Backwards Gait Analysis as a Predictor of Postural Stability & Risk of Falls in Individuals with Parkinson's Disease

Student Researchers: Marisa Linde, SPT, Andriy Lukomsky, SPT, Justine Zink, SPT
Mentor: Lisa Inglis, PT, DPT, NCS

RESEARCH QUESTION

Is backwards gait analysis an accurate predictor of postural stability and risk of falls in patients with Parkinson's disease (PD)?

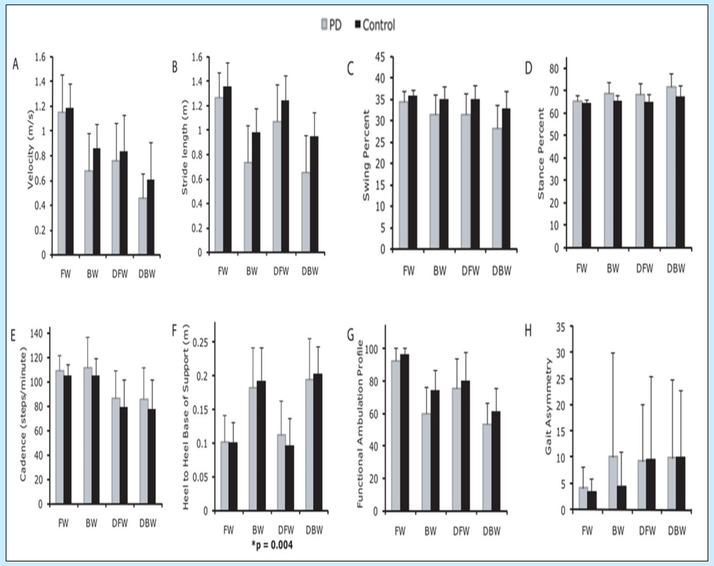
PURPOSE

The purpose of this literature analysis is to review the efficacy of backwards gait analysis as a predictor of falls in patients with PD.

BACKGROUND

Parkinson's disease is a primarily idiopathic progressive neurodegenerative disease, which involves a loss of dopaminergic neurons in the basal ganglia. This decrease in dopamine leads to many signs and symptoms such as tremors, bradykinesia, rigidity, gait and postural control deficits.[1] Gait deficits include reduced cadence, shorter stride and step length, and a decreased time in swing phase.[2,3] PD is the second most common neurodegenerative disease, affecting more than one million people in the US with incidence increasing with age.[4,5] Falls are common for people with PD with 70% experiencing a fall each year and half of these individuals experiencing multiple falls. [5,3] Direct consequences of falls consist of fractures, head trauma, contusions and other injuries, and even death. Falling may also induce fear of new falls, which can in turn reduce mobility and lead to osteoporosis, a loss of independence, social isolation, and depression. Finally, falls increase the risk of admission of patients with PD to hospitals and nursing homes.[5] Many falls occur while patients are either moving backward or after a posterior perturbation.[5] Due to decreased visual cues, individuals must rely more on proprioception while ambulating backward. In individuals with PD, inappropriate processing of proprioceptive input in the basal ganglia may contribute to postural instability.[2,5] Extensive research regarding forward gait has been conducted [2,4,6]; however, the research investigating backwards gait in patients with PD is limited.

FIGURE 1: Gait Parameters[1]



Walking Velocity (A), stride length (B), swing percent (C), stance percent (D), cadence (E), base of support (F), functional ambulation profile scores (G), and gait asymmetry (H) of individuals with PD (light gray bars), and Controls (black bars) in forward walking (FW), backward walking (BW), dual task forward walking (DT), and dual task backward walking (DTB). Values are means =/- SDs.

LITERATURE REVIEW

Authors	Subjects	Methods	Results
Bryant[2] MS, Workman CD, Jackson GR	• Thirteen men with PD (mean age = 65.54 years)	• The participants walked forward, backward, and sideways to the left and right on the GAITRite mat (Figure 2) at their self-selected speed. • They walked in all four directions, and the walking time as well as the step count was recorded. • The individuals performed two trials in all four directions and gait was analyzed.	• GAITRite was determined to be the preferred assessment tool. • Stride length and gait speed had significant differences between forwards and backwards walking (stride length 121 cm vs 78 cm) and (gait speed110 cm/s vs 67 cm/s). • Similar results were found with overground walk test with strong correlation (0.75-0.93) for measures of backwards gait.
Hackney[5] ME, Earhart GM	• Seventy-eight people with PD (mean age = 65.1 years, Female: 28%) • Seventy-four age and sex-matched controls (mean age = 65.0 years, Female: 23%)	• Forward and backward gait were measured using a 5-meter long computerized GAITrite walkway (Figure 2). • Participants were instructed to walk at their normal pace forward and backward 3 times each with adequate rest time between trials. • Researchers primarily assessed the following variables: gait velocity, stride length, cadence, base of support (BOS), double support percent, swing and stance percent, and functional ambulation profile (FAP).	• While walking backwards, those with PD walked significantly slower with shorter strides, lower swing percents, and higher double support and stance percents, and lower functional ambulation profiles compared to controls. • Differences between those with PD and controls were more pronounced in the backwards compared to forward. • As scores on the Berg Balance Scale improved, gait speed increased in both backward walking (r=0.538) and forward walking (r=0.486) (p<0.001).
Hackney[1] ME, Earhart GM	• Seventy-eight people with PD (mean age = 65.1 years, Female: 28%) • Seventy-four age and sex-matched controls (mean age = 65.0 years, Female: 23%)	• A computerized GAITRite (Figure 2) walkway measured gait parameters. • Participants began walking prior to the mat and were required to walk across the walkway. • They were instructed to perform simple and dual conditions while walking at their normal pace forward and then backward. • The GAITrite analyzed gait velocity, stride length, swing and stance percent, cadence, heel to heel base of support, functional ambulation profile, and gait asymmetry.	• Walking backwards impacted gait more than dual tasking in those with PD. • Shown in Figure 1, participants with PD demonstrated shorter strides, lesser swing percent, greater stance percent, wider base of support, and lower functional ambulation profile values in backwards walking compared to forward walking. • There was a greater decrement in stride length and swing percent in the group with PD compared to the control group when asked to perform a dual task.
Jacobs[3] JV, Earhart GM, Mcneely ME	• Eighty people with PD (mean age=67 years) • Complete data were available for 43 of 80 participants	• At baseline, participants completed the BESTest, the Unified PD Rating Scale motor section (which includes the Pull Test), and the participants' reported falls experienced in the previous 6 months. • Participants were classified as recurrent fallers if they reported more than one fall in the 12 months subsequent to baseline. • Stepwise logistic regressions determined whether the P&R Test, Pull Test, Brief-BESTest, Mini-BESTest, or UPDRS motor score improved predictions of recurrent fallers independent of baseline fall-group status.	• Predictions of fallers with PD benefit from a balance examination. • At the 12-month follow-up, the P&R Test, the Pull Test, and the UPDRS motor exam did not significantly improve predictions beyond knowledge of fall-group status at baseline. • The Brief-BESTest and Mini-BESTest improved predictions of fall-group status at the 12-month follow-up when coupled with fall-group status at baseline.

ANALYSIS OF LITERATURE

In patients with PD, backward gait is characterized by reduced cadence, increased double support time, shorter stride length, and decreased time spent in swing phase when compared to forward walking (Figure 1).[2,3] When compared to controls, differences in backwards gait are more pronounced then those observed in forward gait.[5] Backward gait is a less automatic task compared to forward walking and individuals must rely more heavily on proprioception due to decreased visual cues compared to forward walking. Individuals with PD maintain inappropriate processing of proprioceptive input in the basal ganglia, leading to balance impairments; therefore, backward walking may be more indicative of postural instability and risk of falls compared to forward walking.[1,5] Research demonstrates that both the GAITRite and overground walking are effective tools to analyze multidirectional gait, including backward walking, in individuals with PD; however, most clinics do not have a GAITRite device available.[1,2,5] While measures including the P&R test, miniBESTest, and the Pull Test are predictors of falls, they are limited in their items related to backward gait.[3]

CONCLUSIONS

Although research confirms that backwards gait is characterized by significantly decreased postural stability in patients with PD relative to healthy controls, it is inconclusive as to whether or not backwards gait is efficacious in predicting falls in individuals with PD. Backwards gait assessments may display a superior representation of degree of basal ganglia involvement in individuals with PD due to its heavy reliance on proprioceptive input. Based on the current research, measures available to quantify backward gait and determine their ability to accurately predict falls risk in patients with PD are limited. Further research is required to validate backwards gait as a predictor of falls in patients with PD.

FIGURE 2: GAITRite Device [7]

Figure 2: 5-meter long computerized GAITRite device used to assess gait parameters. http://www.emsphysio.co.uk/wp-content/uploads/2016/01/Gill.jpg

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