Treadmill Training As an Adjunctive Physical Therapy Modality to Improve Gait Deviations in Children with Lower Limb Burn Injury

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ABSTRACT

The aim of the current study was to investigate the efficacy of treadmill training program on improving gait deviations in children with lower limb burn injury. Forty children (males and females) were included in the present study, their ages ranged from 6 to 10 with the mean age of 6.7 ± 1.23 years old. They were classified randomly into two groups of equal number. Group (A) composed of 20 children (study group) who received treadmill training and traditional physical therapy program for burn cases and group (B) composed of 20 children (control group) who received traditional physical therapy program only. Assessment was done through measurement of stride length, cadence, and cycle time pre treatment and at two weeks post treatment. Results showed a statistically significant increase in stride length and cycle time and statistically significant decrease in cadence in both groups with p<0.05. Also the results showed a statistically significant differences in treadmill group in comparison with control group with P<0.05. Conclusion, these results suggested that treadmill training program had a significant effect on improving gait deviation in children with lower limb burn injury.

INTRODUCTION

Burns are among the most serious injuries sustained by people and are the most medically difficult injuries to manage[2].

The indicators of successful rehabilitation include the return to activities of daily living which in the case of children, means the patient's ability to return to school, to walk, and to play constructively[21].

A careful and comprehensive burn rehabilitation program must be developed to restore a patient's foundation for efficient ambulation. Rehabilitation literature emphasizes positioning exercise and scar control with less attention paid to mobility and ambulation. Currently, there is a lack of objective, measurable documentation on the success or failure of therapy treatment and ambulation protocols for patient with a lower extremity burn[13].

The ability to stand and ambulate efficiently is an integral part of human activity. Lower extremities must provide a strong yet flexible base for ambulation activities. When a person sustains a burn injury to lower extremities, this mobile base can be compromised severely[16].

Confinement to bed is often necessary in early recovery. If bed rest is prolonged, patients may become deconditioned[13].The

presence of pain may further predispose the patient to contractures and muscle atrophy[10]

In many cases, it is common to encourage early activity for those with burn injuries to prevent the effects of immobilization[3].

The patient with burn injuries walks with both limited knee and ankle motion[20]. Typically, while walking on the ground, a patient with gait deviation will decrease his or her walking speed to accommodate the efficient gait pattern[19].

Gait deviations produced a less efficient walking pattern that consumed more energy. Gait deviations imposed by pain, paralysis, or lack of range of motion can cause an increased energy consumption[12, 18].

Common gait deviations following burn injury include; increased hip flexion, knee flexion or extension maintained throughout the cycle, ankle planter flexion with no heel strike, decreased step length, increased cadence, and decreased gait cycle time[13].

Treadmills have become a popular form of home exercise and commonly are located in a family recreation room, equally accessible to adults and children[4]. The convenience of motor driven treadmill makes it an attractive instrument for investigating human locomotion. It provides a well standardized and reproducible running environment where speed and slope can be easily controlled[15].

On the treadmill, where the patient is restricted to a defined space, therapist has a better chance to correct gait deviations. In addition, patients could practice a more favorable gait on treadmill. Gait is characterized by a higher symmetry and a greater stimulus for balance training as indicated by a prolongation of highly relevant single stance period of affected lower limb[8].

Treadmill offers less local fatigue, more natural movement particularly with children. It needs no attention to keep appropriate pace, so it is good with children inspite of their mental age and attention. In addition, there is no need to modify ergometer according to body size[6].

METHODS

Subjects

Forty children (males and females) ranged in age from 6 to 10 years old were participated in this study in the out clinic of El-Azhar University Hospitals. The children with the mean age of 6.7 ± 1.23 years had a lower limb scald burn injury from 15 to 30 % of total body surface area with the mean percentage of 23 ± 4.99 %.

The children participated in this study after burn injury during remodeling phase with the mean days after injury of 24.08 ± 1.82 days. The children were randomly assigned to study group (n=20) and control group (n=20). Informed consents were taken from the parents before the children participated in this study.

The study group received treadmill training in addition to traditional physical therapy program for burn injury in form of gait training exercises on the ground, stretching exercises, strengthening exercises to the opposite group of muscles, and using of Transcutaneous Electrical Nerve Stimulation (TENS) for pain relief.

The control group received only traditional physical therapy program as described before.

Criteria of selecting children

1-They were free from any structural changes in the joints of the lower limbs.
2-They were able to walk independently on the ground.
3-They were free from any mental problems.
4-They had no past history of surgical intervention in the lower limbs.
5-They were able to stand and walk on treadmill.

Procedure of the study

Assessment procedure

Certain measurable parameters were chosen as being most important in reflecting changes in each child's gait pattern.

To measure the spatial and temporal parameters of gait we used the footprint method. The child was asked to put his feet one by one in a water container then in a shallow tray of talcum powder. After that he or she walked across a sheet of calk paper, leaving a trial of footprints.

The calculated parameters were as follows

1. A stride length: is measured from heel contact of one leg to next heel contact of the same leg.
2. Cadence: is measured by using stop watch; the number of steps per minutes was calculated.
3. Gait cycle time: is measured by using stop watch; the time taken from heel contact of one leg to the heel contact of another leg per seconds was calculated.

Treatment procedure

Traditional physical therapy program: consists of gait training on the ground, stretching exercises for all flexor groups of the muscles of the lower limbs, strengthening exercises for the opposite group of muscles, and using of Transcutaneous electrical nerve stimulation (TENS) paravertebrally for relieving of pain during the treatment.

Gait training included

1. proper weight shift to each lower extremity,
2. step alteration,
3. and walking between parallel bars.

Treadmill group

This group received treadmill training as follows

En Tred apparatus was used in this study for training the children. Each child was asked to walk on the treadmill with a speed of 1.5 kilometers/hour and 0 degree inclination for 10 minutes, increased gradually to reach 3 kilometers/hour for 20 minutes at the end of the study. At the beginning of the treadmill training one therapist stood behind the child to provide manual support. The children received treadmill training day after day for two weeks.

***Control group*:** This group received traditional physical therapy program only. The children received their program day after day for two weeks.

Data analysis: The data obtained was statistically analyzed using:

Descriptive analysis: The mean and standard deviation were calculated for each variable, for both study and control groups before and after treatment.

Inferential statistics: Analysis was done by using t-tests. Paired t-test was used to compare the mean values before and after application of treatment in both groups. Independent t-test was used to compare between treadmill group and control group before and after application of treatment. The acceptable level of significance was measured at P<0.05.

RESULTS

A-Descriptive statistics showed that there was no significant difference regarding age, percentage of burn before treatment and the duration after burn injury as shown in table (1).

Table (1): Descriptive characteristics in both groups.

Comparison variables	Age in years		Percentage of burn		Duration after injuries in days	
Groups	Study group	Control group	Study group	Control group	Study group	Control group
Mean	7.55	7.69	22.75	23.25	23.7	24.45
Standard deviation	1.36	1.13	5.33	4.76	1.92	1.67
T-value	0.25		o.313		1.317	
P-value	0.312		0.493		0.492	
Level of significance	NS		NS		NS	

NS= no significant difference.

B-Comparison before and after treatment for study and control groups

1- Stride length

Comparison between pre and post treatment of the stride length in the study group revealed a significant increase in stride length with P<0.05.and the results of control group also revealed a significant increase in stride length with P<0.05 as shown in table (2) and figure (1).

2-Cadence

Comparison between pre and post treatment of the cadence in the study group revealed a significant decrease in cadence with P<0.05.and the results of control group also revealed a significant decrease in cadence with P<0.05 as shown in table (2) and figure (2).

3-Gait cycle time

Comparison between pre and post treatment of the cycle time in the study group revealed a significant increase in cycle time with P<0.05.and the results of control group also revealed a significant increase in cycle time with P<0.05 as shown in table (2) and figure (3).

Table (2): Comparison between study and control groups (pre and post treatment) regarding stride length, cadence and cycle time.

	Stride length				Cadence				Gait cycle time			
Groups	Study		Control		Study		Control		Study		Control	
Time	pre	post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	post
Mean	0.4	0.8	0.4	0.5	127	120	127	125	0.66	0.89	0.7	0.78
Standard deviation	0.008	0.007	0.008	0.007	1.65	1.05	2.31	2.21	.006	.006	0.002	.002
T-value	35.904		9.903		16.345		18.423		21.877		6.474	
P-value	0.000		0.008		0.043		0.000		0.000		0.000	
Significance	S		S		S		S		S		S	

S= significant difference

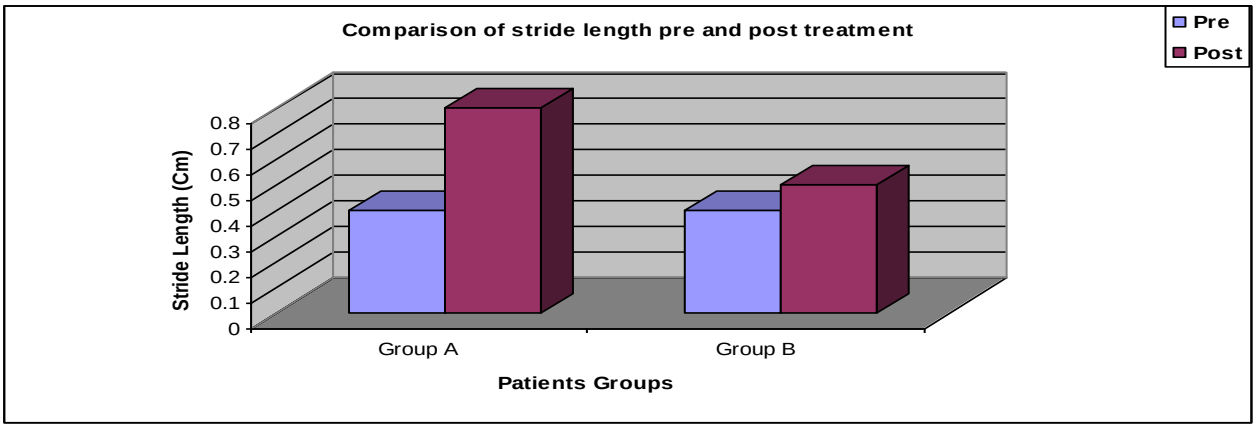

Fig. (1): Comparison between the mean values of stride length pre and post treatment in study and control groups.

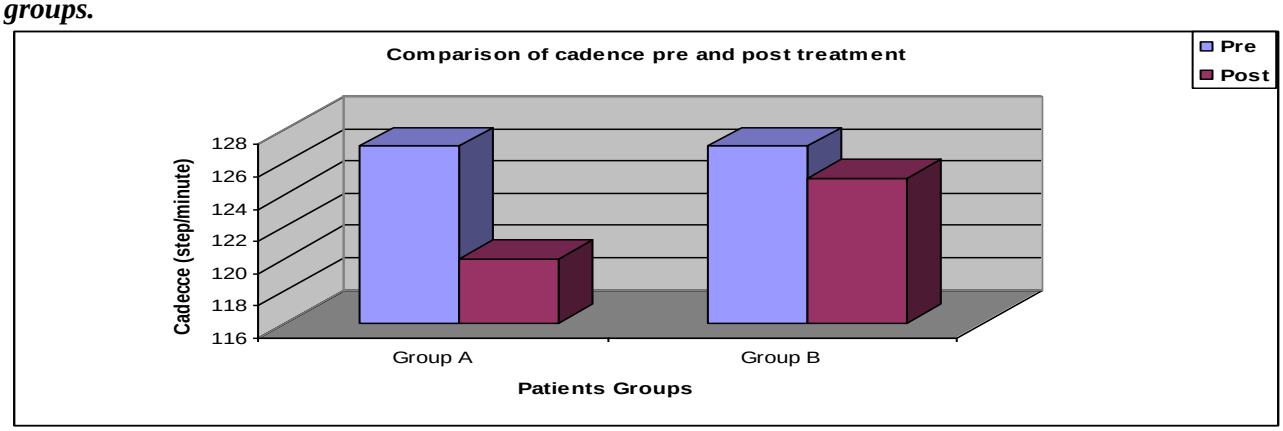

Fig. (2): Comparison between the mean values of cadence pre and post treatment in study and control groups.

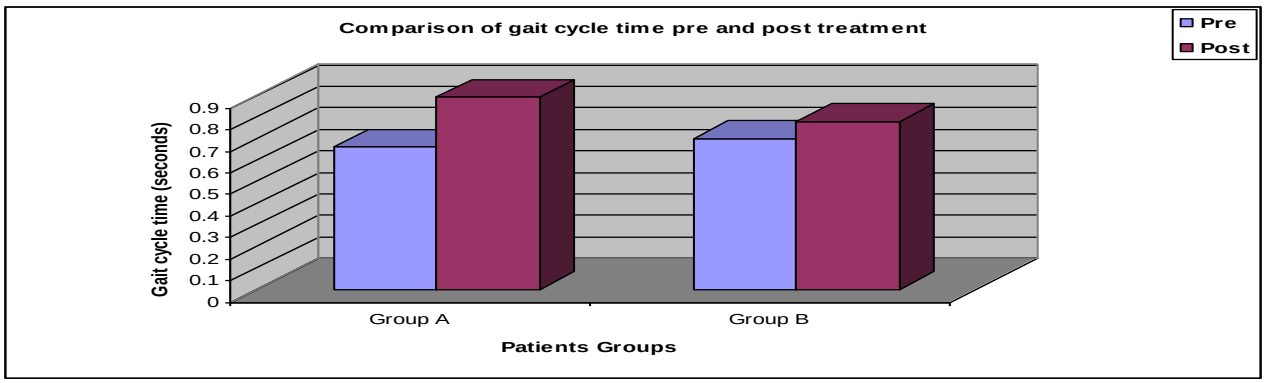

Fig. (3): Comparison between the mean values of gait cycle time pre and post treatment in study and control groups.

Comparison between study and control groups after two weeks (at the end of treatment:

Comparison between study and control groups showed that

There was a significant increase in stride length in study group with P<0.05, also there was a significant decrease in cadence in study group with P<0.05, and a significant increase in gait cycle time in the study group with P<0.05 as shown in table (3).

Table (3): Comparison between study and control groups (post two weeks of treatment)) regarding stride length, cadence, and cycle time.

Measuring variables	Stride length		cadence		Gait cycle time	
Groups	Study	control	Study	Control	Study	Control
Mean	0.8	0.5	120	125	0.9	0.8
Standard deviation	0.008	0.007	1.05	2.21	0.001	0.002
T-value	11.33		8.66		4.62	
P-value	0.001		0.008		0.04	
Level of significance	S		S		S	

S= significant difference.

DISCUSSION

Exercise and functional training are an integral part of rehabilitation process, both for remodeling of the treating wound and for further reconditioning. Early mobility is advocated in the literature and specially is cited as a means to reduce blood clot formation, maintain lower extremity strength and range of motion and to increase a patient's functional independence. However, there can be problems associated with early ambulation, including pain, bleeding, increased edema, and delayed or poor wound healing[13].

Gait means manner or way in which walking takes place and implies a detailed consideration of way in which joints and muscles are involved. In health care professionals it is quite common for term gait to be used in preference to walking[17].

A considerable portion of many physical therapists' time is spent in improving a patient' ability to walk. In order to improve a patient' gait, the physical therapist must first ascertain what gait deviations are occurring and what is causing the deviations. Therefore, much attention is given to gait evaluation[14].

The aim of our study is to investigate the effect of treadmill on improving the gait pattern in thermally burned children. Our results showed the effectiveness of treadmill training in improving gait in study group in comparison with the control group with p<0.05 regarding stride length, cadence, and gait cycle time which is consistent with some studies[1,7,9].

The strength and aerobic training were based on the principle of progressive loading. Strength training utilized free weight and aerobic training used a motorized treadmill, stationary bicycle or independent walking[5].

The treadmill apparatus was developed to provide conditions for locomotor evaluation, and rehabilitation that are

frequently impractical in an indoor over ground situation. It enables the study of locomotor pattern for people with severe gait disability. It may assist in the evaluation of interventions to improve gait pattern and process of rehabilitating patients with gait disabilities[11].

Treadmill training offers the advantages of task-oriented training with numerous repetition of a supervised gait pattern. Treadmill training could therefore become an adjunctive tool to regain walking ability in a shorter period of time[8]. One of the advantages of using treadmill is that it allows someone to walk continuously within restrained space. It can also be advantageous for evaluation or training purposes to have close control of gait speed. In addition, many treadmills can provide an uphill walking surface, thus providing a different locomotor task[11].

Conclusion

It can be concluded that treadmill training could be used effectively in post burn cases for improving gait pattern .We can start with 10 minutes of training and increasing the time to 20 minutes. The period of the study was two weeks, day after day. Another study should be attempted with different time to show the most suitable time for training the children with lower limb burn.

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الملخص العربى

التدريب بجهاز الجري علي السير الكهربائي كوسيلة ملحقة ببرنامج العلاج الطبيعي لتحسين انحرافات المشي في الأطفال المصابين بحروق الأطراف السفلية

تهدف هذه الدراسة الي بحث فاعلية التدريب بجهاز الجري علي السير الكهربائي علي تحسين انحرافات المشي عند الأطفال المصابين بالحرق في الأطراف السفلية . أجريت هذه الدراسة علي أربعين طفلا (ذكور وإناث) تراوحت أعمارهم من 6 إلي 10 سنوات. وقد قسموا إلي مجموعتين متساويتين ، المجموعة الأولي مجموعة الدراسة تكونت من عشرين طفلا الذين تلقوا التدريب بجهاز الجري على السير بالإضافة الي برنامج العلاج الطبيعي التقليدي والمجموعة الثانية المجموعة الضابطه تكونت من عشرين طفلا الذين تلقوا برنامج العلاج الطبيعي التقليدي فقط . وقد أشتمل التقييم علي قياس طول الخطوة وعدد الخطوات في الدقيقة ووقت دورة المشي قبل العلاج و بعد أسبوعين من العلاج . ولقد أظهرت النتائج وجود فروق ذات دلالة إحصائية فى الفارق بين قبل وبعد العلاج في المجموعتين، وأيضا وجود فروق ذات دلالة إحصائية في مجموعة التدريب بالجري علي السير بالمقارنة بالمجموعة الضابطة الحاكمة . و لذلك فإن التدريب باستخدام جهاز الجري علي السير الكهربائي يعتبر ذو فاعلية في تحسين انحرافات المشي عند الأطفال المصابين بالحرق في الطرف السفلي .