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Wheeled and standard walkers in Parkinson's disease patients with gait freezing

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Abstract

Objectives. Compare the efficacy of two walking assistance devices (wheeled walker and standard walker) to unassisted walking for patients with PD and gait freezing.

Background. Although numerous walking devices are used clinically, their relative effects on freezing and walking speed have never been systematically tested.

Methods. Nineteen PD patients (14 non-demented) walked under three conditions in randomized order: unassisted walking, standard walker, and wheeled walker. Patients walked up to three times in each condition through a standard course that included rising from a chair, walking through a doorway, straightway walking, pivoting, and return. Total walking time, freezing time and number of freezes were compared for the three conditions using mixed models (walking time) and Friedman's test (freezing). The wheeled walker was further studied by comparing the effect of an attached laser that projected a bar of light on the floor as a visual walking cue.

Results. Use of either type of device significantly slowed walking compared to unassisted walking. Neither walker reduced any index of freezing, nor the laser attachment offered any advantage to the wheeled walker. The standard walker increased freezing, and the wheeled walker had no effect on freezing. Among the non-demented subjects ($n = 14$), the same patterns occurred, although the walking speed was less impaired by the wheeled walker than the standard walker in this group.

Conclusions. Though walkers may stabilize patients and increase confidence, PD patients walk more slowly when using them, without reducing freezing. Because the wheeled walker was intermediate for walking time and does not aggravate freezing, if walkers are used for these subjects, this type of walker should be favored.

Keywords: Gait freezing; Parkinson's disease; Voluntary motor activity

1. Introduction

Gait freezing is frequent in advanced Parkinson's disease (PD) and is associated with falls and fractures [1]. Freezing is a transient halt in voluntary motor activity that particularly occurs when the patient encounters obstacles or meets a constriction in visual or propioceptive input. Gait freezing includes start-hesitation, interruption in pivoting, and sudden festination in a doorway or narrow space [2].

Ambulatory aids such as walkers can be used to reduce some aspects of walking disability [3], and can be particularly valuable to patients who have impaired balance [4]. Wheeled walkers and standard walkers are commonly used for walking difficulties [5] including instability and freezing in parkinsonism. Freezing is resistant to medication, but can be helped by manipulating sensory inputs, including auditory stimuli like metronome beats or visual stimuli like lines or laser lights on the floor [6–9]. Although commonly advocated for gait problems due to impaired balance in Parkinson's disease, walkers have not been assessed specifically for their utility and safety among subjects with freezing.

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The purpose of our study was to compare the efficacy of two walking devices, wheeled and standard walkers, to unassisted walking in patients with PD and gait freezing. We were particularly motivated to conduct this study, because so many patients in our practice used walkers that were self-prescribed. Because a number of studies have found that there is an increased dependence on visual cueing for control of motor activity in PD [10–12], we further determined whether a laser light attached to the wheeled walker improved freezing. In recognition that dementia can coexist with motor impairment in PD, we included both demented and non-demented subjects. These objective data can serve as the basis for practical guidelines to physicians on the utility of prescribing standard or wheeled walkers with visual cues, for PD patients with gait freezing. We elected to study patients with PD with 'on' freezing because their freezing does not adequately respond to other therapeutic manipulations.

2. Methodology

2.1. Subjects and definitions

Consecutive PD ambulatory outpatients in a university center for movement disorders with 'on' freezing episodes after taking their regular PD medications were invited to participate in the study. PD was defined by the presence of at least two of the four cardinal features (bradykinesia, tremor, rigidity, and postural reflex abnormality) without evidence of other forms of parkinsonism. Gait freezing was defined as sudden episodes of immobility at the start or in the midst of walking or turning. A freezing episode was measured from the time a patient's gait stopped or hesitated until the next full step. All patients were evaluated in the middle of their levodopa dose cycle at maximal mobility ('on'). All patients signed informed consent before participation.

2.2. Experimental procedure

Freezing was evaluated using a standardized 60-feet walking course. The patient arose from a chair, walked through a doorway, down a hallway, turned, walked through the doorway again and sat down. This walking course was designed to reproduce conditions that increase freezing. Because we were concerned that a walking device could aggravate freezing and increase falls, we conducted the study exclusively in an outpatient setting under direct medical supervision.

Three primary walking conditions were evaluated: unassisted walking, walking with the standard walker, and walking with the wheeled walker (the combined analysis for the wheeled walker combined all settings under the wheeled condition not just the one without the laser). The wheeled walker condition was further analyzed in three settings: the walker used alone, with a laser beam turned on throughout the trial, and with a laser beam activated by the patient when freezing occurred. The five conditions were performed in random order. Depending on individual patient stamina, we evaluated one, two or three trials of unassisted walking and walking with both types of walkers with/without the laser. Prior to timed trials, patients familiarized themselves with the walking course, and were properly trained with the use of the walkers and the laser by the first investigator (EC). The standard walker consisted of a lightweight metal four-legged support apparatus with adjustable height. To use the walker, patients had to pick it up and set it down sequentially with each step. The floor contacts were rubber tipped without wheels. The wheeled walker consisted of a four-wheel walker with locking loop brakes and a laser beam attached to a bottom. The wheels permitted patients to advance the walker without having to pick it up or set it down on the floor. The laser cue was a color light band projected onto the floor perpendicular to the walker. The laser could be turned on or off by the patient through a switch attached to the top of the walker. For the two laser conditions, the patients were instructed to use the laser beam as a visual aid and to step over it. All patients were videotaped by the primary investigator (EC). A second investigator otherwise unrelated to the study (CGG) rated freezing based on the videotape recordings.

On the day of testing, we also rated patients using the motor section of the Unified Parkinson's Disease Rating Scale (UPDRSm) and Hoehn and Yahr stage (HY) [13]. We performed the Mini-Mental Status Examination (MMSE) [14] and categorized patients as demented if they met the clinical criteria of DSM-IV [15] and if their MMSE was 23 or less.

2.3. Outcome measures and statistical analysis

Four outcomes were compared across the walking conditions: (1) walking time, (2) freezing time, (3) number of freezes, (4) mean duration of freezes. Walking time was defined as total trial time minus the total freezing time. The average freezing time and number of freezes were calculated (across trials) for each subject under each condition. Mean duration of freezes was calculated by dividing the total freezing time by the number of freezes. If no freezing occurred, the mean duration of freezes was taken to be 0.

The natural logarithmic transformation was applied to the walking time and then compared across conditions using mixed models. These models accounted for correlations among observations from the same subject. We additionally controlled for trial number and total number of freezes in these models [16]. These results are presented transformed back into the original scale as geometric means plus-or-minus standard errors.

All freezing outcomes were compared across conditions using Friedman's test and $\alpha = 0.05$. Follow-up tests performing multiple comparisons of pairs of conditions were performed using Signed Rank tests, with a Bonferroni correction for multiple tests, so that statistically significant comparisons of two conditions requires a p-value less than $0.05/3 = 0.017$. Analyses were performed using SAS version 6.12 (SAS Institute, Cary, NC).

3. Results

Nineteen consecutive male patients with PD and freezing after taking their regular PD medications qualified for study entry and all participated in the study. Their mean age was 72 ± 8 years, with a mean PD duration of 14 ± 5 years. Their mean UPDRS motor score taken at the time of the walking trials was 39 ± 10 and their median Hoehn and Yahr stage was 3 (range 2–4). All were taking levodopa, mean daily dose 672 ± 461 mg, and 15 patients received agonists at a mean daily pergolide mesylate equivalent dose [8] of 2.7 ± 1.5 mg. Five out of 19 patients were clinically demented; this group was characterized for being slightly older (75 ± 5 years), with a similar PD duration (14 ± 6 years), higher mean dose of Sinemet: 790 ± 574 mg, lower pergolide mesylate equivalent dose of 1.0 ± 0.1 mg (2 patients), and greater motor disability with a mean UPDRSm of 46 ± 11, and median HY stage of 4 (range 3–4). The full protocol (five conditions) was completed by 17 subjects. In the other two subjects, the blinded rater could not distinguish among the three wheeled walker conditions. Their data were included in analysis of wheeled walker versus standard walker versus unassisted walking, but not included for analysis within wheeled-walker conditions. All subjects completed the testing without falls.

Total walking times in the three walking conditions (unassisted, standard, and wheeled walkers) were significantly different from one another ($p = 0.0037$, Table 1). Walking was fastest in the unassisted condition, and walking with each type of walker was significantly slower ($p = 0.0017$ for the standard walker, $p = 0.0081$ for the wheeled walker). Likewise, freezing time, number of freezes, and duration of individual freezes differed significantly among the three walking conditions ($p = 0.0068, 0.012$ and 0.016, respectively). Walking with the standard walker significantly increased freezing time ($p = 0.0015$), number of freezes ($p = 0.016$), and freezing duration ($p = 0.0006$) (Table 1). Walking with the wheeled walker was not associated with enhanced freezing as

Table 1
Walking time and freezing outcomes by walking condition

$n = 19$	Wheeled walker	Standard walker	Unassisted walking	p-values
Total walking time (s)				
Geometric mean ± SE[a]	50.2 ± 11%	52.8 ± 11%	40.7 ± 11%	0.0037, 0.0017,[b] 0.0081[c] 0.51[d]
Total freezing time (s)				
Mean ± SD	34.7 ± 74.5	55.6 ± 113.2	21.6 ± 52.1	
Median (min, max)	3.5 (0, 234.3)	4.5 (0.7, 457.5)	2 (0, 225.5)	0.0068 0.0015[b] 0.53[c] 0.0064[d]
Number of freezes				
Mean ± SD	2.5 ± 3.8	3.9 ± 4.7	2.6 ± 3.7	
Median (min, max)	1.1 (0, 15)	2 (0.7, 19.5)	1.5 (0, 13)	0.0119 0.016[b] 0.86[c] 0.0041[d]
Duration of a freeze				
Mean ± SD	5.7 ± 7.7	7.7 ± 10.6	4.1 ± 5.7	
Median (min, max)	2.5 (0, 28.1)	3 (1, 43.5)	2 (0, 19.6)	0.0156 0.0006[b] 0.10[c] 0.77[d]

The top p-value is the overall p-value from the comparison of the three conditions.
[a] Model-based standard errors for the least square means.
[b] Value is from comparison of standard walker with unassisted walking.
[c] Value is from comparison of wheeled walker with unassisted walking.
[d] Value is from comparison of wheeled walker with standard walker.

Table 2
Walking time and freezing outcomes for wheeled walker by kind of laser cueing

$n = 17$	Laser when freezing	Laser all the time	Wheeled without the laser	p-value*
Total walking time (s)				
Geometric mean ± SE	49.3 ± 11%	50.1 ± 11%	45.9 ± 11%	0.45
Total freezing time (s)				
Mean ± SD	24.9 ± 64.4	25.4 ± 60.7	24.0 ± 55.2	0.75
Median (min, max)	1 (0, 218)	2.7 (0, 191)	1.3 (0, 172)	
Number of freezes				
Mean ± SD	2.5 ± 4.9	2.0 ± 3.0	2.3 ± 3.6	0.90
Median (min, max)	0.7 (0, 20)	1.0 (0, 12)	1 (0, 13)	
Duration of a freeze (sec)				
Mean ± SD	3.4 ± 5.4	4.9 ± 7.9	4.0 ± 5.2	0.58
Median (min, max)	1.3 (0, 21.4)	2 (0, 31.8)	1.7 (0, 19.1)	

Table 3
Walking time and freezing outcomes by walking condition for non-demented PD patients

$n = 14$	Wheeled walker	Standard walker	Unassisted walking	p-value
Total walking time (s)				
Geometric mean ± SD[a]	42.1 ± 9%	48.8 ± 9%	34.4 ± 9%	0.0002 <0.0001[b] 0.0082[c] 0.053[d]
Total freezing time (s)				
Mean ± SD	19.7 ± 61.9	41.4 ± 120.6	20.2 ± 59.5	
Median (min, max)	1.7 (0, 234.3)	3.5 (0.7, 457.5)	2 (0, 225.5)	0.0724
Number of freezes				
Mean ± SD	1.5 ± 2.1	3.3 ± 4.9	2.1 ± 3.2	
Median (min, max)	0.9 (0, 8.3)	1.7 (0.7, 19.5)	1.3 (0, 11.5)	0.0033
Duration of a freeze				
Mean ± SD	4.1 ± 7.1	4.5 ± 6.0	2.9 ± 5.1	
Median (min, max)s	2.2 (0, 28.1)	2.1 (1.0, 23.5)	1.5 (0, 19.6)	0.11

The top p-value is the overall p-value from the comparison of the three conditions.
[a] Model-based standard errors for the least square means.
[b] Values is from comparison of standard walker with unassisted walking.
[c] Values is from comparison of wheeled walker with unassisted walking.
[d] Values is from comparison of wheeled walker with standard walker.

determined by any of the three measures. The use of the laser device did not change walking speed or any freeze measure (Table 2).

Because we were concerned that dementia could impede the handling of a walker and the execution of the complicated walking protocol, we reanalyzed the data omitting the five demented subjects (Table 3). As with the total group, non-demented PD subjects with freezing showed a significant difference in total walking time across the three conditions ($p = 0.0002$). This difference occurred for both the standard walker ($p < 0.0001$) and the wheeled walker ($p = 0.0092$). The total walking time with the wheeled walker was intermediate between unassisted walking and standard walker. Differences among the three conditions in the other freezing measures were not significant, except when comparing the number of freezes between walking with the wheeled walker to walking with the standard walker ($p = 0.0033$) (Table 3).

4. Discussion

Animal studies suggest that the basal ganglia provide internal cues to trigger movement, and that in hypokinetic states like Parkinson's disease a deficiency in these cueing mechanism exists [6,17]. To overcome these internal deficits, Parkinson's disease patients typically rely on external cues to overcome start hesitation and other forms of freezing. Traditional strategies include removing obstructive, low-lying objects like coffee-tables and other furniture from the patient's environment in order to allow more open space. Visual cues, like specialized walking sticks, lines on the floor, and laser beams have also been helpful in improving freezing [18,19]. Limited reports on auditory cues like metronome pacing and pulsed electromagnetic fields suggest that non-visual, rhythmic cues may also ameliorate freezing in some patients [20,21].

Walkers are frequently used by Parkinson's disease patients, but the question of whether they influence freezing has not been extensively addressed. Manufacturers laud wheeled walkers as superior to standard walkers because they are easier to manipulate and do not require that the patient stop and lift the walker forward. No comparison between these two types of walkers has been conducted in Parkinson's disease, especially in regards to freezing. Our data clearly demonstrate that neither type of walker nor the use of a laser line added to a wheeled walker is useful as a tool to overcome freezing. In fact, standard walkers aggravated freezing. With these findings, we confidently discourage PD patients with predominant freezing from utilizing a walker to overcome this clinical problem.

Our clinical study does not establish the mechanism underlying the walker-induced exacerbation of freezing with the standard walker. In our view, the most likely explanation is that the walker acts as a visual obstacle. Because doorways, narrow passages and other restricting environmental elements typically aggravate freezing, the presence of the walker with the patients' close extra-personal space may have contributed to the poor outcome on freezing. Even though one of the wheeled walker conditions included a light beam that in other settings has been effective for overcoming freezing, the light stimulus did not improve freezing in this context. This observation suggests that different perceptual cues are simultaneously operative in PD. Because our focus was on walkers, we did not test patients with a laser stimulus without the walker. We are confident from our findings that a laser addition is not beneficial in a walker for the treatment of freezing.

In the case of the standard walker, where lifting and replacing the walker on the ground impedes smooth walking these interruptions may increase freezing. Because the aggravation of freezing was most marked when the demented patients were included in the sample, the cognitive complexity of using a standard walker that requires lifting and placing the apparatus continuously may also contribute to freezing. This finding is supported by studies showing that PD patients, especially those with cognitive impairment, have difficulty performing simultaneous tasks, while walking [22,23].

The second change observed in this study concerned the slowed speed of walking. Use of either walker significantly prolonged walking time in Parkinson's disease patients. Because our focus was specifically on freezing, we did not analyze this observation further. Given the fact that Parkinson's disease patients generally complain of slowed walking as part of their disease, the impact of further slowing from an intervention deserves study. On the other hand, if the primary gait concern focuses on instability or lack of confidence, the walker may be perceived as useful in spite of its impact on walking speed.

We recognize that our study included a small sample size, and we did not measure the reliability of assessing the number and duration of freezes on the video by other independent observers. Our study conclusions are limited to short-term results and it is possible that long term effects of walkers on freezing could differ. Because of the poor responses, we did not feel that a request to try the walkers at home was safe or justified. We did not examine balance improvement with walkers and therefore cannot comment on whether this feature of parkinsonian gait impairment changed. The multifaceted elements of the parkinsonian gait require that the patient's deficits and expectations be considered in detail before deciding on the purchase of a walker. The fact that walkers can be acquired without prescription or physician approval underscores the need for clear definition of the positive and negative outcomes of their use. Based on our data, if walkers are used for these subjects, wheeled walkers should be favored.

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