The Analysis of Gait Kinematics of Participants in the Subacute Phase of Stroke with and without a Front-Wheeled Rolling Walker

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Introduction

Each year 750,000 people in the United States are diagnosed with having a stroke. Approximately 81% of the strokes diagnosed per year occur to people experiencing their first stroke. Americans paid over 70 billion dollars in 2010 for medical cost due to a stroke (Go, Mozaffarian, Roger, Benjamin, & Berry, 2013).

The frontal lobe of the brain, basal nuclei, and the cerebellum are responsible for the process of gait. The frontal lobe parts can be broken down into 3 parts, which are the primary motor cortex, premotor cortex, and prefrontal cortex. The primary motor cortex is responsible for the control of voluntary movement. The premotor cortex, also known as the somatic motor association area, is used for more complex movements such as making a fist with one hand and putting the palm down on the other. The prefrontal cortex functions to integrate sensory information with appropriate motor responses (Schenkman, Bowman, Gisbert, & Butler, 2013).

There are many types of gait patterns in patients post-stroke. Verma, Arya, Sharma, and Garg (2012) conducted a meta-analysis concentrating on post-stroke gait deviations of patients and the therapeutic interventions used to assist with the gait. Some common signs in post-stroke gait are poor paretic (affected) limb body weight support, unbalanced forward movement, slower gait speed, unequal step lengths, and prolonged swing time. On the non-paretic or unaffected limb, patients often have decreased swing phase and an increased stance phase (Verma, Arya, Sharma, & Garg, 2012).

Research is lacking comparing the gait kinematics of participants post-stroke both with and without a walker. The studies that were analyzed for this research study were the only studies available that may show similar results for participants post-stroke. These studies involve participants with Parkinson's disease, Huntington's disease, Spina Bifida, and spinal cord injury. These groups may show similar gait kinematics when compared to participants post-stroke, although the data cannot be generalized to participants post-stroke because the brain is affected differently as opposed to the spinal cord being affected.

Research Question

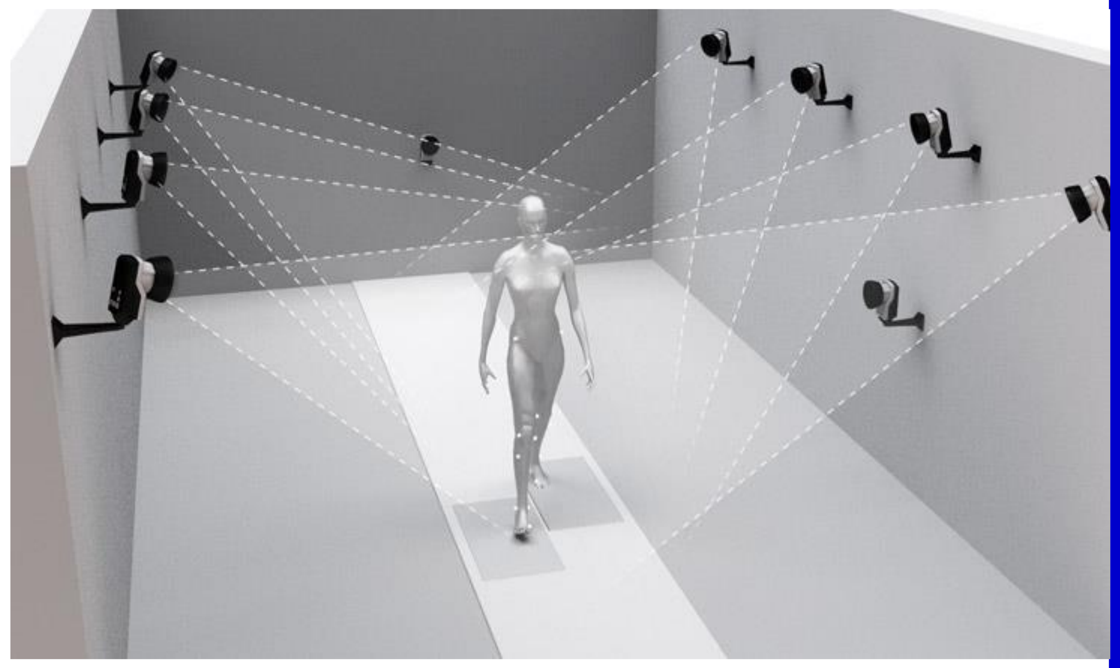
Is there a difference in the gait speed, step length, step width, peak knee flexion moments, peak hip flexion moments, trunk rotation moments, and trunk flexion moments of participants in the subacute stroke phase with and without the use of a front-wheeled rolling walker as measured by Qualisys and analyzed through Visual 3D©?

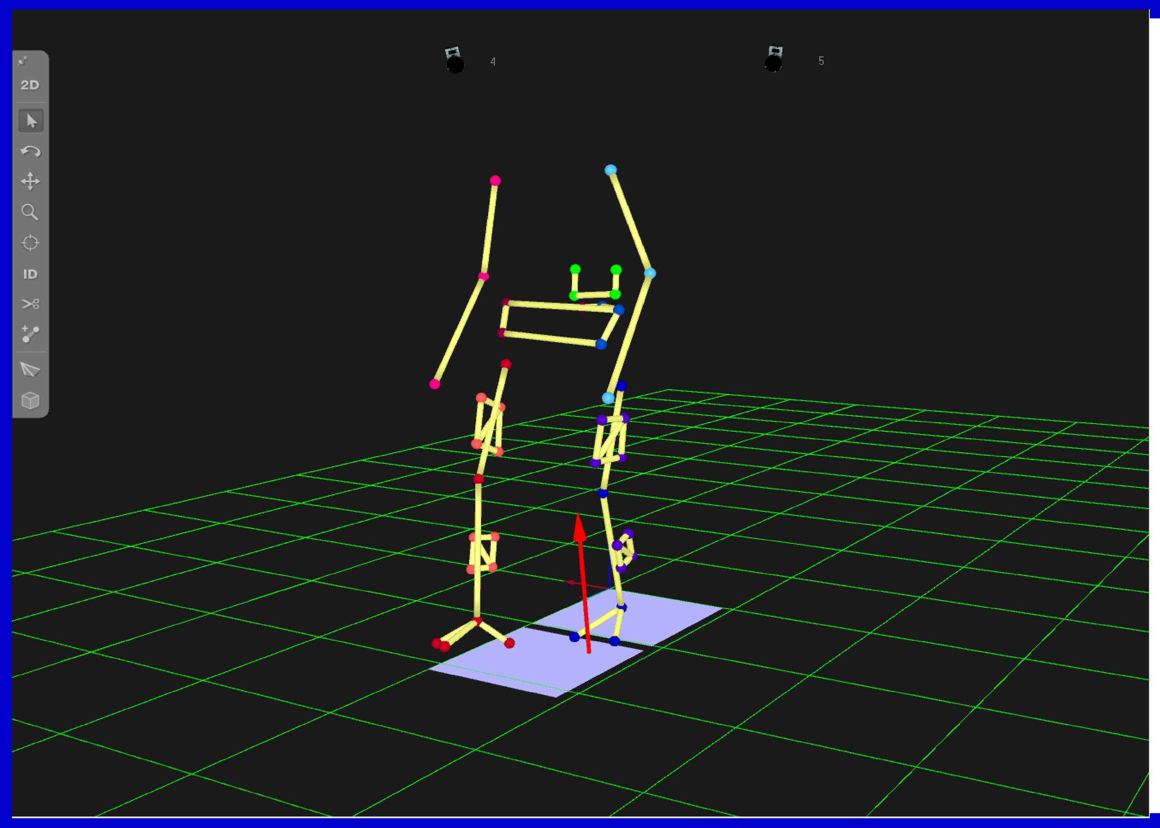
Acknowledgements

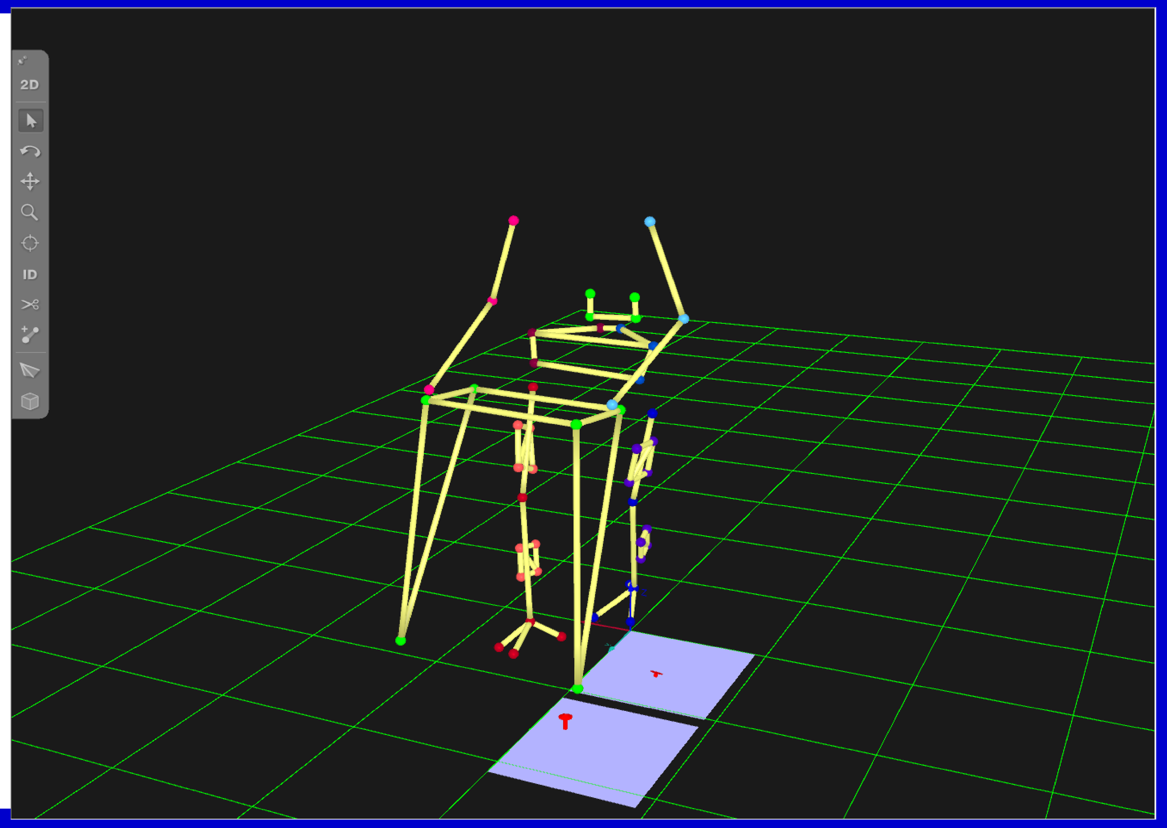
NCH Brookdale Center for Healthy Aging and Rehabilitation were key contributors in making this study possible. They were the main recruiters for participants in the study and provided transportation for the participants to come to FGCU for the study. They also collected data for the study such as age, affected side, and if they had a previous stroke. They provided a great deal of their time to making this study happen and without their support this study would not have happened.

Procedure

- Participants walked for approximately 20 meters across a room
- The participants walked 10 times (5 with an assistive device)
- Marker data was collected using a Qualysis camera system
- Kinematic and Kinetics data was collected using Visual 3D
- Pipeline formulas were made to collect the data in Visual 3D
- The data was analyzed using univariate and multivariate analysis







Results

Table 1. Comparison of Means Without and With a Front-Wheeled Rolling Walker

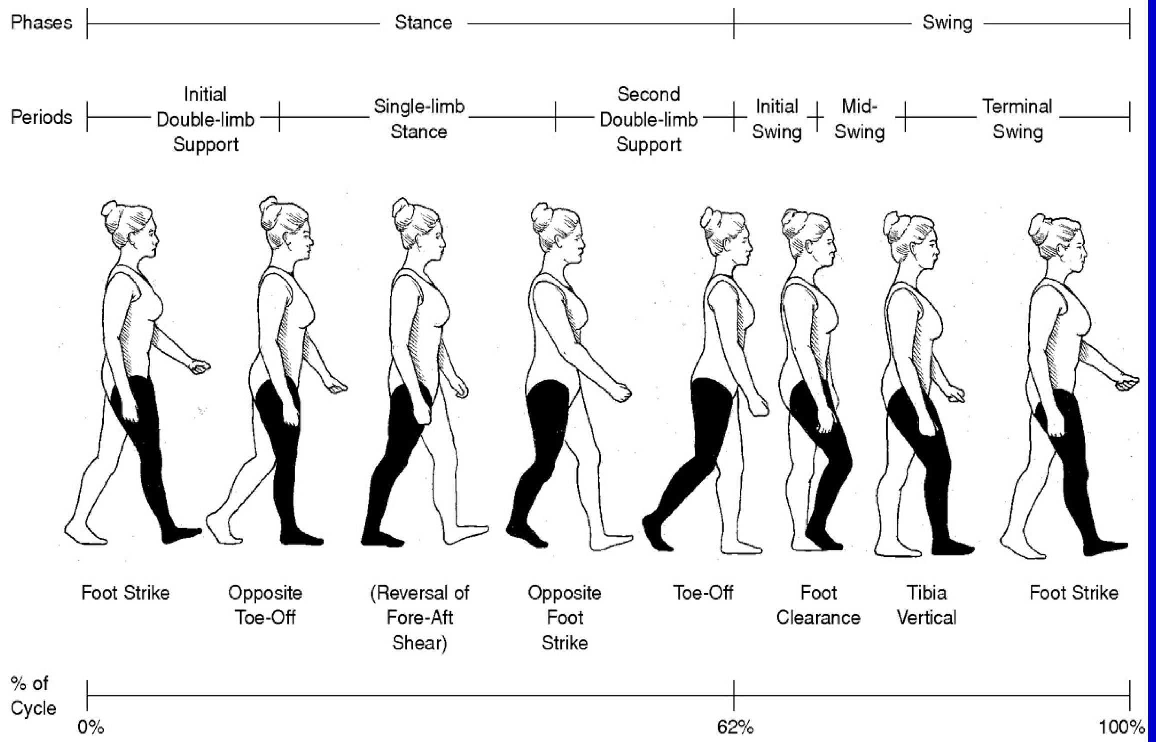
Participant	Step Length (m)	Step Width (m)	Stride length R (m)	Stride length L (m)	Peak R knee flex (deg)	Peak L knee flex (deg)	Peak R hip flex (deg)	Peak L hip flex (deg)	Trunk Rotation (deg)	Trunk Flexion (deg)
1	.3891	.0024	.7655	.7613	*46.45	*13.85	16.96	*14.44	*13.78	*31.63
	.3869	.0029	.7778	.7745	*44.76	*12.09	16.02	*12.70	*16.18	*23.91
2	*.5211	.0035	*1.031	*1.035	72.72	13.97	*7.15	2.50	10.05	10.49
	*.4132	.0050	*.7569	*.8695	66.88	18.06	*18.11	7.90	11.33	8.09
3	.3706	.0010	*.4613	*.4848	*43.32	24.66	*12.47	11.20	*18.42	*20.30
	.3608	.0034	*.7249	*.7388	*46.44	23.31	*6.71	8.61	*15.10	*6.69
4	*.5186	.0010	.9926	1.013	48.63	23.55	14.55	19.27	*11.24	8.60
	*.5705	.0110	1.029	1.024	42.76	22.11	11.13	18.38	*8.35	9.20
5	.4062	.0195	.8271	*.8308	55.53	38.67	16.45	*20.24	*9.60	7.85
	.3881	.0232	.7929	*.7760	53.85	39.39	15.31	*22.60	*12.51	6.96

* signifies p-value less than .05

The top number is without a walker and the bottom number is with a walker

Figure 1. Normal Gait Kinematics

http://www.jaaos.org/content/15/2/107/F1.large.jpg



Discussion

The results from the data varied for each participant. The only common occurrence within all of the participants was that walking with and without a front wheeled rolling walker did not result in a significant difference in step width. The type of treatment received did not have a significant impact on the kinematic data. It was thought that walking with an assistive device would decrease the step width due to the improved base of support when using the front-wheeled walker. The assistive device did not impact significantly decreasing or increasing step width.

Participants 1, 2, and 5 showed improved gait kinematics without the front-wheeled rolling walker. More specifically the participants 1,2, and 5 had either improved step length, stride length, peak knee flexion, or peak hip flexion gait kinematics when walking without a front-wheeled rolling walker **(Table 1)**. The results of this study were the same as the study by Liu et al (2009). The participants in the Liu et al study demonstrated decreased step length, stride length, and increased double limb stance time when using an assistive device. The front-wheeled rolling walker could have acted like an obstacle for these participants during the gait trials limiting their ability to walk with a normal gait pattern. Participants 3 and 4 had improved gait mechanics when using an assistive device (**Table 1**). This was more evident with participant 3. The largest impact of walking with the front-wheeled rolling walker was improved step and stride length in these subjects. The assistive device allowed for the participants to bear weight through their arms and achieve longer steps.

Participants 1 and 5 showed significantly less trunk rotation when walking without the assistive device as opposed to participants 3 and 4 who had more trunk rotation with the front-wheeled rolling walker **(Table 1)**. Fear of falling can lead to a tightened trunk and less trunk rotation, although this is a hypothesis and was analyzed in the study (Chamberlin et al., 2005; Delbaere et al., 2009). Participants 1 and 3 had significantly more trunk flexion when walking without the assistive device. The increased trunk flexion with an assistive device could be because the participants had weak back extensors that would not allow them to stand more upright during gait. The assistive device helped these subjects to maintain a more upright posture and increased safety during gait.

The difference in the participants gait kinematic data with and without a front-wheeled rolling walker proves that more research needs to be performed in this area. The results from the study differed from participant to participant except for no significant difference with step width for all of the participants. In addition to a large number of participants, future studies should look at the difference in gait kinematics when using other assistive devices, such as a 4-wheeled walker or lofstrand crutches, among participants in the subacute phase of stroke.

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