist extensors	Pre test	2.35 ± 0.86	2.61±1.22	0.26		0.5448
	Post test	2.92 ± 0.81	4.22 ± 1.2	1.3	44.52 %	0.0035*

*Significant level is set at alpha level <0.05.

Table 4: Pre and post treatment mean values of muscle strength of lower limbs between both groups (A and B):

Muscle Tested	Examination Time	Group (Mean ± SD)		MD	% of Change	P value
		A	B			
Rt. Hip flexors	Pre test	3.75 ± 1.07	4.52 ± 1.72	0.77		0.1838
	Post test	4.25 ± 1.04	6.19 ± 1.71	1.94	45.65 %	0.0019*
Lt. Hip flexors	Pre test	3.44 ± 0.94	4.01 ± 1.76	0.57		0.313
	Post test	3.9 ± 0.94	5.75 ± 1.8	1.85	47.44 %	0.0031*
Rt. Hip extensors	Pre test	1.7 ± 0.72	2.56 ± 1.9	0.86		0.1394
	Post test	2.23 ± 0.7	3.92 ± 1.98	1.69	75.78 %	0.0081*
Lt. Hip extensors	Pre test	1.52 ± 0.68	2.35 ± 1.81	0.83		0.1314
	Post test	2.05 ± 0.69	3.65 ± 1.88	1.6	78.05 %	0.0084*
Rt. Knee extensors	Pre test	3.48 ± 0.7	4.6 ± 1.74	1.12		0.0423*
	Post test	3.98 ± 0.73	6.12 ± 1.78	2.14	53.77 %	0.0005*

Lt. Knee extensors	Pre test	3.16 ± 0.83	4.19 ± 1.99	1.03		0.0979*
	Post test	3.65 ± 0.82	5.95 ± 2.13	2.3	63.01 %	0.0013*
Rt. Ankle dorsiflexors	Pre test	2.75 ± 0.61	3.6 ± 1.14	0.85		0.0269*
	Post test	3.31 ±0.58	4.84 ± 1.37	1.53	46.22 %	0.0011*
Lt. Ankle dorsiflexors	Pre test	2.47 ± 0.57	3.09 ± 1.14	0.62		0.0896*
	Post test	2.98 ± 0.56	4.33 ± 1.33	1.35	45.3 %	0.0024*

*Significant level is set at alpha level <0.05.

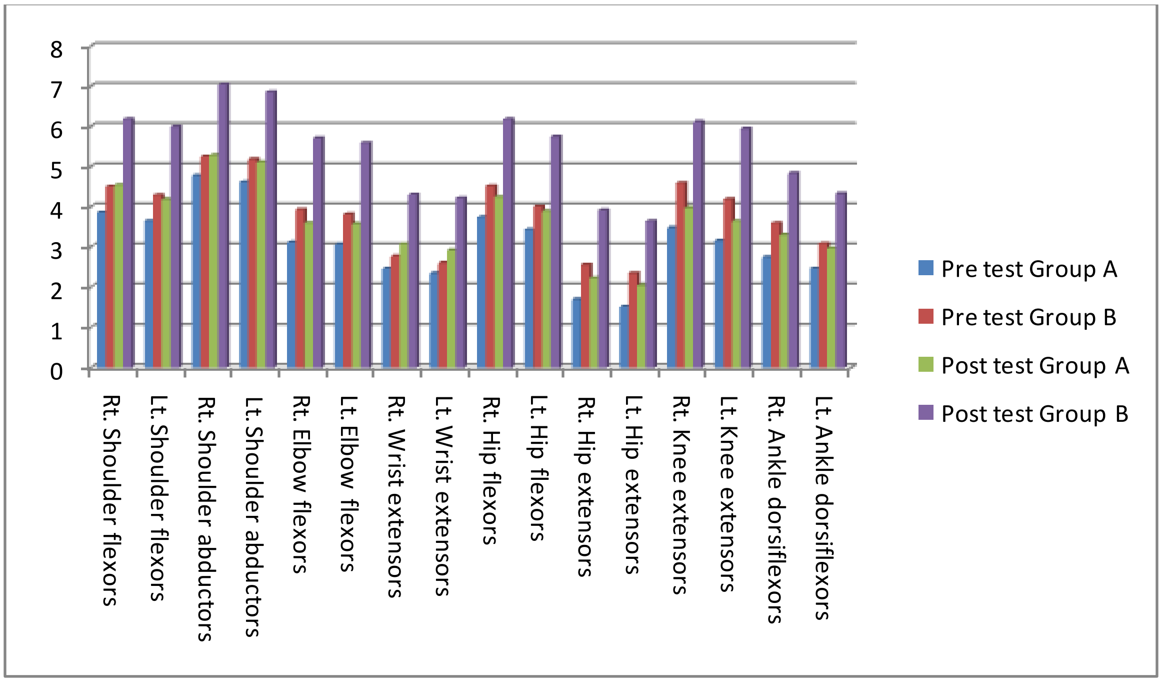

Fig. 2: Pre and post treatment mean values of muscle strength between both groups (A and B).

IV.DISCUSSION

This study was conducted to investigate the effect of pool therapy on muscle strength in children with brain tumor. The present study included medulloblastoma that constitutes a major classification among brain tumor types. This finding was reported by **(Packer, 1999)**who stated that Medulloblastoma is the most common malignant brain tumor in pediatric patients and is a significant cause of cancer morbidity in children.

Observation of the pre-treatment mean values of this study confirmed no significant differences which indicate muscle weakness due to treatment procedures (Surgery, Chemotherapy or Radiotherapy).Weakness was the second most common deficit reported in patients with brain tumours. Muscle weakness may be related to an isolated limb weakness, hemiparesis, steroid-induced myopathy or other neurological impairment, for example, ataxic hemiparesis. It may also be associated with sensory loss, cranial nerve palsy, dysarthria, dysphagia, aphasia, ataxia, diplopia and general debilitation. Symptoms will depend on the size, location and type of the brain tumour, as reported by **(Davies et al., 2003)**.

Significant improvement obtained in the post treatment mean values of the measured variable of the study group may be also attributed to the effect of different properties of water which increase potential benefits of exercise, such as buoyancy, which significantly decreases stress on weight-bearing joints, bones, and muscles, thereby reducing pain. Exercise can reduce depression, anxiety, and improve mood state in brain cancer survivors. Aquatic group exercise interventions have also been shown to improve psychological state in several conditions, as reported by **Waller et al., (2009)**.

There is evidence that participation in a rehabilitation program is associated with improved performance of mobility function in patients with brain tumours and at a rate comparable to improvement seen with rehabilitation therapy of motor function in benign neurological diagnoses. While the gains in motor function are slightly less for high-grade gliomas, these patients nevertheless improve with therapy, and with an improvement rate similar to other brain tumour groups **(Cole et al., 2000)**.

There is level III evidence that participation in a rehabilitation program is associated with improved performance of personal activities of daily living, in patients with brain tumours**(Garrard et al., 2004)**.

It was found that an exercise program in a deep water pool including aerobic/endurance exercise as a principal component (70% of each session), which could require more exertion than exercises in a chest-high pool with reduced cardiovascular demands (20% of each exercise session). It is possible that the decreased stress on weight-bearing joints and decreased axial loading facilitated aquatic exercise. Aquatic exercise could improve the fitness level of participants, which is known as one of the pillars to attenuate Cancer-related fatigue (CRF). Hydrostatic pressure during water exercise redistributes blood from the limbs to the thoracic cavity; this redistribution may have reduced the heart rate and transiently increased the blood pressure **(Campos et al., 2011)**.

It was also showed that there are significant and clinical improvements in leg and abdominal muscle strength. The decreased muscle function in cancer survivors during and after the oncology treatment is well known. This reduced force had been associated with an increase in CRF and reduction in quality of life. Large effect sizes in muscle strength were reported and could possibly be linked to the resistance effects offered by water **(McMillan and Newhouse, 2011)**.

The reported psychological positive effects of aquatic exercise could help to explain the reduction in CRF. Exercise facilitators were used in aquatic exercise program, such as high therapist/patient supervision ratio (1 therapist for each patient), individually tailored, and gradually progressed. These exercise motivators can be related to self-perceived exercise benefits. Relief of CRF and improvement in strength reported may improve the patients' ability to perform daily activities and to interact with others. These improvements in the relationship between survivors and proxy environment could help to improve several aspects of mood state **(Blaney et al., 2010)**.

V. CONCLUSION

From the obtained study it can be concluded that 6 weeks hydrotherapy is effective, so hydrotherapy can be added to the regular physical therapy program to improve muscle strength in children with brain tumor.

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