Bull. Fac. Ph. Th. Cairo Univ., Vol. 19, No. (2) Jan. 2014

Faculty Of physical Therapy
Cairo University

Cairo University

Functional Electrical Stimulation versus Hinged Ankle Foot Orthosis in Improving Gait Parameters in Hemiplegic Cerebral Palsy

Mohamed A. Eid[1]*, Rasha A. Mohamed[1], Sobhy M. Aly[2]

1Department of Physical Therapy For Disturbance of Growth and Development in Children and Its Surgery, Faculty of Physical Therapy, Cairo University, Cairo, Egypt, 2Department of Biomechanics, Faculty of Physical Therapy, Cairo University, Cairo, Egypt

ABSTRACT

Background*:* Children with spastic hemiplegic cerebral palsy (CP) often demonstrate equines deformity that causes loss of the smooth translation of the body over the foot during stance phase of gait, and often leads to inadequate clearance of the foot during the swing phase of gait.. *Purpose:* To compare the effects of functional electrical stimulation (FES) to that of hinged ankle foot orthoses (AFO) on gait parameters in children with spastic hemiplegic CP. **Methods***:* Thirty children with hemiplegic CP aged 8 to 12 years were assigned randomly into two equal groups. The study group I received physical therapy program in addition to FES, while the study group II received the same physical therapy program in addition to hinged AFO for three successive months. Measurement of gait parameters using 3 D-motion analysis was conducted before and after the three months of the treatment program. **Results:** Both groups demonstrated significant increase in stride length, gait velocity and ankle dorsiflexion at initial contact and mid-swing ($p < 0.05$). While no significant change in cadence was observed in both groups following treatment ($p > 0.05$). Functional electrical stimulation demonstrated a significant improvement in ankle dorsiflexion at mid swing compared with hinged AFO ($p < 0.05$). **Conclusion:** Both FES and hinged AFO induced improvement of gait patterns of children with hemiplegic CP, but FES is more effective in improving ankle dorsiflexion at mid-swingphase of the gait cycle.

Keywords:Cerebral palsy, Functional electrical stimulation, Hinged ankle foot orthoses, Hemiplegia, Gait**.**

INTRODUCTION

Cerebral palsy (CP) is the most common neuromuscular disorder among children [1]. Cerebral palsy is a group of motor disorders resulting from a non-progressive injury during early brain development leading to impairments of movement and posture [2].Hemiplegic CP is the most common type of CP, affecting up to one per thousand of live births [3]. Spastic hemiplegia accounts for more than a third of all cases of CP, and the resulting impairments to extremities affect functional independence and quality of life [4].About 75% of children with spastic hemiplegic CP walk independently, but most still show abnormal gait patterns as a consequence of contractures across the joints and muscle spasticity [5].Children with hemiparetic CP learn to walk with their feet wide apart, knees stiff and feet turned in with their weight is born on medial aspects of the feet. They have poor balance, visual motor control, strength, shorter step length, stride length, high cadence and slow velocity [6].The ankle joint is the most commonly affected joint in children with CP who are ambulatory. Common impairments are insufficient ankle dorsiflexion during swing phase of gait, or foot drop, and excessive planterflexion during early to mid-stance. These abnormalities may cause standing and walking instability, and greater risk of falling [7].Equinus gait, the most common deformity in children with CP, is usually accompanied by additional abnormalities at the upper segments of the lower extremities [8].Equinus is defined as the inability to dorsiflex the foot above plantigrade, with the hindfoot in neutral and the knee extended [9].

Ankle foot orthoses (AFOs) are commonly prescribed for children with spastic CP to improve biomechanical alignment and functional capability [10].Various AFOs have been used to correct the equinus gait pattern in children with spastic CP. Among them, hinged AFOs with a planter flexion stop have been increasingly recommended. The beneficial effects of hinged AFOs on gait were widely studied in the literature

[11].The use of AFOs were widely recommended to prevent the development or progression of the equinus deformity and to improve the dynamic efficiency of the child's gait [12].Ankle foot orthoses are prescribed to facilitate ankle control in cases of equinus deformity and reduce energy expenditure while walking [13].

Functional electrical stimulation (FES) has been studied as a means of providing upright mobility for both adults and children. Functional electrical stimulation uses small amounts of electrical current to activate paralyzed muscles and providing joint stability [14].It can be considered an alternative approach to aid foot clearance through electrical stimulation of the common peroneal nerve to produce ankle dorsiflexion during swing. Stimulation of the peroneal nerve may also trigger reflex synergistic flexion enhancing hip and knee flexion during the swing phase of gait [15].Functional electrical stimulation may be an effective alternative treatment for children with CP. In contrast to bracing, FES does not restrict motion, produce muscle contraction, and thus has the potential to increase strength and motor control through repetitive neural stimulation over time [16].

Therefore, the primary objective of the present study was designed to compare the effects of FES to that of hinged AFO on spatiotemporal parameters including stride length, gait velocity, cadence in addition to angular displacement of the ankle joint at initial contact and mid-swing in children with hemiplegic CP.

METHODS

This study used pre-test post-test control group design to compare the effects of FES to that of hinged AFO on improving gait parameters in children with spastic hemiplegic CP. All procedures for evaluation and treatment, purpose, potential risks and study benefits were explained to all children and their parents.Evaluation procedures were performed before and after 3 months of treatment by the same examiner who was blinded regarding the group to which each child was assigned. This work is carried out in accordance with the code of ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. Parents of the children signed a consent form prior to participation as well as acceptance of the ethical committee of the university was taken.

SD; standard deviation

Item		Study group I Frequency	%	Study group II Frequency	%
Gender	Males	9	60	8	53.3
	Females	6	40	7	46.6
Affected side	Right	4	26.67	3	20
	Left	11	73.33	12	80
Age, mean (SD), yrs		10.26 (1.43)		10.2 (1.26)	

1.

Subjects

Thirty children with spastic hemiplegic CP (Table 1), aged 8 to 12 years were enrolled in this study. They were recruited from the outpatient clinic of the Physical Therapy Department, College of Applied Medical Sciences, Najran University, Najran, KSA. They assigned randomly into two equal intervention groups (the study group I and the study group II). Children in both groups were selected with inclusion criteria, including children who demonstrated unilateral dynamic equinus deformity, all children must be ambulant independently and they were classified at Gross Motor Function Classification System (GMFCS) levels I or II[17],they must be free from any skeletal abnormalities other than spasticity and the degree of spasticity was determined according to the Modified Ashworth Scale (MAS)[18]to be within the range of 1+ and 2 grades, all children must have a minimum five degrees of passive ankle dorsiflexion with knee joint extended. Exclusion criteria, the use of botulinum toxin injection of the planterflexor muscles within the 4 months before the study and orthopedic surgery to the ankle joint in the previous 6 months before or during the study.

Randomization

Forty three children were assessed for eligibility. Nine children were excluded as they did not meet the inclusion criteria, and four children were excluded as their parents refused to participate in the study. Children were stratified according to GMFCS level to ensure similar functional levels in both study groups. Following the baseline measurements, randomization process was performed using closed envelopes. The investigator prepared 30 closed envelopes with each envelope containing a card labeled with either study group I or study group II. Finally, each child was asked to draw a closed envelope that contains whether he/she was allocated to the study group I or the study group II. The experimental design is shown as a flow chart in Fig. 1

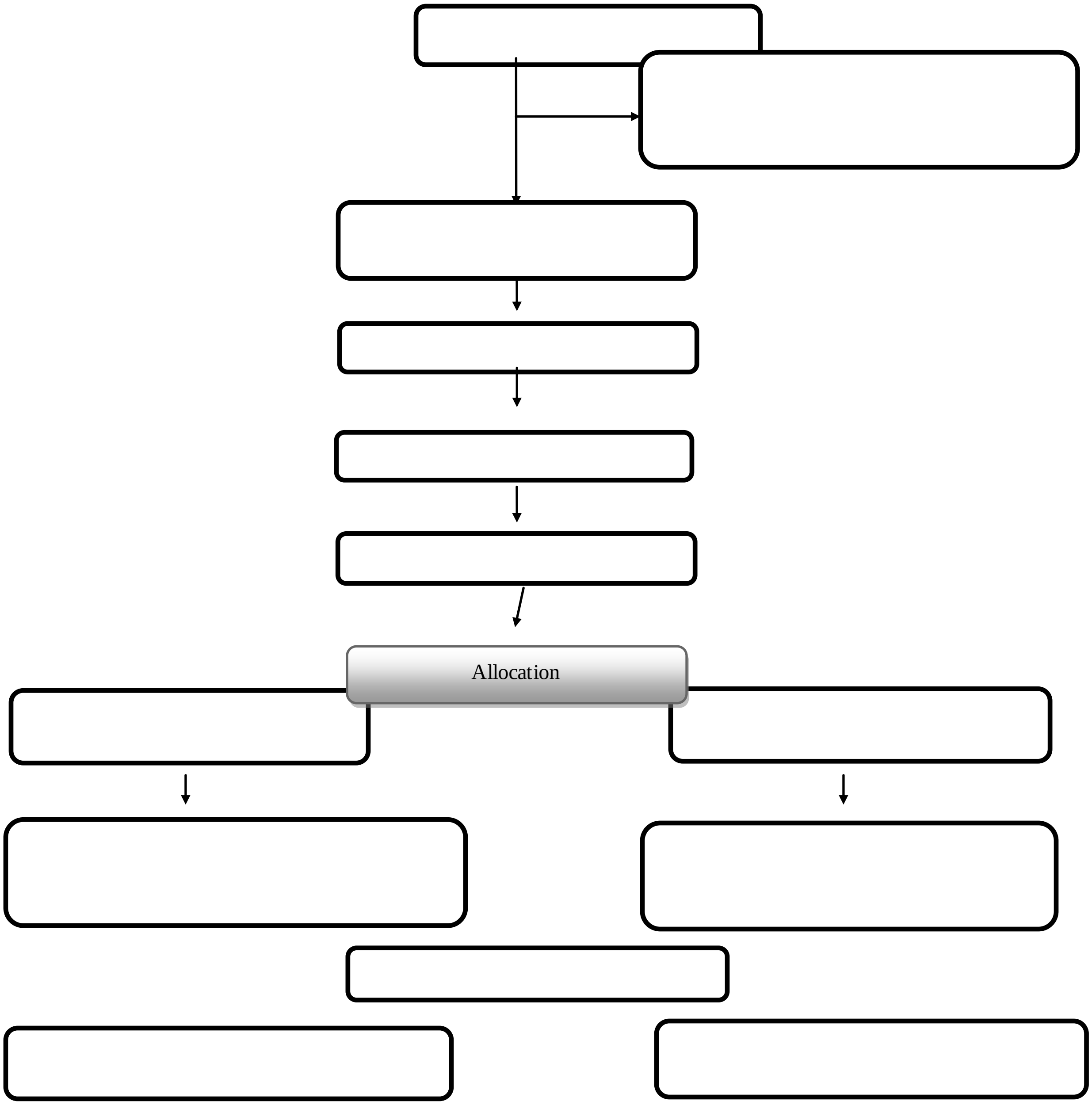

Fig. 1*Flow chart showing the experimental design of the study*

Procedures

Both Parents and their children were informed about the study procedures. Weight and height were recorded using electronic weighing and measuring station. Functional levels of children were determined by using GMFCS for cerebral palsy. The degree of planterflexor spasticity was determined by using the Modified Ashworth Scale(MAS) in which the child was in a comfortable supine lying position with the head in midline position, the arms were extended beside the body and the lower limbs in extension. The therapist applied passive dorsiflexion of the ankle on the affected side by one hand while the other hand stabilized the limb around the ankle joint. The therapist performed three trials and then graded the amount of spasticity by a score according to the MAS.

Gait Analysis

The evaluation procedure was applied with the children were barefoot before applying the treatment program and then with the treatment modality after 3 months of treatment. Gait analysis was evaluated using the three dimensional motion analysis system (Qualisys; Qualisys Inc, Goeteborg, Sweden). It consists of; motion capture unit that includes six high speed pro reflex infrared cameras with a frame rate of 120 Hz, with three cameras were arranged on each side of the 6-meters long walkway at a height of 1.5 to 2 meters. A computer software was used for data processing and analysis. Light-weight reflective markers, silver in color (diameter, 14 mm) were placed over specific bony landmarks using double faced adhesive tape. These landmarks including, the lateral border of the shoulder, the anterior superior iliac spine, the greater trochanter, the superior surface of the patella, the lateral surface of the knee along the lateral joint line, the tuberosity of the tibia, the lateral malleolus, the dorsum of the foot between the bases of the 2nd and 3rd metatarsal bones, the heel (posterior aspect of calcaneus) at the same horizontal plane level as the toe marker. Before data collection, the motion capture system was calibrated to ensure accuracy of the obtained values. The child stood midway on the walkway, to ensure that all cameras view the markers and start walking from the starting point to the end of the walkway until the Q-Trac measurement is completed. The measurement was saved and three trials were performed and saved for each child with at least two acceptable trials. Selection of one acceptable and complete gait cycle was export for analysis.

Treatment

The study group I

Children in the study group I received a designed physical therapy program in addition to FES. The physical therapy program consisted of gentle stretching exercises, facilitation of muscle contraction for the antispastic muscles, proprioceptive training, balance and postural control exercises, neurodevelopmental techniques, and gait training.The total program lasted for 1 h, three times/week for 3 successive months.

Functional electrical stimulation was applied using the WalkAide system (Innovative Neurotronics, Austin, TX, USA). It is a highly advanced medical device that consists of a battery-operated, single-channel electrical stimulator, two electrodes, and electrode leads with a cuff holds the system in place. The WalkAide system provides electrical stimulation through surface electrodes over the common peroneal nerve to elicit dorsiflexion and eversion of the foot with every step. The WalkAide system utilizes patented tilt sensor technology that measures the tilt of the shank with respect to gravity.[19]The stimulation was initiated and terminated to synchronise with the swing phase of gait to raise the foot at the appropriate time during the step cycle, creating a more natural and efficient walking pattern. (figure 2).

The stimulation parameters included pulse frequency (16-33 pulses per second), pulse width (25-300 µs) to produce a desired movement as close to normal as possible at the ankle during gait. During the three months of treatment, children were asked to wear the device during the day activities for 6 hours daily[16].

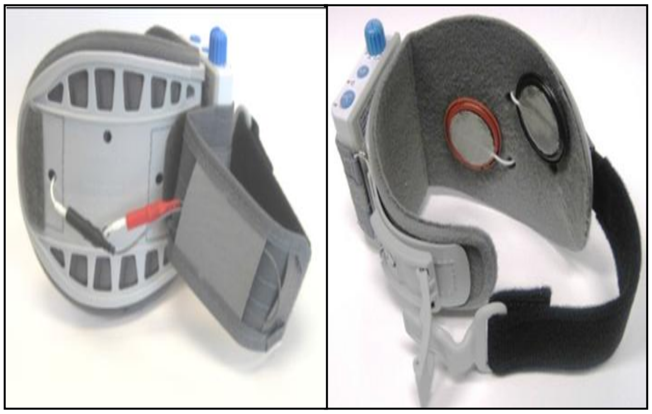

FIGURE 2:*WalkAide system (Electrodes & Electrode leads)*

The study group II

Children in the study group II received the same physical therapy program given to the study group I in addition to hinged AFO. A plastic hinged AFO was used to allow for dorsiflexion at the ankle joint during the swing phase of gait. The polypropylene AFO was 3-mm thick. The upper part of the hinged AFO extended to just below the fibular head and its flat footplate extended to the tips of the toes. The hinged AFO blocked ankle planterflexion, but allowed free dorsiflexion through the hinge in both the stance and swing phases of gait. The hinged AFO was custom fitted for each child. Each child was allowed to wear hinged AFO during all day activities for at least 6 hours daily.

Data Analysis

Data was tested for normality by using the Shapiro-Wilk test. The age, weight, height, and BMI were expressed as mean ± standard deviation. t test was conducted for comparing the pre and post treatment mean values of all measured variables between both groups. Paired t test was conducted for comparing barefoot and treatment conditions in each group. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through **SPSS** (Statistical Package for Social Sciences, version 19).

RESULTS

Average training attendance: the average training attendance was 86.13 ± 5.47%. There were no withdrawals in both groups.

Testing the normal distribution of data

Shapiro-Wilk test was conducted to test the normal distribution of data for each dependent variable. The results revealed no significant deviation from normal distribution for all variables in both groups ($p > 0.05$).

Subject characteristics

There was no significant difference between both groups in the mean age, weight, height and BMI ($p > 0.05$) as presented in Table 2.

***Table 2: t test for comparison of mean age, weight, and height in the study group I and II*:**

Item	$\bar{X}$ ±SD		t- value	p-value
	Study I	Study II		
Age (years)	10.26 ± 1.43	10.2 ± 1.26	0.13	0.89
Weight (kg)	29.66 ± 0.81	29.26 ± 1.03	1.17	0.24
Height (cm)	127.86 ± 2.79	128.06 ± 2.43	- 0.2	0.83

$\bar{X}$, Mean; SD, standard deviation; p-value, level of significance

There was no significant difference between both groups in the distribution of spasticity grades ($p = 0.71$) as presented in table 3. The distribution of GMFCS in both groups revealed that 7 subjects had grade I and represent 46.7%, While 8 subjects had grade II and represent 53.3%. These data indicated that both groups were homogeneous.

Table 3: Chi squared test (X^2) for comparison of the distribution of spasticity grades in the study group I and II:

	Study I	Study II	X^2 value	p-value

Spasticity	**Grade 1+**	(8) 53. 3 %	(7) 46.7%	0.13	0.71
	Grade 2	(7) 46.7 %	(8) 53.3 %		

Gait parameters of the study group I:

There was a significant increase in stride length (12.12%) and velocity (10.29%) with FES compared with barefoot condition (p = 0.0001), while there was no significant change in cadence (p = 0.09). Functional electrical stimulation significantly increase ankle dorsiflexion at initial contact (p = 0.0001) and mid-swing (p = 0.0001) compared with barefoot condition as represented in table 4.

Table 4: Paired t test for comparison of gait parameters between barefoot condition and FES in the study group I:

Study group I				
Gait parameters	**Barefoot**	**FES**	**t-value**	**p-value**
	$\overline{X}$ **±SD**	$\overline{X}$ **±SD**		
Stride Length (m)	0.66 ± 0.02	0.74 ± 0.04	-10.35	0.0001*
Velocity (m/sec)	0.68 ± 0.03	0.75 ± 0.02	-5.87	0.0001*
Cadence (steps/min)	119.66 ± 3.17	118.86 ± 2.44	1.82	0.09
Ankle dorsiflexion at initial contact (degrees)	-4.52± 0.4	3.04 ± 0.42	-63.16	0.0001*
Ankle dorsiflexion at mid-swing (degrees)	-7.66 ± 0.94	4.21 ± 1.12	-29.51	0.0001*

$\overline{X}$**, Mean; SD, standard deviation; p-value, level of significance * Significant -ve values indicate planter flexion**

+ve values indicate dorsiflexion

Gait parameters of the study group II:

There was a significant increase in stride length (8.95%) and gait velocity (10.14%) with hinged AFO compared with barefoot condition (p = 0.0001), while there was no significant change in cadence (p = 0.36). Ankle dorsiflexion angle significantly changed from planter flexion to dorsiflexion at initial contact (p = 0.0001) and mid-swing (p = 0.0001)with hinged AFO compared with barefoot condition as presented in table 5.

Table 5: Paired t test for comparison of gait parameters between barefoot condition and AFO in the study group II:

Study group II				
Gait parameters	**Barefoot**	**AFO**	**t-value**	**p-value**
	$\overline{X}$ **±SD**	$\overline{X}$ **±SD**		

Stride Length (m)	0.67 ± 0.02	0.73 ± 0.03	-7	0.0001*
Velocity (m/sec)	0.69 ± 0.02	0.74 ± 0.03	-8.7	0.0001*
Cadence (steps/min)	119.06 ± 4.55	118.4 ± 2.41	0.93	0.36
Ankle dorsiflexion at initial contact (degrees)	-4.62± 0.76	2.91 ± 0.51	-28.27	0.0001*
Ankle dorsiflexion at mid-swing (degrees)	-7.8 ± 0.82	3.37 ± 0.71	-36.08	0.0001*

$\bar{X}$, Mean; SD, standard deviation; p-value, level of significance * Significant -ve values indicate planter flexion +ve values indicate dorsiflexion

Comparison between groups:

Barefoot condition: There were no significant differences in gait parameters between the study groups in the barefoot condition (p > 0.05) as presented in Table 6.

Treatment condition: comparing gait parameters between the study group I who received FES and the study group II who received hinged AFO revealed no significant difference in stride length, velocity, cadence and ankle dorsiflexion at initial contact (p > 0.05). While, there was a significant increase in ankle dorsiflexion angle at mid swing with FES compared with hinged AFO (p = 0.02) as presented in table 6. These data showed remarkable improvement in gait parameters in both groups with significantly increase in ankle dorsiflexion angle during mid-swing in favor of the study group I.

Table 6: t test for comparison of gait parameters between the study group I and II in barefoot condition and treatment condition:

Gait parameters	**Study group I**	**Study group II**	**t- value**	**p-value**
	$\bar{X}$ ±SD	**$\bar{X}$ ±SD**		
Barefoot				
Stride Length (m)	0.66 ± 0.02	0.67 ± 0.02	-0.39	0.69
Velocity (m/sec)	0.68 ± 0.03	0.69 ± 0.02	-0.93	0.35
Cadence (steps/min)	119.66 ± 3.17	119.06 ± 4.55	0.41	0.67
Ankle dorsiflexion at initial contact (degr	-4.52± 0.4	-4.62± 0.76	0.44	0.65
Ankle dorsiflexion at mid-swing (degrees)	-7.66 ± 0.94	-7.8 ± 0.82	0.45	0.65
Treatment				
Stride Length (m)	0.74 ± 0.04	0.73 ± 0.03	0.62	0.53
Velocity (m/sec)	0.75 ± 0.02	0.74 ± 0.03	0.26	0.79
Cadence (steps/min)	118.86 ± 2.44	118.4 ± 2.41	0.52	0.6

Ankle dorsiflexion at initial contact (degr	3.04 ± 0.42	2.91 ± 0.51	0.73	0.47
Ankle dorsiflexion at mid-swing (degrees)	4.21 ± 1.12	3.37 ± 0.71	2.44	0.02*

$\overline{X}$, Mean; SD, standard deviation; p-value, level of significance * Significant -ve values indicate planter flexion

+ve values indicate dorsiflexion

DISCUSSION

The present study compared the effects of FES to that of hinged AFO on improving gait performance in children with spastic hemiplegic CP. Gait parameters including, stride length, velocity, cadence and ankle dorsiflexion angle at initial contact and mid-swing were measured for children who received FES and for those who were using hinged AFO. The main finding of this study showed that both FES and hinged AFO induced significant improvement in stride length, gait velocity and ankle dorsiflexion angle at initial contact and mid-swing. No significant change in cadence was recorded in both groups. While, significant improvement was observed in ankle dorsiflexion angle at mid-swing during gait cycle in favor of FES group.

However, numerous studies evaluated the effects of AFO on gait pattern in CP, but to our knowledge, this study is the first to compare the effects of FES to AFO in these populations.

The results of the study group I revealed that there was an improvement in functional gait after 3 months of FES. It was possible to verify that this period of training changed some gait parameters as there was significant increase in stride length, gait velocity, ankle dorsiflexion at initial contact and mid-swing, while there was no significant change in cadence. These results may be attributed to the effects of FES on skeletal muscles that it can reduce spasticity and improve muscle strength as stated by Sabut et al.[20] who reported that FES combined with conventional rehabilitation program can reduce spasticity, improve dorsiflexors strength and lower extremity motor recovery in stroke patients. This comes in accordance with Rydahl and Brouwer [21] who reported that stimulating the antagonist muscles with FES increased the inhibitory effect, so-called reciprocal inhibition, on the agonist muscles and therefore decreased spasticity.

Functional electrical stimulation can decrease spasticity through its effect on higher centers that in addition to its localized effects, it may generally desensitize the spinal pathway. This is consistent with Kralj and Bajd [22] who approved that electrical stimulation not only affects the nerve fibers going to the muscles, but also travels to higher brain centers, potentially stimulating the reorganization of neuromuscular activity.

Results of the study group I revealed that FES has an orthotic effect as it prevents ankle planterflexion in addition to its advantage over AFO through its stimulation for tibialis anterior and evertor muscles to produce ankle dorsiflexion during gait. This is consistent with Sabut et al.[23] who apply FES on tibialis anterior muscle in stroke patients and found that the mean walking speed has increased significantly by 38.7% and reported that the increased in muscle activity was caused by a local training effect of the stimulated muscle with change in motor control, suggesting an orthotic effect of FES. Also, reported that more effectively walking with FES, reduces the need for compensatory mechanisms such as hip hitching and circumduction, and thus reduces the biomechanical impairments, energy expenditure and increases the speed of walking.

Improvement in gait velocity was observed in both groups and this may be due to increased activity of the tibialis anterior and evertor muscles of the foot which produce ankle dorsiflexion during initial contact and mid-swing that enables the foot to take longer step and stride length. These results are congruent with Miller and Light[24] who described that increased muscle activity, can be accomplished in several ways, such as increasing the number of activated motor units, increasing the rate of activation, or increasing the synchronization of activation.

Increasing gait velocity is widely used to analyze the functional ability, and it is an important indicator of motor recovery[25].Improvement in gait velocity may be attributed to an increased stride length and speed of both lower limbs. This may be due to improvement in hip flexor muscle activation pattern and the energy generation in the affected lower limb, especially in the final supporting period, which is essential to lead the limb forward and to control the displacement speed[26].

Results of the study group II revealed that there was significant improvement in stride length, gait velocity, and ankle dorsiflexion at initial contact and mid-swing during gait cycle, While there was no significant change in cadence. Selecting hinged AFO for children with hemiplegic CP in the present study as they had knee extension and equinus deformity of the ankle joint and this is consistent with Hayek et al. [27] who stated that patients with adequate knee extension and excessive equinus will benefit from a hinged type AFO that allows dorsiflexion in the stance phase.

Results of the study group II come in accordance with the findings of Rowkes et al.[28] who compared gait with and without an articulated orthosis in 10 children with hemiplegic CP and found changes in all gait parameters, stressing the improvement in step length, cadence, and gait velocity as well as greater hip flexion upon initial contact and a reduction in plantar flexion in the swing phase. The authors concluded that this type of orthosis offers children with a more functional gait. Other findings[12, 29] confirmed our results and reported that the use of AFOs significantly increased walking velocity and stride length, but did not alter cadence. On the other hand, Buckon et al. [30].found that the use of AFOs in CP children increased stride length, reduced cadence but did not significantly change walking velocity.

The use of hinged AFO, which allow dorsiflexion movement, thereby promoting the stretching of the posterior musculature and reportedly reducing electrical activity in this muscle group[31].Also, Maltais et al.[32] concluded that a hinged AFO reduces oxygen uptake and the ventilatory cost of walking.

Increasing gait velocity and stride length with hinged AFO may be attributed to improving standing and walking balance while wearing this type of orthosis as stated by Burtner et al.[33] who revealed that dynamic AFOs are more advantageous for children with CP when balance control is required during unexpected perturbations in standing, compared to solid AFOs. Also, Radtka et al. [34] stated that a hinged AFO is favored over a solid AFO because it has more beneficial effects on ankle dorsiflexion, ankle power generation and energy expenditure during walking.

The overall results of the present study revealed that both the FES and the hinged AFO demonstrated walking benefits, but FES offer a more effective functional gait in which it promotes foot clearance in children with hemiplegic CP who had equinus deformity at the ankle in the form of increasing ankle dorsiflexion at initial contact and mid-swing during gait cycle.

The present study has some clinical implications. The findings from this study suggested that a combination program of both FES and proper physical therapy program in rehabilitation of children with spastic hemiplegic CP may be more effective in improving gait parameters and produce a more functional gait pattern. Since children with CP are at higher risk of developing muscle weakness, atrophy, decreased physical activity and abnormal gait pattern, FES needs to be part of their functional training program.

The present study has also some limitations. Small sample size represents one of the limitations for this study and therefore, future investigations with a larger sample would increase the generalizability of the findings from this study. Finally, the results could potentially differ if the various parameters of the FES are changed as pulse frequency, pulse width, and duration. Therefore, there is a potential for future studies to investigate these parameters.

CONCLUSION

This study compared the effects of FES to that of hinged AFO on gait performance in children with spastic hemiplegic CP. Both FES and hinged AFO could promote walking and improve gait parameters as stride length, gait velocity and increasing ankle dorsiflexion angle at initial contact and mid-swing. But, FES is more effective in increasing ankle dorsiflexion angle at mid-swing of the gait cycle. Future investigations are recommended to study the combined effect of both FES and hinged AFO on gait parameters in children withCP.

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الملخص العربي

التحفيز الكهربائي الوظيفي مقابل جبيرة كاحل القدم المفصلية في تحسين مقاييس المشي في الشلل المخي الطولي

مقدمة: يعاني الأطفال المصابون بالشلل المخي الطولي من سقوط في القدم والذي يسبب فقدان الانتقال السلس للجسم فوق القدم وكذلك عدم كفاية رفع القدم أثناء المشي.

هدف البحث: مقارنة تأثيرات التحفيز الكهربائي الوظيفي إلي تأثيرات جبيرة كاحل القدم المفصلية علي مقاييس المشي في الشلل المخي الطولي.

وسائل البحث: شارك في هذه الدراسة ثلاثون طفلا من الأطفال المصابين بالشلل المخي الطولي ممن تتراوح أعمارهم مابين 8 سنوات إلي 12 سنة، تم تقسيمهم عشوائيا إلي مجموعتين متساويتين في العدد وهما مجموعة الدراسة الأولي وقد تلقت هذه المجموعة برنامج العلاج الطبيعي بالإضافة إلي