The Efficacy of AFO Use in Ambulatory Children with Spastic Diplegia

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Introduction

Ankle foot orthoses (AFOs) are prescribed for ambulatory children with spastic diplegia to improve biomechanical alignment and functional capability. Orthotic prescription is often based upon clinical experiences, treatment paradigms (biomechanical vs neurodevelopmental), and the perceived desires of the child/family. Previous investigations have reported that AFO use in ambulatory children with spastic diplegia normalizes ankle kinematics/kinetics and gait parameters [1-4]; however, a recent comparison of three AFO configurations to shoes alone concluded that all configurations promoted abnormal ankle kinematics in comparison to shoes alone with no significant improvement in walking efficiency [5]. The purpose of this study was to examine the efficacy of three commonly prescribed AFO configurations (solid (SAFO), hinged (HAFO), posterior leaf spring (PLS) during gait and energy expenditure (O_2 consumption) in ambulatory children with spastic diplegia.

Clinical Significance

AFOs are an integral component in the management of ambulatory children with spastic cerebral palsy, therefore, delineation of the different AFO configuration effects is needed in order to establish guidelines for lower extremity orthotic prescription and management in this population.

Methodology

Sixteen independently ambulatory children with a diagnosis of spastic diplegia (range 5+3 to 15+3 yrs) participated in this study. Study design involved utilization of multiple single subjects with randomized crossover after a three month baseline where no orthotic was used. Children were assessed barefoot at baseline and in each orthotic configuration following a three-month accommodation period, for a total of four assessments per child over a one-year period of time. Gait analysis was performed using a 6-camera Vicon 370 system, 2 AMTI forceplates, and Vicon clinical manager. Energy consumption was performed using a SensorMedics 2900 Metabolic Cart in the dilution mode. Kinematic and kinetic variables at the pelvis, hip, knee, and ankle, gait parameters, and energy consumption data were analyzed using one-way repeated measures ANOVAs and linear contrasts. Statistical significance was established for each variable group using Bonferroni corrections.

Results

AFO use did not significantly alter the gait kinematics or kinetics of proximal joints. All AFO configurations significantly increased the degree of ankle dorsiflexion at initial contact and during stance while limiting plantarflexion in swing. Despite excessive ankle dorsiflexion during stance in the HAFO, a significant concomitant increase in knee flexion was not observed. Orthotic configuration had no effect on the ankle plantar flexion/knee extension couple as stance phase knee flexion was similar in all conditions. All AFO configurations

increased stride length and decreased cadence resulting in no change in velocity. All AFO configurations significantly increased the energy efficiency of gait during self-selected and fast walking.

Table 1 Variable mean ± standard deviation

Variable	Barefoot	HAFO	PLS	SAFO	Norm
•knee fl min st º	8.1±10.4	11.8±10.7	9.8±7.4	8.2±11.1	.4±4.8
*ankle df ic º	-7.2±13	5.4±3.9 [a]	4.8±4.6 [a]	5.0±4.5 [a]	-4.2±3.1
*ankle pk df st º	5.7±12.9	18.6±8.3 [a, b]	14.8±7.3 [a]	12.5±5.3 [a]	9.2±2.6
*ankle pk pf sw º	24±19.8	-2.0±4.2 [a]	-.26±5.0 [a]	-1.8±4.7 [a]	22.5±5.3
•ankle pk pf (Nm/kg)	.84±.18	1.09±.13 [a]	1.09±.13 [a]	1.08±.13 [a]	1.29±.15
•ankle pk gen st (w/kg)	1.59±.51	1.18±.31 [a]	1.23±.45 [a, c]	.83±.17 [a]	3.51±.44
•stride (m)	.91±.15	.99±.18 [a]	1.05±.15 [a]	1.02±.18 [a]	1.15±.13
•cadance (stps/min)	142±23	118±14 [a]	127± 22 [a]	124±15 [a]	133±11
•velocity (m/s)	1.08±.22	.98±.21	1.11±.19	1.04±.18	1.28±.19
*cost (ml 0_2/kg/m) SS	.417±.11	.363±.09 [a]	.368±.08 [a]	.353±.09 [a]	.22
*cost (ml 0_2/kg/m) F	.398±.10	.360±.08 [a]	.352±.08 [a]	.338±.07 [a]	.22

fl, flexion; min, minimum; st, stance; df, dorsiflexion; ic, initial contact; pf, plantarflexion; sw, swing; gen, generation; SS, self-selected; F, fast; •, $p \leq .012$, *, $p \leq .016$.

a. mean of this condition differed significantly from the mean of the barefoot condition
b. mean of the HAFO differed significantly from the mean of the SAFO
c. mean of the PLS AFO differed significantly from the mean of the SAFO

Discussion

The results of this study support previous investigations and substantiate that the AFO configurations studied do not significantly alter the proximal joint kinematics and kinetics of ambulatory children with spastic diplegia [1-5], indicating that the mechanical benefits of these configurations are limited to the ankle joint. While all AFO configurations studied prevented equinus, increased stride length, decreased cadence, and enhanced the energy efficiency of gait subtle differences in configuration efficacy were seen. While unrestricted ankle dorsiflexion has been proposed to have functional benefits, detrimental effects were observed in this population of children, thus the use of a PLS or SAFO should be considered.

References

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