OBJECTIVE EVALUATION OF ANKLE FOOT ORTHOTICS FOR AMBULATORY FUNCTION IN HEMIPLEGIC GAIT

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INTRODUCTION

Ankle foot orthotics (AFO) are often prescribed to patients with motor deficits due to stroke to address impairments, assist with ambulation, and lower the energy cost of walking. AFOs are designed to help compensate for common problems in hemiplegic gait such as foot drop (inadequate ankle dorsiflexion) or inappropriate foot strike due to spasticity or contracture (Gok et al. 2003). Currently, initial fit and subsequent improvements in AFOs are evaluated visually during gait by a clinician or corrected after patient feedback (Meyring et al. 1997). An objective study of the plantar pressure distribution within AFOs is needed to provide more quantifiable and functional information about the AFO’s efficacy. The objective of this investigation was to use objective measureable gait parameters to evaluate the affect of a solid AFO for ambulatory function during walking in hemiplegic gait. The secondary objective was to use dynamic pedobarography to begin to understand how an AFO affects plantar pressure and loading during gait.

METHODS AND PROCEDURES

Participants (n=19) diagnosed with hemiplegia secondary to stroke currently using an AFO during ambulation were recruited for participation. All subjects were able to safely ambulate without their prescribed AFO for at least 25 feet. Subjects performed walking trials in two conditions: 1) with and 2) without the AFO. All subjects completed 10 walking trials, of a 4.5 meter walk at a self-selected walking speed on a level surface. The order of conditions was randomly assigned. During all walking trials, wireless pedobarography data was collected using the Pedar®-x Expert System (Novel Electronics Inc., St Paul, MN, USA) data included regional analysis of peak pressure, and maximum force on the plantar aspect of the foot. Selected temporal-spatial gait parameters: walking speed, double support, single support, stride length, and step width were used for analysis. A two-way mixed effect analysis of variance (ANOVA) was used to test for significant differences in outcome loading parameters.

RESULTS

While wearing the AFO there was a significant decrease in double support, and single support time remained significantly higher on the unaffected limb. Mean stride length increased with the AFO on both the affected and unaffected limb and step width remained unchanged regardless of condition or limb. While wearing the AFO, lateral and medial heel peak pressure, and maximum force at the lateral heel were significantly reduced. Maximum force at the medial heel showed a trend towards reduction. Maximum force in the medial arch significantly
increased. Trends for increases were observed in peak pressure at the medial arch and beneath the 2nd metatarsal head.

**DISCUSSION**

Temporal Spatial Outcomes: Walking speed increased with the AFO, due to the decrease in double support and increase in step length. Increased walking speed has been shown to positively correlate with a reduced energy cost ultimately improving gait efficiency. The decreased double support time may indicate a more stable gait when wearing the AFO. Single support on the unaffected side was more than the affected side regardless of condition. This increased swing time on the affected limb is likely utilized to ensure toe clearance. The subject spent more time on the unaffected limb in both conditions, even with the added support and stability afforded by the AFO. This compensatory gait deviation causes asymmetrical gait and greater difficulty maintaining balance during gait. The AFO provided more stability but walking gait was still affected. Step length and step width contribute to balance during walking gait. An increase in step length with the AFO demonstrated that the subject improved the distance covered with each step, indicating improved balance. Step width remained unchanged suggesting that the brace effectively changed functional mobility to improve balance while the base of support remained unchanged.

Pedobarography Variables: The addition of an AFO significantly decreased peak heel pressure and caused an increase in medial peak pressure during gait. The decreased heel pressure is likely to be a direct result of the increased contact area afforded by the AFO. This may increase heel strike total contact area indicating a more stable foot strike during gait. The increase in medial pressure may indicate increased weight bearing on the affected limb and potentially a more effective rollover during gait. This may create a more efficient gait pattern increasing walking speed and decreasing energy cost. The addition of an AFO significantly decreased lateral heel forces and increased medial arch forces during gait. The increase in heel maximum medial force may indicate a more controlled foot strike when wearing the AFO. The increase in medial maximum force continues to indicate that the affected limb may support more bodyweight during gait causing an increase in balance.

**SUMMARY**

Quantitative assessment of gait parameters and plantar loading in hemiplegic gait can help identify which specific design characteristics of an AFO are functioning and which need improvement or correction to ultimately improve an individual’s gait. Mechanically the brace can put the limb in the correct position but the individual may still be hesitant or not able to balance on their affected limb due to loss of sensation or motor control. Adding discrete pressure measurements to that region could further our ability to design a more effective AFO that minimizes stress and maximizes walking efficiency.

**REFERENCES**


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