Ventilatory Functions in Response to Spasticity Control After Treadmill Training in Hemiplegic Children

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ABSTRACT

Purpose: This study is a trial conducted to determine the effects of treadmill training when added to the exercise therapy program on controlling spasticity of the lower limbs and on ventilatory response in hemiplegic cerebral palsied children. Subjects: Forty spastic hemiplegic children ranging in age from six to eight years represented the sample of this study. The degree of spasticity ranged from 1^+ to 2 grades according to the modified Ashworth scale. They were able to walk independently with an abnormal gait pattern. They were able to understand commands and follow instructions. The study sample was divided randomly into two groups of equal number (A and B). Evaluation included determining the joints' angles and percentage of stance and swing phases, using an electronic motion analysis system, and measuring the ventilatory functions, using electronic spirometer. It was conducted for each child of the two groups before and after three months of treatment, which was conducted six times / week. Procedures: Group A (control) received a designed exercise program, while group B (study) received treadmill training in addition to the same exercise program given to group A. Results: The results of this study revealed no significant differences when comparing the pre-treatment mean values of the measuring variables for the two groups. Also, no significant differences were observed in the ventilatory function tests of group A, when comparing its pre and post treatment mean values. However, significant improvement was observed in the results of group B, when comparing its pre and post treatment mean values. Highly significant improvement was reported when comparing the post treatment results of the two groups in favor of group B. Conclusion: Significant improvement observed in group B may be attributed to the effects of treadmill training when added to the exercise therapy program which augmented gait abilities in hemiplegic cerebral palsied children. Consequent decrease in spasticity improved physical activities, which lead to reduction of work capacity, improvement of energy expenditure and so increased ventilatory functions.

INTRODUCTION

Movement is essential for performance of routine daily tasks and recreational activities and is the direct result of many factors. An individual must have the willingness or motivation to accomplish a task, and the movement must be supported by the musculoskeletal, neuromuscular, and cardiopulmonary systems. As experts in the science of movement dysfunction, physical therapists determine probable causes of problems related to movement and then design programs to improve physical function[5].

The ability to walk is a major concern of the parents of children with cerebral palsy, improving or maintaining this ability is often considered to be the primary focus of most therapeutic interventions addressing the motor problems seen in children with cerebral palsy[2].

The reason for emphasis on the table of walking, apart from any other abilities, is the measure of independence and social acceptance. The ultimate goal for many pediatric therapists is to help the cerebral palsied child to walk independently[4].

Spastic hemiplegia is a common form of cerebral palsy. It is the commonest neurological cause of an abnormal gait[30]. The abnormal hemiplegic gait is characterized by uneven step length and a limp[26]. There is asymmetry, decreased step length and stride length, poor pelvic and shoulder girdle rotation with retraction and absence of heel strike on the involved side[21].

Hemiplegic patients also lack the motor control necessary to distribute weight evenly onto their lower extremities during standing, resulting in averages of only 28-36% of body weight, supported by the paretic limb[7].

During hemiplegic walking, there are deficits in balance, proprioception, and selective control that limit their ability to shift and support body weight on the paretic limb. Decreases in velocity, cadence and stride length occur with relative increases in gait cycle duration and initial and double limb support period. Marked asymmetries are evident between the paretic and uninvolved limbs in stance and swing times, single limb support and stance to swing ratio[23].

It has also been reported that less efficient gait lead to more energy expenditure and offers load on ventilatory functions which has also been attributed to be due to the increased spasticity.

Patients could practice a more favorable gait on the treadmill, which is characterized by a greater stimulus for balance training and higher symmetry[11].

Treadmill has been used as an alternative method of gait training for neurologically impaired persons, it allows simultaneous retraining of the various components of gait during actual locomotion and facilitates the expression of a normal gait pattern[8].

It has been used to reduce gait deviations seen in patients who are functional ambulates. Treadmill training offers the advantages of task oriented training with numerous repetitions of a supervised gait restoration of non-ambulatory patients with chronic hemi paresis. Treadmill training could therefore become on adjunctive tool to regain walking ability in a shorter period of time[10].

Treadmill training is also considered one of the main components of pulmonary rehabilitation program. Its objectives are to control and alleviate, as much as possible, the patho-physiological complications of respiratory impairment and to teach the patient how to achieve optimal capability for carrying out activities of daily living[12]. It also improves pulmonary function, specially FEV_1, the exercise capacity, the efficacy of walking and the shortening of breath, dyspnea associated with increased effort[31].

During exercise, skeletal muscle activity results in an increase in cellular O_2 requirements and in the amount of CO_2 that must be removed by the lungs. To meet the increased O_2 needs, both ventilation and cardiac output must increase in proportion to the increased metabolic rate[20].

Moreover, psychological outcomes of aerobic training; such as running, swimming, pace walking and treadmill walking or cycling ergometer, include reduction in dyspnea, reversal of anxiety and depression and better quality of life[18].

The purpose of this study was to determine the effectiveness of treadmill training on controlling lower limb spasticity as well as changing ventilatory function measurements.

It has been hypothesed that treadmill training had no effect on gait parameters or ventilatory functions.

SUBJECTS, INSTRUMENTATION AND PROCEDURES

Subjects

Forty spastic hemiplegic cerebral palsied children (27 left and 13 right sided), ranging in age from six to eight years (X` 7.2 ± 0.45 years) participated in this study. They were selected from both sexes (19 boys and 21 girls), from the out-patients clinic of the Faculty of Physical Therapy, Cairo University. The degree of spasticity was determined according to the modified Ashworth scale[3], to be ranging from 1^+ to 2 grades. They were able to understand any command given to them with an IQ within normal average. They were able to walk independently with an abnormal gait pattern. The affected lower limb was free from any structural deformities, however there was mild degrees of tightness in the lower limb muscles. They were examined by a chest specialist to exclude any child with chronic chest disorders as; asthma, or congenital heart problem. They were divided randomly into two groups of equal number A and B, each composed of twenty children. Evaluation was conducted for each child individually before and after three months of treatment. Group A (control) received a designed exercise therapy program, while group B (study) received treadmill training in addition to the exercise program given to group A.

Instrumentation

For evaluation:

*Electronic motion analysis system, Qualisys medical, AB system, was used. It consisted of:

-Six cameras arranged on both sides of the walkway.

-A wand kit for calibration.

-A PC computer with the Q Trace software installed.

-A communication card which is mounted in the PC(ACB – 530 serial interface adapter)

-Eight meters long wooden walkway.

-Reflective dots and sticky material.

*Electronic Spirometry: Datospir 120-Sibelmed, made in Barcelona.

It was used for ventilatory function measurement.

-Weight and Height scale: Health made in China. It was used for measuring the weight and the height of each child in order to determine the predicted values of ventilatory functions.

-For treatment:

Treadmill apparatus (En Tred) by universal gym Iowa, USA for gait training.

Procedures

****For evaluation:***

1) Gait evaluation: The reflective dots were placed on specific bony landmarks [acromion, spinous process of the twelfth thoracic vertebra, anterior superior iliac spines, sacrum, suprapatellar (along the central line of the patella at the rectus femoris tendon), tibial tuberosity, lateral malleolus, posterior aspect of the calcaneus].

Each child was then asked to stand at the border of the measurement volume (part on the walkway that covered the volume required for the whole body of the child to perform an entire gait cycle) where the right and left sides were visible in the cameras.

Each child was asked to start walking, an entire gait cycle was captured within the volume. He / She was allowed to continue walking several meters after the measurement volume. Data collected started just before the patient entered the measurement volume and after it, for a few seconds. All subject’s data was displaced and all relevant data was entered. When the calculations were completed, the results were displayed showing the global gait parameters, and a standard graph of calculated parameters were displayed. 2)Ventilatory function measurements: FVC, FEV_1, PEF were measured by the Spirometer. Each child was asked to assume an erect standing position, carry the breathing tube and close his/her lips firmly around the disposable mouthpiece. The child's age, sex, weight and height were introduced to the apparatus, then, each child was instructed to perform the test while he/she wearing the nasal clip. The child was asked to inhale air slowly until the lungs were completely fill, and then blow out as hard and fast as much as he/she could.

The above procedures were repeated 3 times with rest in between (until regain the pre test condition) and the maximum value was recorded.

Evaluation was conducted for each child of the two groups, before and after three months of treatment. Groups A and B received a designed exercise therapy program including neurodevelopmental approach for inhibition of increased muscle tone and abnormal postural reflexes and facilitation of normal patterns of postural control (righting and equilibrium reactions), approximation, facilitation of protective reactions, strengthening exercises of the anti-spastic muscles, gait training in forward, backward and sideways directions in a closed then in an open environment. In addition to stretching exercises to maintain the length and elastic recoil of the soft tissues liable to be tight specially the Achilles tendon, hamstrings, hip flexors and adductors of the lower limbs. Also, free active exercises of the upper limbs combined with respiratory exercises were applied.

In addition, group B (study) received treadmill training as follows:

Each child was asked to walk on the treadmill with a speed of 1.5 kilometers/ hour and zero degree inclination for 10 minutes[17], increased gradually to reach 3 kilometers/ hour and 10 degrees inclination for 20 minutes at the end of the study.

The treatment program was conducted for each child of the two groups three times/ week for three successive months.

RESULTS

The collected data from the two groups were statistically treated to show the mean and standard deviation of joints' angles of the affected lower limb, percentage of stance and swing phases, which denoted changes in the degree of spasticity. The ventilatory function tests including forced vital capacity (FVC), forced expiratory volume at first second (FEV_1) and peak expiratory flow (PEF) reflected improvement in lung capacity and respiratory muscles function. The student t-test was then applied to determine the significance of treatment for each group.

No significant difference was observed when comparing the pre-treatment mean values of all the measuring variables for the two groups. No significant difference was also observed in the results of ventilatory functions of group A, while significant improvement was observed in the results of joints' angles and percentage of swing and stance phases, when comparing their pre and post-treatment mean values. Highly significant improvement was reported in group B, when comparing its post-treatment mean values of all measuring variables with the post-treatment mean values of group A.

I- Joints' angles

-Group A:

**** During initial contact:**

As shown in table (1) and figure (1), the mean values of hip, knee and ankle joints' angles (degrees) during initial contact pre and post-treatment for group A were as follows:

1- Hip joint:

The mean values of the angle of hip flexion of the affected lower limb, pre and post-treatment were 8.07±3.15° and 14.13±2.94° , respectively (P < 0.0001)

2- Knee joint:

The mean values of the angle of knee flexion of the affected lower limb, pre and post-treatment were 1.93±1.71° and 4.93±1.83° , respectively (P< 0.001)

3- Ankle joint:

The mean values of the angle of planter flexion of the affected ankle joint pre and post-treatment were 38.47±4.58° and 33.8±4.5°, respectively (P < 0.0001).

Table (1): Mean values of hip , knee and ankle joints' angle(degrees) during initial contact, pre and post treatment, for group A.

	Hip joint		**Knee joint**		**Ankle joint**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
X`	8.07	14.13	1.93	4.93	38.47	33.8
SD	± 3.15	± 2.94	± 1.71	± 1.83	± 4.58	± 4.5
t-test	8.991		3.467		5.824	
P value	< 0.0001		< 0.001		< 0.0001	
Sig.	Highly Significant		Significant		Highly Significant	

X`: Mean SD : Standard deviation P : Level of significance Sig.: Significant

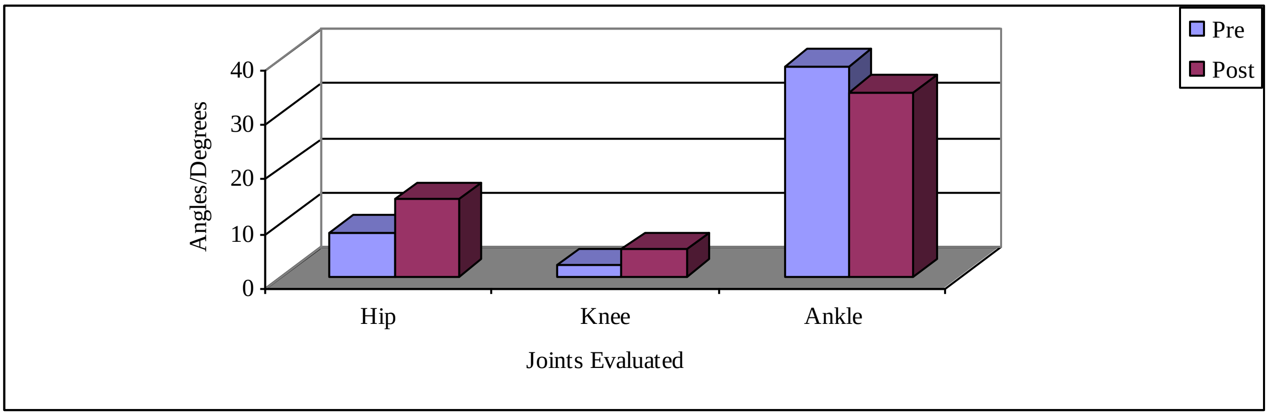

Fig. (1): Illustrating the mean values of hip, knee and ankle joints' angles (degrees) during initial contact, pre and post-treatment, for group A.

-Group B:

**** During initial contact:**

As shown in table (2) and figure (2), the mean values of hip, knee and ankle joints' angles (degrees) during initial contact, pre and post-treatment for group B were as follows:

1- Hip joint:

The mean values of the angle of hip flexion of the affected lower limb, pre and post-treatment were 8.4±2.35° and 19.86±2.16°, respectively (P < 0.001).

2- Knee joint:

The mean values of the angle of knee flexion of the affected lower limb, pre and post-treatment were 2.66±1.59° and 8.73±1.62°, respectively (P < 0.01).

3- Ankle joint:

The mean values of the angle of planter flexion of the affected ankle joint, pre and post-treatment were 38.33±4.03° and 27.66±3.33° respectively (P < 0.001).

Table (2): Mean values of hip, knee and ankle joints' angle(degrees) during initial contact, pre and post treatment, for group B.

	Hip joint		**Knee joint**		**Ankle joint**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
X`	8.4	19.86	2.66	8.73	38.33	27.66
SD	± 2.35	± 2.16	± 1.59	± 1.62	± 4.03	± 3.33
t-test	3.846		2.419		3.536	
P value	< 0.001		< 0.01		< 0.001	
Sig.	Significant		Significant		Significant	

X: mean SD: Standard deviation P: Level of significance Sig.: Significant

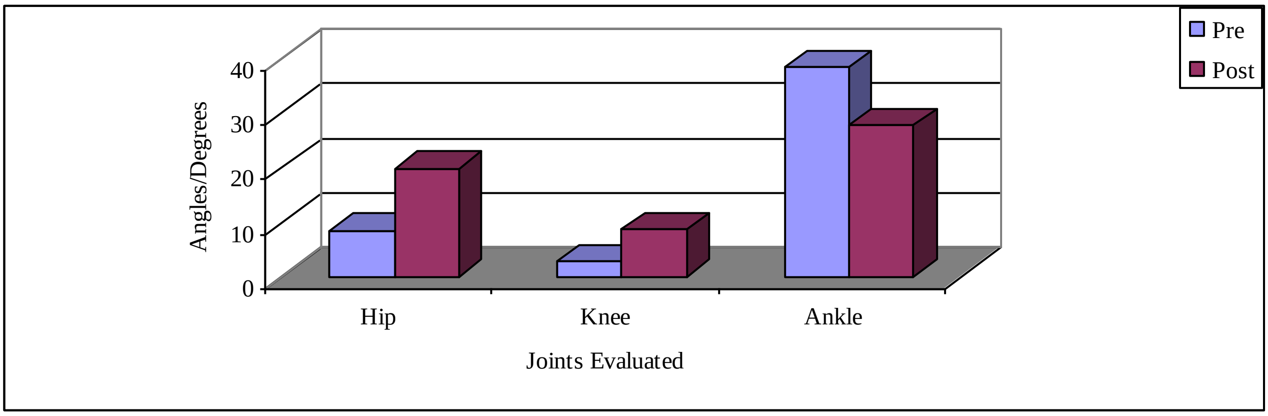

Fig. (2): Representing the mean values of hip, knee and ankle joints' angle (degrees) during initial contact, pre and post-treatment, for group B.

Comparing the post-treatment mean values of joints' angles of the affected lower limb for groups A and B revealed highly significant improvement in favor of group B, as shown in figure (3).

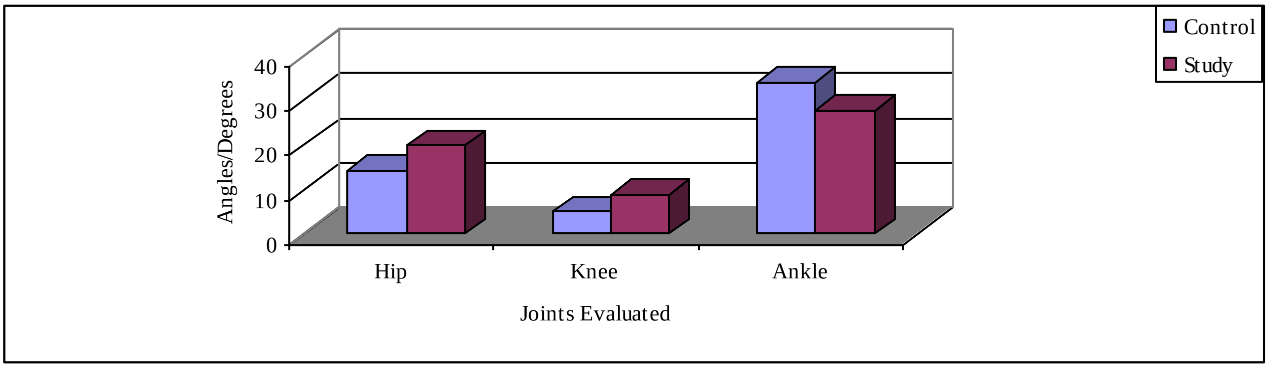

Fig. (3) : Illustrating the post-treatment mean values of hip, knee and ankle joints' angles (degrees) during initial contact for groups A and B.

II- Percentage of stance and swing phases

-Group A:

As shown in table (3) and figure (4), the mean values of stance and swing phases (percentage), pre and post-treatment, for group A were as follows:

Stance phase:

The mean values of stance phase (percentage) pre and post-treatment were 44.87±2.09 % and 51.4±3.27 %, respectively (P< 0.001).

Swing phase:

The mean values of swing phase (percentage) pre and post-treatment were 55.13±2.1% and 49.93±2.05%, respectively (P<0.0001).

Table (3) : Mean values of stance and swing phases (percentage) pre and post-treatment for group A.

	Stance phase %		**Swing phase %**	
	Pre	**Post**	**Pre**	**Post**
X`	44.87	51.4	55.13	49.93
± SD	± 2.09	± 3.27	± 2.1	± 2.05
t-test	3.848		5.118	
P value	< 0.001		< 0.0001	
Sig.	Significant		Highly Significant	

X` : Mean SD : Standard deviation P value: Level of significance Sig. : Significant

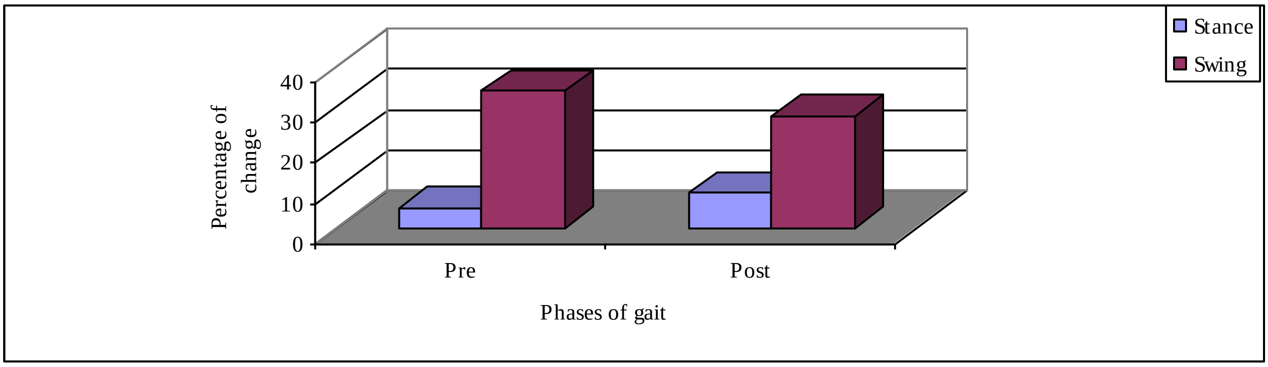

Fig. (4): Demonstrating the mean values of stance and swing phases (percentage) pre and post-treatment for group A.

-Group B:

As shown in table (4) and figure (5), the mean values of stance and swing phases (percentage) pre and post-treatment for group B were as follows:

Stance phase:

The mean values of stance phase (percentage) pre and post-treatment were 45.2±2.14 % and 55.13±2.29 %, respectively (P < 0.0001).

Swing phase:

The mean values of swing phase (percentage) pre and post-treatment were 54.8±2.14% and 44.86±1.39 %, respectively (P< 0.0001).

Table (4): Mean values of stance and swing phase (percentage) pre and post-treatment for group B.

	Stance phase %		Swing phase %	
	Pre	**Post**	**Pre**	**Post**
X`	45.2	55.13	54.8	44.86
SD	± 2.14	± 2.29	± 2.14	± 1.39
t-test	5.876		6.234	
P value	< 0.0001		< 0.0001	
Sig.	Highly significant		Highly significant	

X`: Mean SD: Standard deviation P value : Level of significance Sig.: Significant

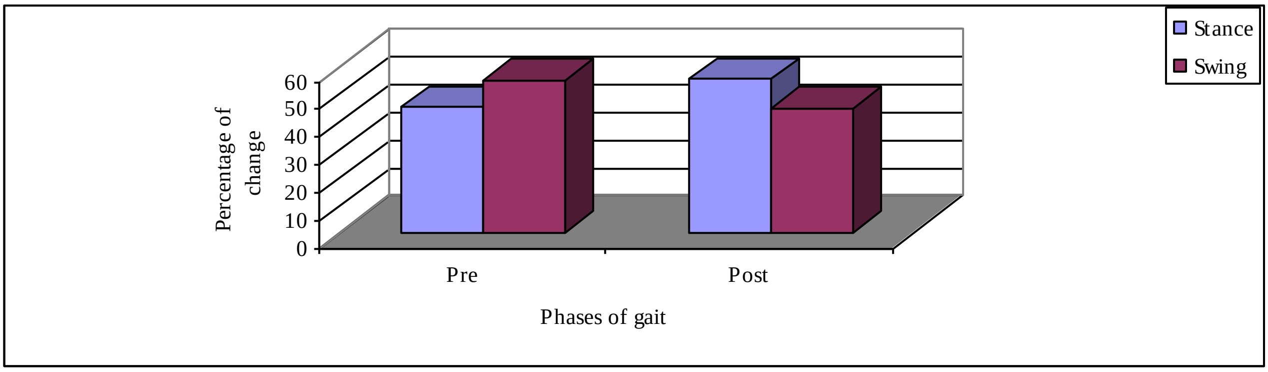

Fig. (5): Representing the mean values of stance and swing phases (percentage) pre and post-treatment for group B.

Comparing the post-treatment mean values of stance and swing phases (percentage) for groups A and B revealed highly significant improvement in favor of group B, as shown in figure (6).

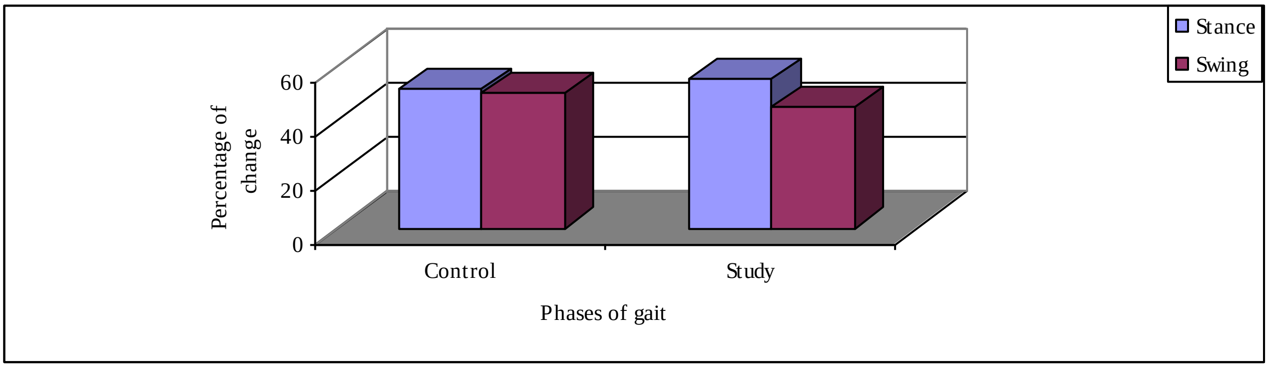

Fig. (6): Illustrating the post-treatment mean values of stance and swing phases (percentage) for groups A and B.

III. Ventilatory function tests

-Group A:

As shown in table (5) and figure (7), the mean percentage of forced vital capacity (FVC), forced expiratory volume at first second (FEV_1) and peak expiratory flow (PEF), pre and post-treatment, for group A were as follows:

***Forced vital capacity**

The forced vital capacity showed statistical non significant changes after treatment from a mean percentage of 55.75±10.04% to 56.94± 4.89% (P > 0.05)

***** Forced expiratory volume at first second:***

Regarding to the FEV_1, the mean percentage changed from 53.8±12.84 % to 55.75±6.97 % after treatment, which is also non significant, (P> 0.05).

***** Peak expiratory flow:***

The mean values of PEF did not show nearly any statistical difference, when comparing between its pre and post treatment mean values, which were 46.45±9.65 % and 46.81±9.01 %, respectively (P > 0.05).

Table (5): Comparison between the pre and post treatment mean percentage of FVC , FEV_1, and PEF for group A.

Variables	X`± SD Pre treatment %	X`± SD Post treatment%	t-test	P value	Significance
FVC	55.75±10.04	56.94± 4.89	0.36	> 0.05	**Non sig.**
FEV_1	53.8±12.84	55.75± 6.97	0.55	> 0.05	**Non sig.**
PEF	46.45±9.65	46.81±9.01	0.12	> 0.05	**Non sig.**

X`: Mean SD: Standard deviation P :Level of significance. Non. Sig.: Non Significant

FVC: Forced vital capacity. FEV_1:Forced expiratory volume at first second PEF: Peak expiratory flow

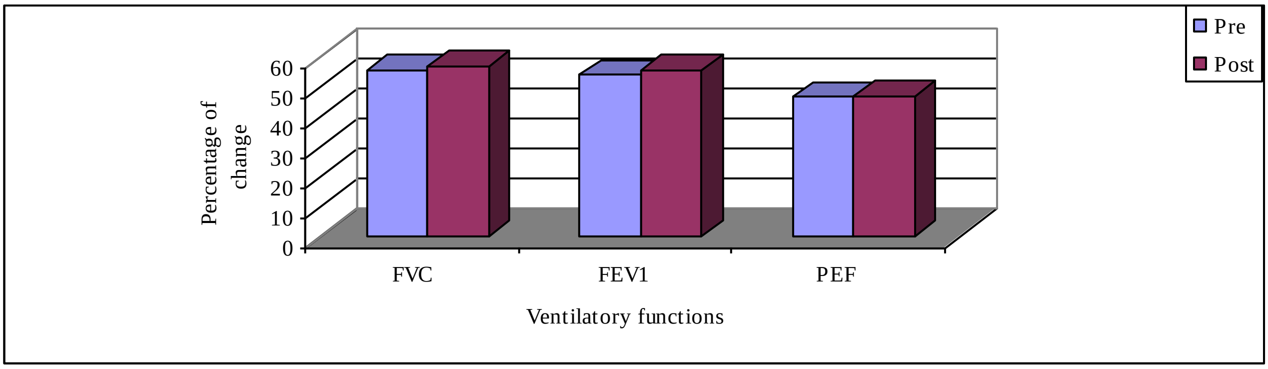

Fig. (7): Illustrates the pre and post treatment mean percentage values of FVC, FEV_1 and PEF for group A.

-Group B:

On the other hand, statistical analysis of the pre and post treatment mean percentage of pulmonary function tests in group (B) showed highly significant difference, table (6) and fig. (8). Dramatic increase occurred in the post treatment mean percentage of FVC when compared with the pre treatment results. The pre treatment mean percentage was 56.75±10.04% while the post treatment mean percentage was 94.2±14.19%, (P<0.001). High statistical significant difference was also found when comparing the pre and post treatment mean percentage of FEV_1. The pre treatment mean value was 53.8±12.84% while the post treatment mean value was 91±16.16%, (P <0.001). Also, the pre treatment mean percentage of PEF was 46.45±9.65% while the post treatment mean percentage value was 87.1±16.89%, (P <0.001).

Table (6): Comparison between the pre and post treatment mean percentage of FVC, FEV_1, and PEF in group B.

Variables	X`± SD Pre treatment %	X`± SD Post treatment%	t-test	P value	Significance
FVC	56.75±10.04	94.2±14.19	11.14	<0.001	**Sig.**
FEV_1	53.8±12.84	91±16.16	10.33	<0.001	**Sig.**
PEF	46.45±9.65	87.1±16.89	9.57	<0.001	**Sig.**

X: Mean SD: Standard deviation P :Level of significance. Non. Sig.: Non Significant
FVC :Forced vital capacity. FEV_1:Forced expiratory volume at first second PEF: Peak expiratory flow

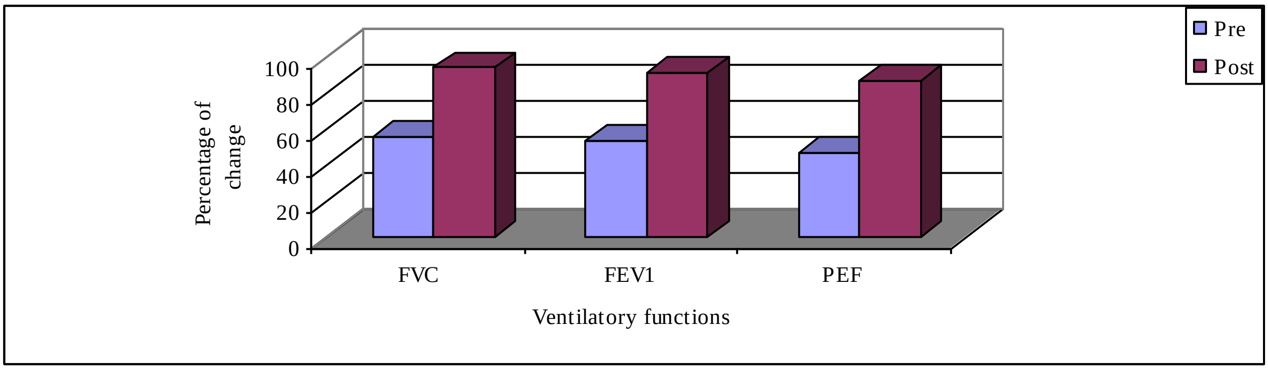

Fig. (8): Illustrate the mean percentage values of pre and post treatment in FVC, FEV_1 and PEF for group B.

Comparing the post-treatment mean values of ventilatory functions (FVC, FEV_1 and PEF) for groups A and B revealed highly significant improvement in favor of group B, as shown in figure (9).

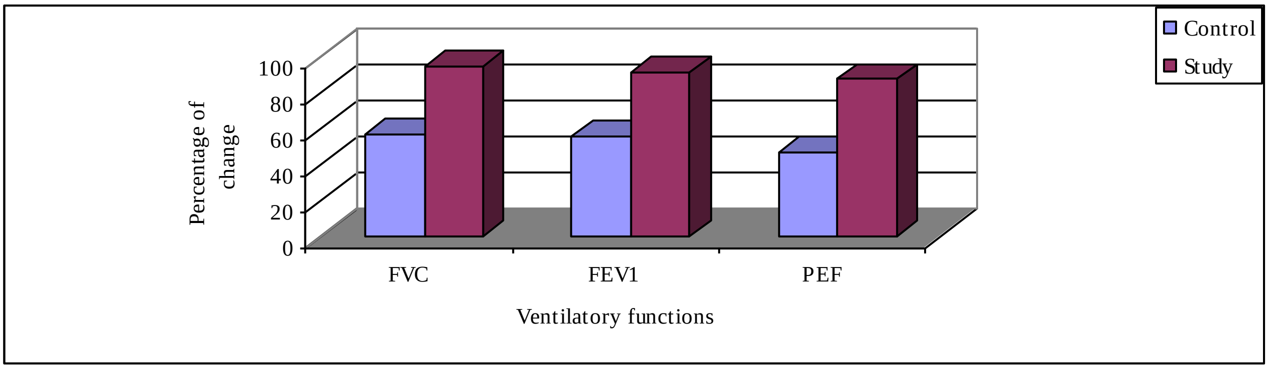

Fig. (9): Demonstrating the post-treatment mean percentage values of ventilatory function tests for groups A and B.

DISCUSSION

This study is a trial conducted to determine the effects of treadmill training, when added to the exercise therapy program, on controlling lower limb spasticity and improving ventilatory functions in hemiplegic cerebral palsied children.

The results of the study rejected the null hypotheses as it revealed that, there was significant improvement in the measuring variables, including joints' angles of the affected lower limb, stance and swing phases (percentage), for the two groups A and B, when comparing their pre and post treatment mean values. As regards to the ventilatory functions (FVC, FEV_1 and PEF), no significant improvement was observed in group A when comparing its pre and post treatment mean values. However, high significant improvement was observed in all the measuring variables in favor of group B receiving treadmill training in addition to the exercise therapy program, when comparing the post treatment mean values of the two groups A and B.

Gait disorders observed in hemiplegic children are believed to be a result of muscle weakness, joint instability, alteration of normal muscle function, sensory loss and loss of normal balance mechanism of the affected leg[9]. Recovery of independent walking is the most important goal for hemiplegic cerebral palsied children and for their rehabilitation therapists[6,13].

Observation of the pre-treatment mean values of the gait parameters of the two groups confirm the findings of Rose and Gamble[8] who revealed that in hemiplegic patients the stance phase is primarily governed by an extensor synergy. They attributed their results to be due to the idea that the hip, knee extensors and the ankle planter flexors are activated simultaneously for weight bearing stability, so, there is a decrease in the flexion angle of the hip and knee joint and dorsiflexion of the ankle joint.

The findings obtained before starting treatment also come in agreement with the results of Thometz et al.,[28] who reported a decrease in the excursion of the joints' angles, temporal and distance parameters in cerebral palsied children who were pre-operatively evaluated for distal lengthening of the medial hamstrings.

Improvement of gait parameters in the two groups may be due to the effect of neurodevelopmental approach using proximal and distal key points of control which lead to inhibition of the increased tone and facilitated postural (righting and equilibrium) and protective reactions.

The designed exercise program concentrated on the effects of disturbed postural reactions and abnormal reflexes on functional skills. The aim of developing automatic postural mechanisms was to help in maintaining an upright position against gravity and to keep a predictable orientation to the surroundings[21].

Applying the exercise therapy program in the two groups are coincided with Tecklin[27] who stated that the ultimate goal of treatment for the cerebral palsied children is to have the best possible function.

Improvement fulfilled in group (A) may also be attributed to the effect of the designed exercise program, which included a group of exercises representing the integral components of the gait cycle. These exercises were advanced in a proximal to distal progression of movements, from bilateral to unilateral activities, from simple to complex movements, from concentric to the eccentric contractions. The exercise protocol was developed upon four elements :

1- The use of sensory inputs to influence muscle tone.
2- Application of concepts from learning theory to shape motor behavior.
3- Interactions of the body and its segments to influence muscle tone and motor control.

4- Manipulation of the therapeutic, environment to accommodate the patient's psychological and physiological needs.

Highly significant improvement observed in group B receiving treadmill training in addition to the exercise therapy program may be attributed to the facilitatory effect of treadmill in which the hemiplegic child was enforced to dorsiflex his ankle which facilitated hip and knee flexion. Also, it allowed him to pull his heel off the ground, his pelvis was kept rotated backwards on the affected side and his hip was fixed in some degrees of flexion.

The post treatment results agree with Manning and Pomery[16] who reported that walking on a treadmill encourages steeping movements and improves functional mobility in hemiplegic patients.

The results obtained in group B also confirm the findings of Wade[29] who recommended the use of treadmill training in conjunction with conventional physiotherapy for post stroke patients, who are unable to walk independently.

Significant improvement observed in group B contradict with the findings of Laufer et al.,[14] who established that treadmill training does not differ statistically from the exercise therapy program for improvement of gait parameters.

The increase in stance phase percentage on the affected lower limb at the end of the study period is a reflection of an improved strength and stability, co-ordination and maturation of the central nervous system, this support the findings of Rose and Gamble[23].

After the suggested period of treatment, it has been observed that the hip and knee flexion angle improved and also the ankle planter flexion. This improvement may be due to the effect of treadmill which helped in the motor learning process and in turn helped in the acquisition of motor control. This come in agreement with Ounpuu et al.,[19] who reported that hip musculature (both extensors and flexors) are responsible for the majority of positive work performed during the walking cycle, with most being produced during stance phase.

The post treatment results of group B agree with Sandhya et al.,[24] who stated that there was an improvement in foot clearance during walking after using treadmill training in hemiplegic patients.

The results obtained in group B after the suggested period of treatment also, come in agreement with Schache et al.,[25] who reported that the treadmill training is effective and superior to the over-ground walking due to many factors:

1- Non-mechanical factors as treadmill familiarity.
2- Differences in air resistance.
3- It is possible that the biomechanical response of the subject was influenced by difference in the mechanical properties of the two walking surfaces.
4- The energy expenditure and ventilatory functions could have been improved with the treadmill than with level walking.

Another important objective of this study was, to analyze the association between possible changes in ventilatory functions and selected gait parameters after aerobic training via using treadmill.

Pulmonary impairment may result from several body system disorders. Measurement of pulmonary functions is an important component of respiratory assessment in children with neuromuscular disorders[1].

The post treatment results of group A receiving exercise therapy program showed significant improvement in gait parameters but not ventilatory functions, as controlling spasticity has been proven to have an indirect short term effect on ventilatory functions, which was not significant. However, group B receiving treadmill training in addition to the same exercise program given to group A, manifested an improvement in both the measured gait parameters and ventilatory functions. These obtained results may be attributed to the effects of treadmill training which has a direct effect on the large muscles of the body, leading to an improvement in the physical fitness, energy expenditure and ventilatory functions, in addition to its effect on gait parameters.

This finding is coincided with Ries et al.,[22] who concluded that, regular physical activity of adequate intensity and duration using treadmill involving large muscle groups has been proved to have a number of potential beneficial effects on general health, including improvement in aerobic capacity, body composition, flexibility, muscular strength, and psychosocial measures.

The obtained results after the suggested period of treatment also confirm the findings of Peg[20] who established that, a possible mechanism for improvement of pulmonary function , may be a result of an increase in regular physical activity of sufficient intensity enough to increase aerobic fitness This will raise the ventilatory threshold, thereby lowering the minute ventilation during mild and moderate exercises. Exercise training may also reduce the work capacity that is, the maximum work output which is consistent with the observation increase in VO_2 max and possible change in energy expenditure associated with treadmill walking.

The results of the present study in group B after the suggested period of treatment may be due to improvement in the gait parameters after treadmill training which was associated with improvement in muscular capillarisation, oxidative capacity, muscular strength, and cardio-circulatory adjustments, which in turn improved ventilatory functions[15].

Conclusion

From the obtained results, it may be concluded that combination of treadmill training with the exercise therapy program had augmented gait abilities in hemiplegic cerebral palsied children, which subsequently lead to improvement in ventilatory functions.

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الملخص العربي

أستجابة وظائف التهويه للتحكم فى التشنجات بعد تدريب على السير الكهربائي للأطفال المصابين بالفالج النصفى

تهدف هذه الدراسة الى تحديد تأثير التدريب على السير الكهربائي بالأضافه الى برنامج من التمرينات العلاجية فى التحكم فى تشنجات الأطراف السفليه وتحسين وظائف التهويه عند الأطفال المصابين بالفالج النصفى. اشترك فى الدراسة ٤٠ طفلا تراوحت اعمارهم بين ٦- ٨ اعوام و كانت درجة التشنج بين ١-٢ درجه بمقياس أشورث . تم تقسيم الأطفال عشوائيا الى مجموعتين متساويتين: أ ، ب. شمل التقييم على قياس مدى حركة المفاصل فى الأطراف السفليه، نسبة مرحلة الثبات الى مرحلة التأرجح فى المشي بالأضافة الي تحديد وظائف التهويه و ذلك قبل وفى نهاية التجربه ، بعد٣ أشهر. وقد تلقت المجموعه أ برنامج من التمرينات العلاجية، اما المجموعه ب فقد تم تدريبها على جهاز السير الكهربائي بالأضافة الي البرنامج المطبق على المجموعة أ . وقد أثبتت النتائج عدم وجود تحسن ذو دلاله احصائيه ملحوظه فى القياسات الخاصة بوظائف التهوية للمجموعه أ عند مقارنة نتائج ما قبل و بعد العلاج بينما أوضحت النتائج وجود فروق ذات دلالة احصائية في مدى حركة المفاصل و مرحلة التأرجح في المشي . وقد أظهرت نتائج المجموعة ب وجود فروق ذات دلالة احصائية عالية للقياسات الخاصة بالمشى و كذلك وظائف التهوية عند مقارنة نتائج ما بعد العلاج للمجموعتين. وعلية يمكن التوصية بضرورة الأهتمام بأستخدام السير الكهربائى بالأضافه الى برنامج العلاج الطبيعى المعتاد لمثل هذه الحالات للوصول الى نتائج افضل والتحكم فى التشنجات وبالتالى زيادة الحركه .