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Original Research Article

EFFECT OF USING TREADMILL EXERCISE ON MOBILITY SKILLS IN HEMOPHILIC CHILDREN

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ABSTRACT

Background: One of the most severe blood coagulation disorders is Hemophilia. As a result of the bleeding episodes, immobilization and diminish physical activities hemophilic patients face serious problems as loss of muscle mass, decreased strength, balance problems and proprioception loss. The treadmill exercise is one of the most effective and available tool to achieve improving mobility skills in those children during walking. The aiming of this study to investigate the effect of treadmill exercises on mobility skills in hemophilic children.

Methodolgy: Thirty hemophilic children ranging in age from seven to eleven years were assigned randomly into two groups of equal number (control and study groups). Control group received selective physical therapy program aiming to facilitate balance, while study group received the same exercises as the control group in addition to treadmill exercise. Dynamic Posturography was used to evaluate mobility skills parameters as Step length, Step Width, Speed, Turn time and Turn Sway of all children in both groups before and after three successive months of treatment.

Results: The results revealed significant differences of all measured variables of mobility skills in two groups after three successive months of treatment, also revealed significant difference when compared the two groups after treatment in favor of the study group.

Conclusion: The using treadmill exercise can be added to the physical therapy program aiming to improve mobility skills in hemophilic children during walking.

KEY WORDS: Balance, Dynamic Posturography, Hemophilia, Mobility Skills, Treadmill.

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INTRODUCTION

Hemophilia is characterized by a deficiency of clotting factor VIII (classic hemophilia, or hemophilia A) or IX (hemophilia B) and defined as an X-linked inherited recessive bleeding disorder. Hemophilia ‘‘A’’ has a frequency of 1 in 5000 male births, where hemophilia ‘‘B’’ has a frequency of 1 in 30,000 male births [1]. Contrasting with the healthy peers, hemophilic children have a decreased aerobic capacity and ability to involve in higher intensity activities [2].

Children with hemophilia often demonstrate a significant reduction in muscle strength and anaerobic power, especially in the lower limbs [3]. Hemophilic present a decrease of proprioception of joint which can provoke alterations in basic force development pattern. Likewise, stability is also impeded in certain positions of dynamic balance [4]. Independent mobility is vital for activity, participation, and self-sufficiency, reducing the dependence on caregivers and the environment. Security and efficiency are major factors while picking mobility methods for different environments. Environmental and personal factors impact the performance, what a child actually does do in a daily life situation [5,6]. There is a positive correlation between balance impairments and decreased lower-limb strength. The treadmill stimulates repetitive and rhythmic stepping during upright position and weight bearing on the lower limbs [7].

Improvement of walking ability is the most common functional motor goal of lower extremity rehabilitation. Training devices are often used to facilitate or augment gait training because the reasons of feasibility, safety or intensity [6]. The therapeutic goals (e.g., strengthen muscles, improve reciprocal muscle activation, or simulate muscle activity patterns during walking) and the functional abilities of the patient influence the choice of a particular training device [8].

The implementation of exercise programs to maintain, improve joint range of motion and muscle strength in hemophilic children, attention should be drawn to activities that help to develop coordination and improve proprioception. Exercises that improve balance and coordination are vital to any rehabilitation program [4]. So, the purpose of this study was to determinate the effect of using treadmill exercise to improve mobility skills during walking in hemophilic children.

METHODOLOGY

The design of the study is a randomized control trial to determine if the treadmill exercise combined with physical therapy treatment improves the mobility skills during walking in children with hemophilia. The study was conducted in the outpatient clinic of the Faculty of Physical Therapy and Abu El-Rish hospital, Cairo University. Thirty hemophilic children participated in this study, and assigned into two groups of equal number (study and control groups) and the children were selected randomly by collecting all names of children that matched with the inclusion criteria of the study then upload the names using an electronic program (SPSS) which divided the sample into two equal groups. Their age ranged chronologically from seven to eleven years old. They were suffering from mild to moderate hemophilia [9].

The children participated in this study would be able to walk independently. They understood and followed verbal commands and instructions included in both test and training. They hadn't impairment of sensation or other neurological or psychological problems, congenital or acquired skeletal deformities in the lower limbs, cardiopulmonary dysfunction, advanced radiographic changes such as; bone destruction, bony ankylosis, knee joint sublaxation. and epiphysial fracture. All the children in this study were clinically & medically stable.

The evaluation of all participated children was taken within one month started on May 2016. The participated children were assessed by Balance Master System in Kasr Eini, Faculty of Medicine, Cairo University. The total time required for evaluating each child was average 20 minutes, and the evaluation was conducted before and after three successive months of treatment program. The procedures followed were in accordance with the Institutional Ethical Committee Clearance, and written informed consent was taken from the parents or legal guardians of the children. The treatment sessions started on June and ended on September 2016. All the children participated in the current study received 75 minutes of treatment session, three times per week for a period of three successive months of each child.

Dynamic Posturography; Balance Master System: The test-retest reliability of data got utilizing the Balance Master system is most prominent for complex tests of balance and that dynamic rather than static balance measures are valid indicators of functional balance performance [10]. Balance Master System is a device was designed to evaluate and treat of balance and mobility skills in patients with impairments and functional limitations as a result of orthopedic, neurologic, vestibular or geriatric diagnoses [11]. Before starting the assessment of children of both groups, the personal data of each child was entered such as name (first and last name), date of birth and height on new patient file and pressed on Save Patient File and Continue buttons to start assessment. After complete the patient file, the assessment was starting through choosing each test from assessment menu. Each child of two groups was demonstrated about his position, how to start and perform the test as a preparation of child before starting each test. The assessment of the study and control children by using of Balance Master System was done through two tests; Walk Across (measured Step Width (cm), Step Length (cm) and Speed (cm/sec) parameters) and Step/ Quick Turn (measured Turn Time (sec) and Turn Sway (deg/sec) parameters).

All the children participated in the current study received 75 minutes of treatment session, three times per week for a period of three successive months .For Control group; the children of this group received special physical therapy program (ultrasonic therapy 10 min, electrotherapy 20 min, bicycle ergometer training 20 min and selected physical therapy exercises 25 min) which include; exercises to facilitate balance [12,13], stretching exercise for tightening muscles aiming to maintain length and elastic recoil of all soft tissue liable to be tight especially the achilles tendon, hamstring, hip flexors and adductors of lower limbs and wrists, fingers flexors and elbows flexors [14,15], strengthening exercises as static muscle contraction for quadriceps, hamstrings, dorsiflexors and planter flexors [16-18], ultrasonic therapy (pulsed ultrasound waves of 1 MHZ frequency and 1.5 W/ cm2) [19] and electrical stimulation (inform of faradic stimulation current, pulses of 0.1-1 ms with repetition rates of 30-100 Hz. with pulses repeated at 100 Hz the time period for each cycle is 10 ms, so with a 1 ms pulse the rest period is 9 ms these pulses may be unidirectional and are thus short duration or they may be biphasic) [20,21].

The tools were used in training program; ultrasonic device (ULTRA COMBI 707) faradic stimulation (Gymna Unifphy, COMBI 200L), bicycle ergometer (Monark Rehab Trainer model 88IE), vestibular board, rolls of different sizes, blocks and wedges of different heights, stepper and balance board. For Study group; the children of this group received 50 minutes of the same physical therapy program of the control group were used for treatment and 25 minutes of gait training using electric treadmill.

Treadmill: Motorized treadmill Make (EN-TRED, Enraf Nonius)). The walking area of these treadmill are made of heavy steel of minimum 8 inch thickness and are available with cushioning to absorb impact load. The procedure and goals of exercise were explained to the child before starting walking on the treadmill. The child was asked to firmly grasp the front bar of the treadmill by both hands, he was instructed to look forward and don't look downward on his feet during walking as this may cause falling. Each child participated in this study walk on treadmill with zero degree of inclination at a speed of 1.5 Kilometers/hour for 5 minutes as a warming up. Then, the speed was increased gradually to reach 3 Kilometers/hour with 10 degrees of inclination for 15 minutes. The speed was returned to 1.5 Kilometers/hour with zero degree of inclination for another 5 minutes as a cooling down [22]. Finally, walking was stopped immediately when the child felt pain, fainting or shortness of breath.

Statistical Analysis: Collected data were collected and analyzed by using Minitab program version 16 through: descriptive statistics to measure the mean and standard deviation of each group for each parameter, and inferential statistics; by comparing mean values of each parameter between before, and after three months of treatment program among each group by using paired t-test, and by comparing mean values of each parameter between both groups after three months of treatment program was done by unpaired t- test. The probability in this study was 95%.

RESULTS

The current study investigated thirty young hemophilic children (boys); their ages ranged from seven to eleven years with their mean values of age and its standard deviation were 9.1± 1.35. Evaluated mobility skills variables data were collected and analyzed statistically before and after treatment period which lasted for three successive months. The children participated in this study were classifies into two groups of equal number; Control group include fifteen hemophilic children with age ranged from 7 to 11 years with the mean value of (9.133±1.302) as shown in Table (1). While in the study group; fifteen hemophilic children with age ranged from 7 to 11 years with the mean value of (9.067±1.438) as shown in Table (1). As indicated from descriptive data of two groups, children participated in two groups were homogenous concerning age.

As revealed from Table (2 to 8) and from figure (1 to 7) significant improvement was observed between pre and post treatment mean values of Step Length (cm), Step width (cm), Speed (cm/sec), Turn time (sec) and Turn sway (deg/sec) in both groups according to Paired t-test ($p < 0.05$).

Table 1: The mean values of the chronological age within the two groups.

Variable	Groups	Mean ± SD	Range	t-value	p-value
Chronological Age (years)	Control Group	9.133±1.302	7 - 11	0.13	0.895*
	Study Group	9.067±1.438	7 - 11		

Table 2: Comparing the mean values of step width (cm) among the two groups.

Group	Control Group		Study Group	
	Pre	Post	Pre	Post
Mean ± SD	22.327±1.066	21.507±1.174	22.3±1.145	20.093±1.261
MD	0.82		2.207	
% of Diff	3.67		9.89	
t-value	3.96		5.53	
p-value	0.001**		0.000**	

Table 3: Comparing the mean values of step length (cm) among the two groups.

Group	Control Group		Study Group	
	Pre	Post	Pre	Post
Mean ± SD	31.693±1.627	32.353±1.455	31.833±1.497	34.28±1.338
MD	0.66		2.447	
% of Diff	2.08		7.68	
t-value	5.66		4.64	
p-value	0.000**		0.000**	

Table 4: Comparing the mean values of speed (cm/sec) among the two groups.

Group	Control Group		Study Group	
	Pre	Post	Pre	Post
Mean ± SD	75.067±2.717	76.267±2.473	73.414±3.201	78.987±2.473
MD	1.2		5.573	
% of Diff	1.59		7.59	
t-value	6.08		6.68	
p-value	0.000**		0.000**	

Table 5: Comparing the mean values of turn time (sec) toward left side among the two groups.

Turn Time (sec)	Left Side			
	Control Group		Study Group	
	Pre	Post	Pre	Post
Mean ± SD	1.846±0.152	1.7067±0.1399	1.7733±0.1262	1.5707±0.1388
MD	0.1393		0.2027	
% of Diff	7.54		11.43	
t-value	8.83		4.73	
p-value	0.000**		0.000**	

Table 6: Comparing mean values of turn time (sec) toward right side among the two groups.

Turn Time (sec)	Right Side			
	Control Group		Study Group	
	Pre	Post	Pre	Post
Mean ± SD	1.79±0.0958	1.6887±0.1103	1.738±0.0999	1.5427±0.1208
MD	0.1013		0.1953	
% of Diff	5.65		11.23	
t-value	7.1		4.58	
p-value	0.000**		0.000**	

Table 7: Comparing the mean values of turn sway (deg/sec) toward left side among the two groups.

Turn Sway (deg/sec)	Left Side			
	Control Group		Study Group	
	Pre	Post	Pre	Post
Mean ± SD	44.973±2.383	43.8±2.141	45.127±1.812	41.813±2.117
MD	1.173		3.313	
% of Diff	2.6		7.34	
t-value	7.8		7.25	
p-value	0.000**		0.000**	

Table 8: Comparing the mean values of turn sway (deg/sec) toward right side among the two groups.

Turn Sway (deg/sec)	Right Side			
	Control Group		Study Group	
	Pre	Post	Pre	Post
Mean ± SD	45.027±1.987	44.013±2.12	44.767±1.84	41.587±1.623
MD	1.0133		3.18	
% of Diff	2.25		7.1	
t-value	10.19		5.16	
p-value	0.000**		0.000**	

Fig. 1: Pre and post treatment mean values of step width among the two groups.

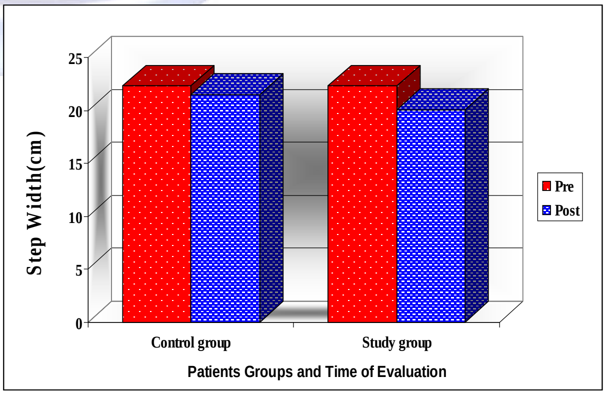


Fig. 2: Pre and post treatment mean values of step length among the two groups.

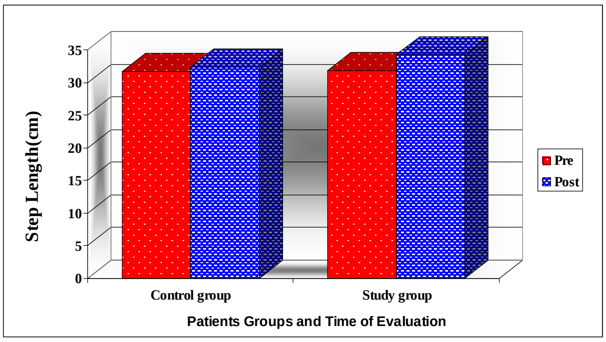


Fig. 3: Pre and post treatment mean values of speed among the two groups.

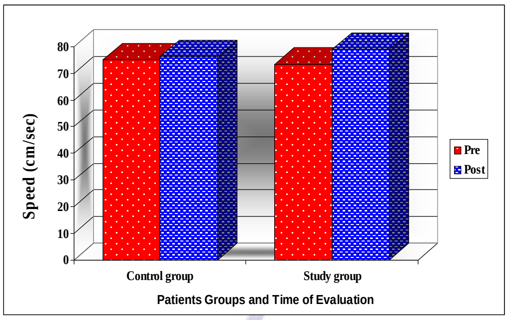


Fig. 4: Pre and post treatment mean values of turn time toward left side among the two groups.

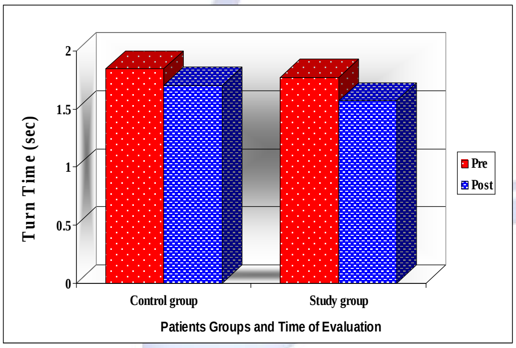


Fig. 5: Pre and treatment mean values of turn time toward right side among the two groups.

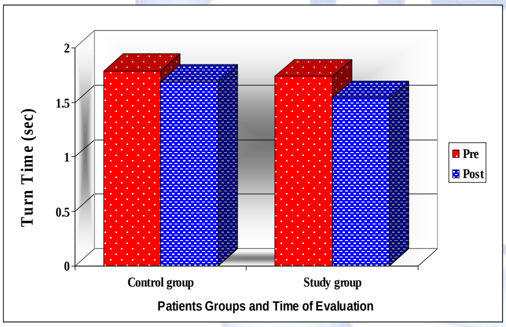


Fig. 6: Pre and post treatment mean values of turn sway toward left side among the two groups.

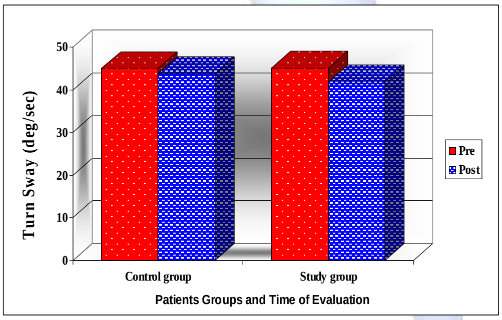
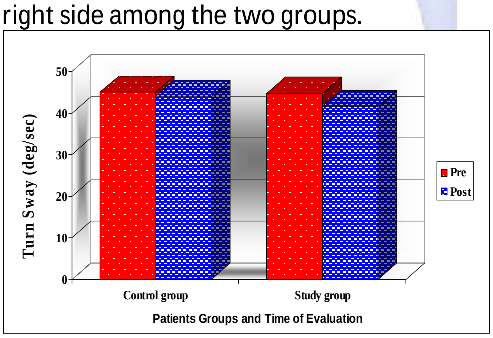


Fig. 7: Pre and post treatment mean values of turn sway toward right side among the two groups.



DISCUSSION

The aim of this work was to investigate the effect of using treadmill training on dynamic balance as consequence to improving mobility skills during walking in hemophilic children. Comparing the pre and post treatment results in Walk Across test of children of two groups revealed that; decrease step width, improvement of step length and speed. These results could be attributed to strengthening of lower extremity muscles might have been cause of sufficient force. Muscle strengthening found in such children is necessary to produce joint stability and adequate equilibrium reactions. These outcomes are supported by Karimi et al., (2008) [23] who stated that an intact neuromuscular system and sufficient muscle strength are the requirements of a proper motor response for postural balance control to maintain the center of mass within the base of support when balance is affected. The declines in strength, range of motion and reaction time are also hypothesized to affect balance control [24].

The significant difference recorded in comparing the pre and post treatment results in Step/ Quick Turn test of children of the two groups which revealed significant decrease the timing and swaying of the turn. These results could be attributed to improvement of somatosensation in hemophilic limbs and in adapting sensory information to the changing environment demand which might affect their abilities to maintain stability in different level of unsteady surface. The previous descriptions were supported by Sanger and Kukke, (2007) [25] who mentioned that somatosensory problems can disrupt postural control by: (a) affecting the child ability to adapt sensory inputs to changes in task and environmental demands and (b) preventing the development of accurate internal models of the body for postural control.

The results of the collected data post treatment of both groups to current study shows significantly decreasing of turning time and sway around right and left side in Step/ Quick Turn test. These results could be attributed to effect of gait training by using treadmill on improving of dynamic balance in the form of ability to safely turn quickly as a resulting in ability to control the moving center of gravity over the small base of support and easy to resort to the much slower strategy of taking multiple steps to turn around. This strategy allows less support time, improve speed for stability. These results comes in supporting with Matsuno et al., (2010) [26] who concluded that the treadmill is considered as a moving surface, so, the children needed to spend more time with both feet on the surface during the walking cycle than when they walked over ground.

Gait deviation may be resulted from frequent immobilization with subsequent weakness, joint changes, muscle shortening, impaired proprioception and pain. Even mild gait deviations can create additional stress on joints, recurrent hemarthrosis, synovitis and further joint destruction. Jean and Stout, (2006) [27] explained that adequate range of motion, strength, appropriate bone structure and body composition also affect the locomotion and its refinement. These variables have significant ramifications as mechanical factors in the development of walking. the factors affected the early patterns of walking are; range of motion, strength, bony structure and the ability to manage gravitational and inertial forces of the lower extremities. In the presence of typical motor control and maturation, constrains in any of these mechanical variables change patterns.

Treadmill exercise facilitates the kinematic, kinetic, and temporal features of walking. It is assumed to enhance motor learning and strengthen the muscles of lower extremities, activate the locomotor control system, and improve functional abilities [28,29] Previous study revealed that, the treadmill exercise improves the balance and build muscle strength in the lower limbs which are involved in the generation of more independent and mature walking. Treadmill exercise is more advanced to regular gait training program as it eliminates the possible compensatory movement. In elderly with hemiparetic cerebral palsy treadmill exercise showed improvement in strength of flexors and extensors of the knee joint as well as dynamic balance [30].

Treadmill exercise is believed to improve the lower limbs muscle power and balance as well as stimulate neuronal connections that are involved in generation of independent balanced walking [31]. Functional lower limb strength training combined with treadmill exercise are considered to be maximally effective than being applied individually [32]. Treadmill exercise has a superior effect on ground walking as it causes higher energy consumption when compared to energy consumption of over ground walking [31].

CONCLUSION

On the bases of the present data, it is possible to conclude that the combined application of treadmill training program in the form of designed program of physical therapy exercises to mobility skills during walking, and treadmill is an effective therapeutic modality for improving dynamic balance in hemophilic children.

ABBREVIATIONS

cm- Centimeter **cm/sec-** centimeter/ seconds
deg/Sec- degree/seconds **sec-** seconds
ms- millisecond **HZ-** Hertz.
MD- Means Difference. **MHz-** Mega hertz
Pre- Before treatment
Post- After three months of treatment.
p-value- Probability value
SD- Standard Deviation.
t-value- UnPaired t-test value.
w/cm2- Watt/centimeter square
% of Dif- Percentage of Difference
******- Significant
***-** Non significant

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Conflicts of interest: None

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