INTER-TRIAL VARIABILITY IN KINEMATIC DESCRIPTORS OF GAIT

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INTRODUCTION

The popularity of gait analysis as a diagnostic and research tool has continually increased in recent years. With this increase in popularity, research literature concerning the efficacy of gait analysis as a clinical diagnostic tool has proliferated (Kerrigan & Glenn, 1994). Topics related to this line of research have included appropriate gait parameters (Olney, Griffin & McBride), functional changes due to various interventions (vonSchroeder et al., 1995) and the proper use of technology (Scholz & Millford, 1993).

Fundamental to the appropriate use of gait analysis as a clinical tool is the proper selection of sample size. In gait analysis, the degree of natural variability within a stride-to-stride performance may taint any analysis designed to detect the effects of an intervention. The measurement and description of the inherent inter-trial variability must, therefore, precede any other analysis. In order to determine the effects of this variability on a clinically relevant case, the purpose of this study was to document the inter-trial variability of kinematic descriptors of gait in a hemiplegic patient before and after an intervention (Botulinum toxin injection).

METHODOLOGY

The subject for this study was a nineteen-year-old male with a traumatic brain injury, incurred as a result of an automobile accident two years previous. He had a hemiplegic right spastic gait pattern characterized by an exaggerated plantar flexion of the affected leg causing a toe-heel foot placement and a "vaulting" motion about the unaffected leg. He was a functional walker with the use of a cane and a plastic rigid ankle foot orthosis. His gait was determined to be static in terms of improvement for the last year.

The subject was treated with 100 mouse units of botulinum toxin (type A) by injection at the midbelly of the medial and lateral heads of the gastrocnemius muscle at the mid-motor points identified by the use of a battery-powered stimulator via a

25-gauge Myoject needle/electrode. Local injection of the toxin in tiny doses produces a local paralysis by preventing the release of acetylcholine (ACh) from the nerve endings. This allows for the selective weakening of individual muscles experiencing spasticity.

Film setting for kinematic data collection included three S-VHS camcorders (60 Hz) with a shutter speed setting of 11100 second, synchronized by a light pulse. The subject was dressed in black tights and retroreflective markers were placed on the selected joint centers. The Ariel Performance Analysis System (APAS) was used for all analyses. Data was smoothed with a Butterworth recursive filter via the power spectrum (6 Hz).

RESULTS & DISCUSSION

Temporal characteristics of the hemiplegic gait are shown in Table 1. The stride time for the affected leg decreased consistently following the botox injection. Stance time on the affected leg also decreased, while the length of the stride increased post-injection.

Table 1. Temporal characteristics by testing session.

Variable	Pre-injection	1-week post	4-week post
Stride Time	1.891 0.052	1.70 0.18	1.71 0.09
Stance Time	1.03 0.63	0.81 0.14	0.82 0.08
Stride Length	32.73 2.15	34.56 2.61	34.42 0.84
%Stance	54.08 2.54	47.63 3.80	47.81 4.14
%Swing	45.80 2.36	52.37 3.80	52.20 4.14

1 Mean of the trials 2Standard deviation of trials

The percent of time spent in the stance phase was dramtically decreased for the affected leg. In response, the percent of time spent in swing phase increased proportionally.

The increase in swing time can be explained by considering the joint angular position data shown in Table 2. For each of the phases of the gait cycle (toe-on, heel-on, heel-off and toe-off), the ankle position was one of increased dorsi flexion following the injection. Knee flexion/extension values were consistent.

Table 2. Joint angular positions of ankle by testing session.

Phase	Pre-injection	1-week post	4-week post
Toe-on	127.551	123.89	113.31
	4.112	2.62	3.52
Heel-on	123.79	120.92	111.74
	2.52	1.87	2.62
Heel-off	107.73	105.19	96.86
	3.30	2.34	2.05
Toe-off	123.39	122.90	108.17
	3.23	5.40	3.19

1 Mean of the trials. 2 Standard deviation of trials.

Variability measures (standard deviations) were deemed small and acceptable for all parameters. This would indicate that large numbers of trials may not be necessary in order to properly characterize gait and produce acceptable reliablity.

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