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Research Article

Effect of ankle foot orthosis on energy expenditure index and gait speed in spastic cerebral palsy children: an observational study

Jumana J. Vanwala*, Shraddha Diwan, Sweety Shah, Neeta Vyas

S.B.B. College of Physiotherapy, V.S. General Hospital, Ellis Bridge, Ahmedabad-380006, Gujarat, India

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***Correspondence:**
Dr. Jumana J. Vanwala,
E-mail: Jumanavanwala90@gmail.com

ABSTRACT

Background: Ankle Foot Orthosis (AFO) is a frequently prescribed intervention modality which plays an important role in the management of gait abnormality. The most typical use of AFOs is to optimize the normal dynamics of walking by applying mechanical constraint to the ankle to control motion & at the same time provide more efficient gait. Solid AFOs are most commonly prescribed to reduce excessive plantar flexion in stance & to prevent or eliminate equinus position. So, purpose of this study is to determine whether use of AFO affect the gait speed & energy expenditure in cerebral palsy children or not.
Methods: a convenient sample of 21 subjects diagnosed with spastic cerebral palsy with presence of spasticity of planter flexors (Modified Ashworth Scale <3) with GMFCS level 1, 2 & 3 were included. Informed consent of parents was taken. Children who had undergone surgical correction within 6 month of testing or botulinum toxin injection of spastic planter flexors or any other lower extremity muscle within 3 months were excluded. For 10 meter walk test child was made to walk barefooted then given 10 minute rest & made to walk again for 10 meters with AFO. Their heart rate (Resting & after walking) & time taken for walk were taken each time & energy expenditure index (walking HR-resting HR/distance) & gait speed (distance/time) were calculated.
Results: Mean Energy Expenditure Index (EEI) with barefoot was 158.8 ± 2.37 & with AFO was 370.4 ± 3.93. Speed with barefoot was 0.22 ± 0.16 & with AFO was 0.148 ± 0.18. There was significant difference in gait speed & EEI between the groups & P value was <0.05.
Conclusion: There is increase in EEI & decrease in gait speed in children with spastic cerebral palsy with the use of AFO.

Keywords: Ankle foot orthosis (AFO), Energy expenditure index (EEI), Gait speed, Cerebral palsy

INTRODUCTION

Cerebral palsy (CP) is most common cause of severe physical disability in childhood. Incidence of CP is up to 3 cases per thousand live births. There are estimated over 25 lakh children & people in INDIA with CP.[1] Spasticity is common finding present in over 80% of all children with CP.[2] Efficient & effective walking is important treatment goal for children with cerebral palsy since mobility is associated with functional independence & participation of child in society.[3] AFO is frequently prescribed orthosis in the management of gait abnormality. Ankle-Foot Orthosis (AFOs) have been suggested to improve the dynamic efficiency of the gait of children with CP, that is ,the degree to which the gait is well controlled and energy efficient.[4] Many authors report positive effects of different types of AFOs on gait kinetic, and kinematics,[5,6] as well as on functional activities of the children with CP.[7,8] These effects include

increased ground reaction force and plantar flexion moment,[5] increased stride length,[5,6] and improvement on the walking, running, and jumping dimensions of the gross motor function measure[7] with the use of AFOs.

Four studies reported decreased energy expenditure with the use of SAFO,[7] PLS,[7] & HAFO.[7-9] In one study, differences were not reported between the use of SAFO, HAFO, and PLS and barefoot condition,[10] and in one study increased energy expenditure was reported with the use of HAFO compared with barefoot condition.[11]

So, there are non-conclusive results with respect to AFO. Secondly, systemic review of 2008 recommended for cross-over study & random allocation of the subjects for future studies. So, purpose of this study is to determine the effect of AFO on EEI & gait speed by overcoming the limitation of previous studies.

METHODS

In this observational study a convenient sample of 21 Children diagnosed with spastic cerebral palsy with presence of spasticity of planter flexors (Modified Ashworth Scale <3), who come under GMFCS level 1 to 3 were included. Children were excluded if they had any orthopedic surgery of lower extremity within 6 months, subjects who had taken Botox injection in lower extremity muscle within 3 months, any orthopedic problems or medical condition that prevented child from participation: severe scoliosis, uncontrolled seizures, kyphosis & untreated cardiac condition or congenital cardiac problems. Nature & purpose of study was explained. Informed written consent & an oral consent were obtained from parent or legal caregiver & child himself respectively. Random allocation as per odd & even numbers were done for study participants. Every odd numbered participant walked for 10 meter with AFO first & then barefooted & vice versa. 10 minute rest was given between two 10 meter walk test[12] i.e. with and without AFO. Their HR and time were noted after walking 10 meters each time. Speed was calculated from distance/time & energy expenditure index was calculated as per the following formula.[13]

$$\frac{\text{Walking HR} - \text{Resting HR}}{\text{Walking speed (m/s)}}$$

Statistical analysis was done using SPSS version 16. Mann Whitney U test was applied to see the difference between the groups.

RESULTS

Mean age of the patients was 6.85 (75% male & 25% female). Types of CP included in this study are shown through pie chart as shown in Figure 1. There is significant value of P for both EEI & gait speed. Mean energy expenditure index with barefoot was 158.8 ± 2.37 & with AFO was 370.4 ± 3.93. Speed with barefoot was 0.22 ± 0.16 & with AFO was 0.148 ± 0.18. There was significant difference in gait speed & EEI between the groups & P value was <0.05. Purpose of the study was to evaluate the EEI & gait speed in children with spastic CP. Result shows that EEI increases & gait speed decreases with the use of AFO.

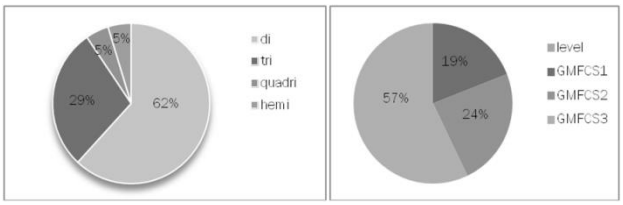

Figure 1: Types of CP in this study.

Table 1: The EEI & gait speed in children with barefoot and AFO.

	EEI	Speed	U value	P value
Barefoot	158.8 ± 2.37	0.22 ± 0.16	117.50	0.010
AFO	370.4 ± 3.93	0.148 ± 0.18	123.50	0.015

DISCUSSION

Purpose of the study was to evaluate the EEI & gait speed in children with spastic CP. Result shows that EEI increases & gait speed decreases with the use of AFO. As statistical analysis of the study shows that most of the patients were spastic diplegic & most of them were falling in GMFCS level 3. So, they were using rollator along with dynamic AFO. So there are chances of increase in EEI because of the same reason. Some studies suggest that there is inverse relationship between EEI & gait speed.[14] So, there is increase in EEI leads to decrease in gait speed.

Radtka et al., 2005 concluded in his study that there is "No differences in timing of lower limb muscles group during stance phase with orthosis, Plantar flexor moment during terminal stance increased with both orthosis Ankle power generation during pre- swing phase increased with articulated AFO, Articulated AFO produced more normal dorsiflexion at terminal stance than solid AFO and more excessive plantar flexion than barefoot "Lam et at., 2005 in his study concluded that patients showed significantly longer total contraction duration and higher median frequency for all muscle groups when the muscles were firing, Maximum planter flexion moment improved with both orthosis, ankle position at initial contact, mid stance & swing phase improved & stride length increased with both conventional & dynamic AFO. Knee flexion at initial range increased with dynamic AFO.

Younger children may take advantage of the distal stabilization provided by the AFO,[15] whereas older children favour minimization of the risk of falling over, by reducing walking velocity.[16]

Small sample size, no blinding & lake of homogeneity was limitation of this study. Same study can be done with large sample size. Further studies can be conducted that allow parity among treatment groups.

CONCLUSION

There is increase in EEI & decrease in gait speed in children with spastic cerebral palsy with the use of AFO compared to barefooted walking especially in children with spastic cerebral palsy. Recommendation of AFO should be done to correct gait biomechanics but consideration should be given to decrease EEI & increase speed in corporation to cardio-respiratory endurance.

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