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The Effect of an Ankle-Foot Orthosis on Gait Parameters of Acute and Chronic Hemiplegic Subjects

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Introduction

An ankle-foot orthosis (AFO) is often used to assist individuals returning to ambulation after a cerebral vascular accident (CVA). An AFO is designed to provide stability in the sagittal and coronal planes during stance phase, to prevent foot drop during swing phase, and to promote heel strike. Improvements in gait resulting from AFO use have been documented for chronic CVA patients.[1,2,3] One study reported gait improvements with an articulated AFO but did not differentiate acute and chronic CVA patients.[4] G�k et al. also reported improvement in gait, recruiting a mix of acute and chronic CVA subjects.[5]

To date, few studies have considered the impact of an AFO on the gait of acute CVA patients or compared the gait of acute CVA patients to chronic CVA patients. The purpose of this study is to compare gait parameters of acute and chronic CVA patients while walking with and without their prescribed AFO. It is hypothesized that the AFO will positively impact gait and that acute patients will ambulate with lower cadence, velocity, and step length than chronic patients.

Methodology

Forty subjects with a hemiplegic gait pattern secondary to CVA were recruited from Marianjoy Rehabilitation Hospital, Wheaton, Illinois, with Institutional Review Board (IRB) approval. A convenience sample was recruited consisting of 25 chronic CVA patients (19 men, six women), and 15 acute CVA patients (ten men, five women). Included subjects presented with an Ashworth* score of less than two. All subjects were prescribed an appropriate AFO for ambulation but were able to ambulate safely without it for ten meters.

Data was collected during the CVA clinic at Marianjoy using the GAITRite portable electronic walkway.[6] The order of walking trials, with or without the AFO, was randomly assigned to the subjects. Three trials at self-selected walking speed were collected for each condition. Subjects were allowed to use an assistive device to ambulate if needed. Participants rested between trials and conditions as needed during the experiment. The subjects were not provided extra practice or adaptation time when changing between conditons.

Subject data for velocity, cadence, stride length, and bilateral step length were exported for statistical analysis. A two-way repeated measures ANOVA* was calculated to test for differences in gait parameters with AFO use as a within-subject factor, and acute versus chronic as a between-subject factor. Eight of the acute subjects accepted delivery of their first AFO on the day of testing. These subjects were examined independently to determine if the AFO had an immediate impact on gait parameters with no prior experience, training, or therapy. A paired t-test* was calculated to check for differences in mean gait parameters between the conditions with and without an AFO. An alpha of 0.05 was set as the level for statistical significance.

Result

The average age of the 40 subjects was 62.5 � 13.3 years. The left hemisphere was affected in 23 subjects, and the right hemisphere was affected in 17 subjects. When using the AFO, both the acute (0.7 � 0.4 months post CVA) and chronic (50.7 � 37.5 months post CVA) groups significantly increased walking velocity, cadence, stride length, and bilateral step length (Table 1). Velocity in the acute group improved from 35.6 � 24.6cm/s to 44.5 � 28.7cm/s ($p<0.001$), while the chronic group improved from 54.2 � 33.0cm/s to 61.3 � 31.3cm/s ($p<0.001$). Cadence in the acute group improved from 58.2 � 20.2 to 65.7 � 21.5 steps/min ($p<0.001$), while the chronic group improved from 74.8 � 22.0 to 80.0 � 19.2 steps/min ($p<0.001$). Stride length in the acute group improved from 67.5 � 22.2cm to 74.7 � 24.8cm ($p<0.001$), while the chronic group improved from 81.4 � 26.4 to 87.8 � 24.8cm ($p<0.001$). Bilateral step-length parameters improved significantly as well. Acute subjects increased their sound-side step length from 30.1 � 12.8cm to 33.8 � 14.9cm ($p<0.001$), and chronic subjects increased sound-side step length from 37.7 � 14.9cm to 41.5 � 13.0cm ($p<0.001$). Affected-side step length improved from 37.4 � 12.4cm to 40.9 � 11.7cm ($p<0.005$) in the acute group and from 43.7 � 13.2 to 46.3 � 12.8cm ($p<0.005$) in the chronic group. There was no significant improvement in step-length symmetry in either group, though. The chronic group walked with a significantly faster cadence than the acute group in both conditions—with and without AFO ($p<0.05$). Other parameters were not significantly different at the alpha equal 0.05 level between the acute and chronic group.

The subgroup of eight acute subjects using an AFO for the first time made significant improvements in velocity (34.8 � 11.1cm/s versus 46.9 � 12.8cm/s; $p<0.05$) and cadence (53.8 � 8.9 steps/min vs. 63.0 � 9.2 steps/min; $p<0.005$), but improvements in stride length and bilateral step length were not significant.

Table 1: Mean and Standard Deviation for Acute and Chronic Subjects' Gait Parameters with and without Their AFO

	Acute w/o	Acute with	Chronic w/o	Chronic with	Sig.
Velocity (cm/s)	35.6 (24.6)	44.5 (28.7)	54.2 (33.0)	61.3 (31.3)	a
Cadence (steps/min)	58.2 (20.2)	65.7 (21.5)	74.8 (22.0)	80.0 (19.2)	a, c
Stride Length (cm)	67.5 (22.2)	74.7 (24.8)	81.4 (26.4)	87.8 (24.8)	a
Sx Step Length (cm)	30.1 (12.8)	33.8 (14.9)	37.7 (14.9)	41.5 (13.0)	a
Ox Step Length (cm)	37.4 (12.4)	40.9 (11.7)	43.7 (13.2)	46.3 (12.8)	b

Sx is sound side and Ox orthotic side. (a) Significant difference ($p<0.001$) between with and without AFO conditions for acute and chronic. (b) Significant difference ($p<0.005$) between with and without AFO conditions for acute and chronic. (c) Significant difference ($p<0.05$) between acute and chronic groups.

Discussion

The results from this study support the hypothesis that an AFO increases the gait parameters for both chronic and acute subjects with hemiplegic CVA and low tone. These findings concur with the previous research, and gait parameters measured in the chronic group are similar in both mean and standard deviation to previously published works. While most prior works have focused on chronic CVA subjects, or not specified whether their sample was acute or chronic, a comparison was made between acute and chronic subjects. Even though the mean gait parameters for the chronic group were much better than the acute group, the within-group variance and the lack of a paired comparison prevented detection of a statistical difference. This study also demonstrated that an AFO can have a meaningful and immediate impact on the velocity and cadence of acute hemiplegic CVA subjects who have no prior experience or training with an AFO.

The data for this study was collected during an active CVA clinic in a rehabilitation hospital using the GAITRite portable electronic walkway. Most clinics are challenging, hectic settings with little time to waste. This demonstrates that the GAITRite is a reasonable tool for rapidly collecting basic gait parameters in an active clinical setting. The fact that this data was collected in a clinical setting also means that it is subject to the limitations imposed by such a setting. Patients used their prescribed AFO, and no attempt has been made to segregate the data based on type of AFO used.

A deeper, prospective examination of the changes in gait and function that occur as CVA patients recover may be beneficial. While fraught with difficulty, such a study could aid in parsing out the influence of orthotic versus other therapeutic treatments at different times during recovery.

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***Editor's Note:** *For more information on research measures and terminology referred to in this article, please visit the Academy's Research Glossary page on this website.*

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