Short Communication

The Feasibility of Measuring Gait in an Outpatient Cognitive Neurology Clinical Setting

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Abstract. There is increasing interest in gait evaluations in clinical settings given the associations between gait and health outcomes. However, efforts examining implementation of gait evaluation in neurological clinics are lacking. Herein, gait implementation within a cognitive neurology clinic is presented. Over a 21-month period, a gait evaluation was collected on 81\% of eligible patients ($n=2,622$; mean age 73.2 $\pm$ 9.5; age range 49–94 years; 47\% female). Patients and staff reported being satisfied with the gait assessment. These finding have implications for gait evaluations in clinical settings and for clinical research aimed at understanding the impact of cognitive symptomatology on gait.

Keywords: Cognition, dementia, gait, implementation

INTRODUCTION

Gait parameters, most notably gait speed, have been evaluated in older adults with neurological, musculoskeletal, and cardiovascular diseases [1–3]. Consistent findings across such populations demonstrate gait indices as a reliable outcome measure associated with falls, hospitalizations, comorbidities, disability, and survival [4, 5]. Gait parameters may also be an important clinical indicator in patients with cognitive impairment as recent studies demonstrate a link between cognitive deficits and gait impairment [6, 7]. Further, for those patients with cognitive symptomology, the assessment of gait could serve as a valuable measure as it integrates critical facets of aging-related and/or disease-related morbidities including decreased mobility, fitness, nutritional status, and emotional state [4]. Thus, the assessment of gait could aid in creating a more complete health profile in patients with cognitive symptomology. In addition, preliminary reports suggest that the gait profile can be utilized to predict cognitive decline in dementias as well as predict those with mild cognitive impairment (MCI) who transition to Alzheimer’s disease (AD) [8]. However, despite the growing significance and noted integration of gait with cognitive symptomology, the feasibility of evaluating gait within an outpatient cognitive neurology clinic has not been adequately described.
Individuals with dementia, including those with AD, experience physical disability and research has demonstrated that 62% of those with dementia experience a fall during just 6 months of observation [9]. Unfortunately, disability and falls can lead to restrictions in daily and physical activities as well as increased hospitalization, thus perpetuating disease sequela. Although the causes of falls and disability are multi-factorial, key temporal (gait speed) and spatial (step length variability) are consistent predictors of falls and physical functioning in non-demented aging populations [10, 11].

Despite the linkage with future health risks, gait evaluation has not traditionally been clinically applicable due to time and space constraints. However, gait mat technologies now offer a quick, efficient, and reliable way to quantitatively assess an individual’s gait profile within a clinical setting. While more simple approaches for collecting gait speed are available (e.g., stop watch, motion sensors) gait mats allow for added gait parameters including temporal, spatial, and pressure values from each step. Such parameters, beyond gait speed, are important as studies have demonstrated that a variable gait pattern (increased step length variability) increases the risk of falls in cognitively impaired older adults and is associated with recurrent falls in patients with dementia [12, 13]. Despite the benefit of utilizing gait mat technology, we know of no published reports on the feasibility of implementing gait evaluation utilizing gait mat technology in clinical practices that focus on cognitive symptomatology. In this paper, we report on the feasibility of implementing a gait assessment utilizing a gait mat in a cognitive neurology outpatient setting.

MATERIALS AND METHODS

From September 2016 to May 2018, gait evaluations were conducted within Emory University’s Brain Health Center (BHC), which houses the cognitive neurology outpatient clinic. Patients attending the clinic were briefly screened for eligibility upon appointment check-in. To be included for a gait mat assessment, individuals were required to be able to follow one-step commands and ambulate 40 feet independently without mobility aid. Protocols were approved by the Emory University Brain Health Center and the Emory University Institutional Review Board.

Following check-in and screening, patients were escorted to the gait mat by clinical staff for evaluation. For patient convenience and efficient clinical flow, the clinic was designed with the gait mat located near the check-in and waiting areas. Once at the gait mat, patients were instructed on the walking procedures. A demonstration and standard set of instructions were provided to each patient. Clinical assistants operating the gait mat were trained to give the same standardized set of instructions to each patient. Each patient performed one practice trial walking on the mat and two evaluation walks for a total of three walks on the mat. Patients started each trial standing behind a line of tape placed 1-m from one end of the gait mat. In line with commonly used gait assessment, patients were instructed to walk at their usual pace during all trials [5, 11]. Short rest breaks (5–10 s) were provided between each walk. Verbal cues were provided to participants as necessary between each trial. Following the walk, patients returned to the waiting room to wait for their scheduled appointment.

Temporal and spatial gait characteristics were measured on the 20 ft long x 4 ft wide ProtoKinetics Gait Mat (PKMAS). The gait mat is an automatic gait analysis system based on the opening and closing of pressure sensitive switches as the patient walks across. Following a walk, each patient’s gait data were processed for analysis unless the data was unusable due to footsteps outside the boundaries of the mat or pauses in ambulation. Once processed, selected gait parameters were generated by the PKMAS gait mat software and exported. The following four key gait parameters were extracted from the gait mat software, written down, and subsequently entered into the patient’s medical record: 1) gait speed, 2) right step length variability, 3) left step length variability, and 4) gait symmetry, which is quantified as the mean of the left step length divided by the mean of the right step length highlighting the differences between the right and left sides of the body during walking. Lastly, because manual entry by clinical staff was required to enter the gait data into the medical record, we performed a data quality control check to quantify the number of data entry errors.

The clinical staff documented in a weekly patient log if the gait assessment was “completed”, “not completed”, or if the patient was a “no show” for their clinical appointment. Staff also made notes of partial gait assessments (e.g., could not complete the walk) or if no assessment was completed on a patient who passed initial screening at check-in. This weekly log permitted the tracking of captured and missed gait collects as well as identification of barriers to the clinical implementation of the gait assessment.
To understand the feasibility of implementing the gait evaluation, the following outcomes were assessed: 1) time each day to set up the mat for collections, 2) total time to train clinical staff and acceptability of clinical staff performing the gait evaluation, 3) average time to complete the gait assessment, 4) patient acceptability, and 5) the total number of recorded gait walks entered into the medical record and the number of data entry errors.

For acceptability, both staff and patients, a 4-point Likert scale (not acceptable, somewhat acceptable, acceptable, very acceptable) was utilized. Likert scales have been utilized to assess staff and patient acceptability following clinical gait implementation in previous studies [14]. Importantly, Likert scales have been utilized in a variety of patients with cognitive symptomology including those with MCI and mild to moderate AD [15, 16]. For the patient acceptability, a convenience sample of 200 patients that participated in the gait evaluation was included. The survey was completed immediately after the gait assessment. Demographics of those patients were also collected.

For statistical analysis, means and standard deviation were calculated to summarize patients and staff demographics and percentages were calculated for descriptive sampling (e.g., percentage of gait evaluations collected). Lastly, t-tests were utilized for comparisons between patients with and without the gait evaluation on age, gender, or MOCA scores. Significance was set at \( p = 0.05 \).

RESULTS

Clinical implementation

Of the 3,238 eligible patients seen in the clinics, gait mat assessment was completed on 2,622 cognitive neurology patients equating to an 81\% collection rate. Reasons that 19\% of eligible patients did not have a gait evaluation included: no staff coverage of gait mat (10.6\% of all non-completed collections), patients not being taken to gait mat following screening and check in. This was typically due to the patients checking in late and being taking directly to the clinical examination room (4.4\% of all non-completed collections), or refusals to walk on mat (4.0\% of all non-completed collections). There was no significant difference in patient characteristics between those that completed the gait assessment and those that did not (Table 1).

After processing gait mat data on the 2,622 patients, 5 patient walks were unusable due to processing errors. Thus, 80\% \((n = 2,617)\) of cognitive neurology patients walked on the mat and had usable gait data. Of the usable gait data collected, 96\% \((n = 2,512)\) of the walks were entered into the medical record. Because manual entry by clinical staff was required to enter the gait data into the medical record, we performed a data quality control check to quantify the number of data entry errors. As such, gait data was exported from the gait mat software and crosschecked with the data in the medical record. This analysis revealed that 13\% \((n = 326)\) of the data entered into the medical record had a data entry error in at least one of the four gait variables.

Set up time

During the implementation period, gait was treated as a vital sign with a goal of each cognitive neurology patient being “walked” on the gait mat. As such, each day the gait mat collection area was set up such that there would be no disruption during gait evaluations (e.g., cone barriers). In addition, the gait mat needed to be calibrated. Time to set up the equipment and calibrate the system each day was 2 min ± 30 s.

Clinical staff training time and acceptability

Clinical assistants operating the gait mat were trained on all set up and gait collection procedures as well as processing of a gait walk prior to the implementation of the gait evaluation. All 14 clinical assistants reported that the training for, as well as, conducting the gait evaluation were “very acceptable” or “acceptable”. The clinical assistants consisted of Doctor of Physical Therapy students \((n = 8, \text{mean age } 25.13 \pm 2.17; \text{age range } 23–30 \text{ years}; 75\% \text{ female})\) and rooming nurses \((n = 4, \text{mean age } 49.25 \pm 9.71; \text{age range } 38–61; 100\% \text{ female})\). All assistants were given a script such that the same standardized instructions were recited to each patient. The average time to train 14 clinical assistants on set up, using the gait mat, instructing the patients, and processing the gait data ranged from 15–22 min.

Average time to complete the gait assessment

During the initial two weeks of the implementation of the gait evaluation, an evaluator assessed and recorded the time it took the clinical assistants to take patients \((n = 68)\) from the waiting room following
check in, to the gait mat and then subsequently take them back to the waiting following the gait assessment. The average time of this was 3 min 35 s ± 2 min 01 s.

Patient acceptability

Of the 200 patients sampled, 189 patients reported the gait evaluation as “very acceptable” (n = 124; 62%) or “acceptable” (n = 65; 32.5%). The remaining 11 (5.5%) reported that the evaluation was “somewhat acceptable”.

DISCUSSION

We aimed to demonstrate the feasibility of implementing gait evaluation utilizing gait mat technology in a cognitive neurology clinical setting. We believe these results indicate that a gait evaluation utilizing gait mat technology can be successfully implemented in an outpatient cognitive neurology clinic. The findings demonstrate that implementation of a gait evaluation is feasible with 81% of patients completing the gait evaluation. Based on set up time and total time to complete the gait assessment, little to no impact was seen in the cognitive neurology clinical flow. Importantly, the patients reported being satisfied with the overall process of the gait mat assessment and the staff reported high acceptability of the training. We believe this positive feedback related to the training is based on the user-friendly gait mat and associated software as well as the ease of evaluation. While a notable disadvantage of gait mat technologies is the cost, they do offer a quick and reliable way to quantitatively assess an individual’s gait profile beyond a simpler timing device limited to just the quantification of gait speed. Karpman et al. [14] evaluated gait implementation in an outpatient COPD clinic and, similar to our results, found high acceptability by clinical staff. Studenski et al. [17] also evaluated the feasibility of measuring gait in older adults in both Medicare Health Maintenance Organizations (HMO) and the Veteran Affairs Health system. Their findings demonstrated that the measures can serve as an accessible “vital sign” that was highly acceptable by healthcare professionals. Similarly, the high level of acceptability among patients in our sample has also been demonstrated in outpatient clinics in which gait evaluations have been implemented [14].

Why would the implementation of a gait assessment be important to cognitive neurology? The assessment of gait is central in the study of physical disability, disease progression, and falls with both temporal and spatial gait parameters being systematically evaluated [8, 10–13]. Increasingly, gait disparities on gait speed and step length variability are observed between healthy, patients with MCI [6] as well as AD populations [7]. For example, in addition to identifying those at risk for a fall, gait speed and step length variability are related to global cognitive function in both AD and MCI populations [9–11]. Thus, it is possible that gait indices can be utilized as a clinical flag for those at high risk of a fall and increased disability such that targeted therapies can be implement earlier.

Preliminary research suggests that changes in gait function may be used in predicting cognitive decline and which patients with MCI will transition to AD [8, 18]. For instance, a recent study was able to establish that MCI patients with poorer lower extremity motor function were at higher risk of conversion to AD [8]. Additionally, a study determined that MCI patients with slower gait speed transitioned to AD at higher rates than those with faster gait speeds who did not convert [18].

There are limitations noted in our evaluation of the gait implementation. The implementation process did not include patients furthest along in the disease process who were unable to follow instructions and/or unable to walk 40 ft independently. While critical to understand implementation of the gait evaluation, it was not feasible to assess these patients due to time constraints in those patients unable to ambulate independently. Future research aimed to better understand to full breadth of gait impairment and its impact on
cognitive symptomology is warranted. Also, the convenience sample of 200 patients surveyed may not be representative of the entire population evaluated. Additionally, a large amount of medical record entry errors were noted (13%) as a likely result of manual entry. The clinical assistants had varied duties including many that required multitasking that may have contributed to the high number of data entry errors. Future developments are underway that would allow clinical assistants to “push” the gait data directly to the medical record to avoid the manual writing down of values and/or data entry errors. Lastly, as this implementation was done in a busy clinic there were limitations of how many protocols could be tested. Future research beyond “usual pace” walking (fast pace and/or dual task walking) may provide additional valuable information.

In summary, the implementation of a gait evaluation is feasible utilizing a gait mat in a cognitive neurology clinic. The training, set up time, and total time to complete the gait assessment resulted in little to no impact to clinical flow. Future longitudinal studies should examine gait variables to better understand what aspects of the gait profile are associated with cognitive status, mobility decline and disease severity.

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