Brace Evaluation in Children with Diplegic Cerebral Palsy: Kinematics and Kinetics

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Introduction

The treatment of gait abnormalities in children with ambulatory spastic cerebral palsy continues to challenge the clinician. In a previous study, two types of braces, hinged (HAFOs) and dynamic (DAFOs) were compared (1,2). Results demonstrated that outcome measures (PODCI and GMFM) lacked sensitivity to the difference in function between braced and unbraced conditions. Conversely, gait temporal measures and postural stability metrics were very sensitive to these changes. Differences between braces were undetected using these measures. No brace effects persisted following two (2) weeks of barefoot walking. The goal of this study was to determine the role and effectiveness of HAFOs and DAFOs using gait kinematic and kinetic measurements.

Statement of Clinical Significance

Objective assessment of orthotic effects on overall motor performance using gait analysis may improve brace prescriptions. This study quantified the effects of orthotic interventions using gait analysis kinematic and kinetic metrics.

Methodology

Sixteen (16) children with a diagnosis of spastic diplegic cerebral palsy (7.5$\pm$ 2.9yrs.) were included in the study. Two types of AFOs were fitted for each subject. Subjects had one month to wear each AFO with a two-week baseline period between usage periods. Gait analyses were evaluated at initial baseline, after each AFO trial, and at baseline between usage periods. A ten-camera Vicon Motion Analysis System was used to acquire gait data. Two AMTI force plates were used to measure ground reaction forces from which joint moments and powers were computed.

Results

A two-sample comparison method was used to determine differences in mean response between the two braced and barefoot conditions. Significant differences between braced and unbraced conditions were found in peak ankle dorsiflexion, and peak ankle plantarflexion, knee stance peak flexion, knee swing peak flexion, hip stance peak flexion, and peak ankle plantarflexion moment ($p<0.01$). There were no significant differences between braced and unbraced conditions in knee stance peak extension, knee swing peak extension, hip stance peak extension, hip swing peak flexion, peak power absorption, or peak power generation. Differences between the HAFO and DAFO were undetected in the kinematic and kinetic metrics (Tables I and II).

Table I. Kinematic Gait : Comparative p values

Variable	Barefoot1 Vs. Barefoot2	Barefoot1 Vs. HAFO	Barefoot1 Vs. DAFO	HAFO Vs. DAFO
Ankle peak stance dorsiflexion	0.999	0.000*	0.000*	0.925
Ankle peak swing plantarflexion	0.537	0.000*	0.000*	0.949
Knee Stance peak flexion	0.997	0.003*	0.021	0.625
Knee Stance peak extension	0.999	0.990	0.986	1.000
Knee Swing peak flexion	0.363	0.000*	0.000*	0.020
Knee Swing peak extension	0.455	0.341	0.246	0.997
Hip Stance peak flexion	0.999	0.001*	0.003*	0.997
Hip Stance peak extension	0.997	0.562	0.999	0.647
Hip Swing peak flexion	0.998	0.939	0.293	0.634

*$p \leq 0.01$

Table II. Kinetic Ankle Measurements: Comparative p values

Variable	Barefoot1 Vs Barefoot2	Barefoot1 Vs. HAFO	Barefoot1 Vs. DAFO	HAFO Vs DAFO
Power peak flexion moment	0.276	0.000*	0.000*	0.418
Power Absorption	0.052	0.021	0.100	0.919
Power Generation	0.369	0.391	0.174	0.965

*$p \leq 0.01$

Discussion

Gait kinematic and kinetic parameters improved toward normal values with bracing in patients with spastic diplegic cerebral palsy, who were independent toe walkers. The braced conditions improved motion at the ankle, hip and knee. These findings indicate that ankle foot orthoses improve motion at several joints. Although the gait measures were very sensitive to differences between barefoot and braces, they were not sufficiently sensitive to detect the differences between the two braces. Motion characteristics return to baseline with no brace effect carry over within a two-week period. The study clearly indicates advantages in function and ambulatory biomechanics with bracing. Further development of dynamic testing is suggested in order to advance our understanding of orthotics intervention

References

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