Impact of Backwards Walking on Balance in a 91 year old Patient with Parkinson’s Disease: A Case Report

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Abstract

Background

Parkinson’s Disease is a progressive neurodegenerative disease which causes postural instability leading to an increased risk for falling.

Patient Description

The patient was a 91 year old female diagnosed with Parkinson’s Disease; presents as Hoehn and Yahr stage 4. She had a history of falls over the past few years since diagnosis resulting in one hospitalization due to fall related pelvic fracture. The patient continued to be a fall risk despite conventional physical therapy management.

Intervention

A 1.5 week intervention of backwards walking in the parallel bars was selected to try and improve the patient’s dynamic balance and decrease risk for falling. Distanced walked backwards were based on patient’s tolerance to pain with movement since it was her limiting factor at the time.

Results

Pain with movement decreased over the intervention period and her score on the Mini BESTest improved by 6 points. Although, her gait speed and pain at rest remained constant.

Discussion/Conclusion
Given the duration of 4 x 60 minute sessions it was difficult to correlate improvements in balance to backwards walking. The most likely cause of improvement was the decreased pain evidenced by increased ambulation distance from 20 to 125 feet, and ability to perform all components of the dynamic gait subsection of the Mini BESTest. Backwards walking provides clinicians with a functional intervention which has the potential to improve balance, but further research needs to be done to determine its validity.
Background and Purpose

Parkinson’s Disease (PD) is a progressive and chronic neurodegenerative disorder affecting approximately 1% of the population over the age of 60. The neurodegeneration leads to decreased levels of dopamine resulting in hypokinesia since dopamine works by stopping the inhibition of the basal ganglia resulting in movement. Current research demonstrated an increased incidence of PD with age, so as our population ages physical therapists (PTs) will see an increased rate of PD patients in their clinics. In fact by 2040 there will be roughly 700,000 cases of PD; therefore it is imperative PTs research and utilize interventions which address the cardinal signs of PD while focusing on decreasing the patients’ risk for falling.

The cardinal signs of PD are considered to be resting tremor, stiffness, slowing of movement (hypokinesia), and postural instability. The postural instability leads to impaired balance and frequent falls. Also, if freezing of gait of any sort (start hesitation, turn hesitation, hesitation in tight quarters, destination hesitation, or open space hesitation) is present the patient will present with more pronounced postural instability increasing their risk of falling. 40% of people with PD experience falls and 10% may have weekly falls. This risk for falls is caused by the forward flexed posture during gait and a shift in their center of gravity anterior, and the loss of anticipatory postural adjustments in the later stages of the disease. In terms of gait, these postural instabilities manifest in a shuffling gait pattern and freezing of gait.

The clinical practice guideline (CPG) for PD suggest to clinicians the best treatment for PD is to re-educate walking through balance training and increasing flexibility, and improving aerobic capacity, initiation of movement and functional
mobility, or utilizing the Alexander Technique in terms of physical therapy management.\textsuperscript{8} Also, from clinical knowledge standard practice is to initiate progressive resistance lower extremity strengthen programs for patients with PD. The current research on progressive resistance training in the PD population demonstrates although the patients improve lower extremity strength there is no correlation between this strength and improved balance, gait, and functional mobility.\textsuperscript{9} This means no matter how strong the lower extremities are in this population there will be no improvement in balance, so other interventions need to be incorporated into physical therapy to address the balance deficits more specifically.

A review of the literature revealed a lack of research utilizing backwards walking to improve gait and balance in this patient population. One randomized control trial (RTC) was found which looked at the intervention of backwards walking. The study found over ground backward walking improved gait parameters (gait speed, cadence, and stride length) after an 8 week intervention, but did not have a significant difference compared to the forward walking control.\textsuperscript{10} Since this was an RTC the results have a potential to differ in the clinic because intensity and dosage could be difficult to match in the clinical setting.

Additional articles noted the use of multidirectional treadmill (MDTT) gait training which includes forwards, backwards, and lateral walking.\textsuperscript{11,12} The studies found a 4-8 week MDTT intervention had improvements on gait and balance in the long term.\textsuperscript{11,12} One of the studies theorized a 6 week long MDTT intervention was the therapeutic dosage since there was no significant change from week 6 to week 8.\textsuperscript{11} Even though this article mentions a potential therapeutic dosage, there is still a lack of evidence to suggest what would be the most beneficial intervention length.
The purpose of this intervention based case report is to determine if a three-week intervention of backwards walking in conjunction with lower extremity strengthening would improve gait and dynamic standing balance in a patient with Parkinson’s Disease.

**Case Description**

**Patient History**

The patient was a 91-year-old female diagnosed with Parkinson’s Disease in 2015 and presented as stage IV on the modified Hoehn and Yahr staging system of PD.\(^1\)\(^3\) She was referred to physical therapy by her primary care physician (PCP) after two recent falls in January 2018. Her chief complaints were falling unsteady on her feet, inability to walk long distances, not being able to go the grocery store, and low back pain primarily on the right side. The patient’s impairments were placed in the ICF model, figure 1.

She had a history of a prior fall in October 2017 which resulted in a hospitalization due to a pelvic fracture; she had a normal recovery from this and successfully progressed to outpatient therapy services culminating in successful discharge with maintenance program. The patient was in fair health with many comorbidities which will be discussed in the review of systems. She was taking many medications listed in table 1 for management of the comorbidities. The patient lived in an apartment alone in an independent living facility, and she had a housekeeper to aid with household tasks. She was independent with activities of daily living (ADLs), and ambulated indoors and outdoors with a rollator later transitioned to front wheeled walker (FWW). Also, the patient previously went to the grocery store with no supervision; she used the grocery cart as her assistive device
for walking. She needed to wear glasses to see and her hearing was within functional limits for her age. Her goals for therapy were returning to prior level of function, improving balance to reduce risk of falling, and increasing lower extremity strength to improve gait particularly issues with foot clearance.

The patient’s low back pain continued to worsen during the course of conventional physical therapy and started to prevent her from walking. She was referred back to her PCP for further investigation and diagnostic imaging which resulted in the diagnosis of compression fractures in the thoracic spine: x-ray showed compression fractures to thoracic vertebrae (T) 4, 5, 7-10. Previous magnetic resonance imaging (MRI) in 2015 showed minimal endplate compressions to T5, 9-11, so the x-ray confirmed new fractures to T4, 7, and 8. This resulted in a hold of therapy for two weeks prior to the start of intervention during the third week of February. Before new evaluation of the patient, she was moved up to the skilled nursing unit of the facility by her own choosing to allow for pain and bowel function to be monitored, and for assistance with ADLs and care management. At this time the patient had transitioned to full time use of transport chair for mobility activities since walking even short distances was very painful. One week in to intervention she was sent for a new MRI scan to determine if a surgical approach was warranted to aide in the healing of the compression fractures. The MRI suggested the compression fractures in the thoracic spine would heal better if a kyphoplasty was performed which the patient under went the following week at which time the intervention was stopped.

**Systems Review**

The patient’s comorbidities are presented in table 2 listed out by the system they involved along with a review of the remaining systems not affected by her
comorbidities.

Table 2: Comorbidities and System Review

<table>
<thead>
<tr>
<th>System</th>
<th>Functioning/Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular</td>
<td>-Hypertension</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>-Normal functioning for age</td>
</tr>
<tr>
<td>Endocrine</td>
<td>-Hypothyroidism</td>
</tr>
<tr>
<td>Urinary</td>
<td>-Chronic kidney disease: stage 3</td>
</tr>
<tr>
<td>Integumentary</td>
<td>-Normal for age</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>-Hx of pelvic fracture</td>
</tr>
<tr>
<td></td>
<td>-Hx of rib fractures</td>
</tr>
<tr>
<td></td>
<td>-Spinal stenosis</td>
</tr>
<tr>
<td></td>
<td>-Scoliosis</td>
</tr>
<tr>
<td></td>
<td>-Osteoporosis</td>
</tr>
<tr>
<td></td>
<td>-Compression fractures in thoracic spine 4-5, and 7-11</td>
</tr>
<tr>
<td>Neurologic: including PD symptoms</td>
<td>-Bradykinesia</td>
</tr>
<tr>
<td></td>
<td>-Postural instability</td>
</tr>
<tr>
<td></td>
<td>-Masked faces</td>
</tr>
<tr>
<td></td>
<td>-Dynamic balance deficits</td>
</tr>
<tr>
<td></td>
<td>-Decreased anticipatory balance reactions</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>-Hx of alcohol abuse</td>
</tr>
</tbody>
</table>

Clinical Impression One

Given the patient’s long episodic history of physical therapy which utilized the same plan of care (POC), gait training and balance training, with limited improvement in dynamic balance, and without decreased risk for falling, she was a good candidate for the intervention of backwards walking. Also, given the progress the patient made after her fall resulting in a pelvic fracture it was evident she could
improve her dynamic balance to further reduce her risk of falling. Plus, backwards walking is a functional task used every day: backing away from the sink, opening the refrigerator, or opening the door; it was important to ensure the patient would be safe with these tasks given her known risk for falling and history of falls.

**Examination**

Examination of the patient was performed in her room on the skilled nursing unit, and included manual muscle testing (MMT) of the lower extremities, assessment of bed mobility, ability to perform transfers, assessment of pain at rest and with movement, modified 30 second sit to stand test (m30STST), and mini BESTest to evaluate balance. This information is presented in Table 3 and 4. In terms of gait, the patient did not have any issues with initiating step or a shuffling gait pattern. Her main gait deficits included decreased cadence and foot clearance, and increased double limb stance time due to postural instability and balance deficits.

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip Flexion</td>
<td>4+/5</td>
<td>4+/5</td>
</tr>
<tr>
<td>Hip Abduction</td>
<td>4/5</td>
<td>4/5</td>
</tr>
<tr>
<td>Knee Flexion</td>
<td>5-/5</td>
<td>5-/5</td>
</tr>
<tr>
<td>Knee Extension</td>
<td>5-/5</td>
<td>5-/5</td>
</tr>
<tr>
<td>Ankle Dorsiflexion</td>
<td>5-/5</td>
<td>5-/5</td>
</tr>
</tbody>
</table>

Table 3: Lower Extremity Manual Muscle Testing

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Pre-Intervention Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain at Rest</td>
<td>5/10</td>
</tr>
<tr>
<td>Pain with</td>
<td>8/10 with walking and transfers</td>
</tr>
</tbody>
</table>

Table 4: Pre-Intervention Outcome Measures
Clinical Impression Two

Despite the patient having not been to physical therapy for two weeks and spending most of her day sitting in the transport chair, she was still very strong in her lower extremities due to her continued ability to perform transfers modified independent. Lower extremity strengthening should be utilized as part of her POC to maintain the strength she had since she was spending most of her day sitting in the transport chair or in bed, and to combat any atrophy which could occur do to decreased functionality on the patient’s part secondary to increased level of assistance from the nursing staff. Her largest deficits were in terms of balance and pain, so IFC e-stim was the selected intervention to address the pain, and backwards walking was the selected intervention to address the balance and gait deficits. Backwards walking was selected since it is a functional intervention to strengthen the lower extremity, and is a higher demand task in terms of balance.
because it is not an automatic movement like forward walking. In terms of ambulation, her limiting factor was pain, so once the pain was under control the patient would be able to ambulate easily further than 20 feet.

**Intervention**

Given the chronic and progressive nature of the patient’s disease, she had been in and out of physical therapy over the years to address declined function and increased risk for falls. The previous episodes of therapy had utilized the interventions proposed in the PD CPG, but even after the episodes were concluded the patient was still at risk for falling despite having increased lower extremity strength, ambulation, and functional movements like transfers. The continued use of interventions which did not impact the patient’s risk for falling was the main push for a different intervention to try to increase patient’s ability to balance. Also, since in school we are taught to use functional training over strength training due to the specificity of task; functional interventions were considered for this patient. Backwards walking was selected because it was a functional activity used by patients in their daily lives, was not an automatic task like forwards walking, and required increased proprioception and attention on the part of the patient. The intervention continued to utilize lower extremity strengthen to try and prevent any lose of strength while patient was on the skilled unit of the facility, and allowed her to be able to walk backwards. Also, gait training and transfer training was incorporated into the POC to increase patient’s independence on the unit and work towards her goal of returning to her apartment.

The intervention was planned for a 3-week period with increased demand of backwards walking each week, and started to incorporate backwards weaving by
week 3. Due to the patient’s kyphoplasty half way through this period the intervention was modified to a 1.5 week period of 4 sessions which lasted 60 minutes. Table 5 outlines the progression of backwards walking in the parallel bars, progressive resistance training used for lower extremity strengthening, and distance ambulated with gait training. The distance walked backwards was determined by the patient’s pain level, and intervention was stopped when pain reached 8/10 with the goal of being able to walk 75 feet backwards. Also, the POC included gait training for increased cardiovascular endurance and transfer training for increased independence in her room and on the unit. The first 2 sessions IFC e-stim was utilized during backwards walking to help address the patient’s pain, and allowed her to be able to participate fully in the session.

Table 5: Intervention by Session

<table>
<thead>
<tr>
<th>Session</th>
<th>Backwards Walking in Parallel Bars</th>
<th>Lower Extremity Strengthening</th>
<th>Gait Training</th>
<th>Pain with Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 feet</td>
<td>Knee flexion 2 x 10 with 2 lbs</td>
<td>25 feet CGA with FWW</td>
<td>6/10</td>
</tr>
<tr>
<td>2</td>
<td>10 feet</td>
<td>Standing hip flexion and abduction 2 x 12 with 2 lbs</td>
<td>25 feet CGA with FWW</td>
<td>7/10</td>
</tr>
<tr>
<td>3</td>
<td>10 feet</td>
<td>Standing hip flexion and abduction, and heel raises 2 x 12 with 2 lbs</td>
<td>25 feet CGA with FWW</td>
<td>6/10</td>
</tr>
<tr>
<td>4</td>
<td>15 feet</td>
<td>Standing hip flexion and abduction, and heel raises 3 x 6</td>
<td>125 feet CGA with FWW</td>
<td>5/10</td>
</tr>
</tbody>
</table>
Outcome

The patient was evaluated using the Numeric Pain Rating Scale (NPRS), the Mini BESTest, and the m30STST both prior to the intervention and 1.5 weeks after intervention was completed. NPRS was assessed at rest and with movement to determine how the pain impacted mobility. The NPRS has an interrater reliability of 100%, construct validity of 94% when compared with visual analogue scale, and minimally clinical important difference (MCID) of 1.3 for acute pain.\textsuperscript{16,17} The Mini BESTest has test-retest reliability of 92%, an interrater reliability of 91%, a criterion validity of 79% when compared to the Berg, a sensitivity of 89%, specificity of 81%, and minimal detectable change (MDC) of 5.52 points for the PD population.\textsuperscript{18,19} The m30STST was a new test, so validity and reliability has not been reported as of yet, but the test was found to have a cut off score of 7 repetitions, sensitivity of 97%, and specificity of 35%; test was good at identifying non-fallers.\textsuperscript{20} The results of this intervention are presented in figure 2. The patient’s gait speed was calculated based off her time during the Timed Up and Go Test (TUG Test), and was determined to be 0.1932 m/s for both pre- and post-test evaluation. The patient’s strength remained constant as well from pre- to post-test. Also, the patient increased the distance she could walk from 20 feet to 125 feet by the end of the fourth session.

Figure 2: Outcome Measures Pre- and Post-Intervention
Discussion

Given that the intervention only consisted of 4 x 60 minutes sessions it was unlikely to show a significant correlation in improved balance to backwards walking. The most likely cause of the improved balance was decreased pain evidenced by the patient’s ability to increase ambulated distance from 20 to 125 feet. Also, during pre-intervention testing the patient was not able to perform all components of the dynamic gait subsection of the Mini BESTest which she was then able to complete during post-intervention testing. This link between pain and movement has been well documented in the literature. When a patient is in pain they tend to make small changes in muscle coordination in order to modify the task to prevent pain or completely avoid the movement. For this patient, she used the strategy of completely avoiding the noxious movement. This lead to her stopping activities to sit since when she was sitting and being still the pain level decreased to a more tolerable range. As her pain with movement decreased to equal the level of pain
she had at rest, she could walk further distances and perform more dynamic gait activities.

In terms of the patient’s gait, some qualitative changes were noted depending on if the backwards walking was performed at the beginning of a session compared to the end. When the backwards walking was performed at the end of the session, a qualitative change was noted in her gait. Her gait quality became less staccato, and she demonstrated a smoother cadence despite there being no change in gait speed. If the backwards walking was performed at the beginning of the session these changes were not present by the end of the session. What this qualitative change demonstrated was the possibility of neuroplastic changes occurring with the backwards walking, but these changes were not long lasting and had no carry over from session to session. There are efforts to demonstrate neuroplastic changes occurring in the brain during backwards walking. Some theories include utilization of intact cortical loops while bypassing the basal ganglia. Also, utilization of the alternative pathways will hopefully lead to motor adaptation restoring coordination and stability with both forwards and backwards walking. Since this intervention was only comprised of 4 sessions, the neuroplastic changes did not have time to become permanent which was why the patient did not have any carryover in the qualitative changes in gait pattern.

The decrease in repetitions completed on the 30mSTST from the pre-test to the post-test is most likely due to the different times of day the testing was completed. The time of day could impact the patient’s level of fatigue given her comorbidity of hypothyroidism. Also, fatigue was an issue the patient has been working to handle better to allow for more consistent levels of energy throughout the day. Since this was a new outcome measure there has not been a MCID
established and the norms found for the older adult population have not been validated. Despite the decrease in repetitions the patient’s results for both the pre- and post-test fell within norms of 3-7 repetitions for 90-98 year old. Although given she still under the cut-off score of 7, the patient still had a risk for falling.¹⁰

A possible limitation in this case report was the delay in post-intervention testing since it occurred 2 weeks after completion of intervention. Also, during the period between end of intervention and post-intervention testing the patient underwent a kyphoplasty. This procedure increased the pain in the patient’s low back and decreased her functionality. Given the tends seen in pain with movement, and distanced walked both backwards and forwards it would have been better to test the patient prior to the kyphoplasty to capture the impact of backwards walking more accurately.

Conclusion

Given the qualitative changes observed in the patient’s gait, backwards walking has the potential to improve balance. Since these changes were transient in nature with no carryover from previous session, further research needs to be conducted to determine the validity of backwards walking, and to determine the effective dosage to achieve improvements in balance and postural control. Plus, backwards walking provides clinicians with a functional intervention to strengthen the glutes in the Parkinson’s population.
References


Appendix A: Figures

Figure 1: ICF Model

- Body Functions/Structures (Impairments)
  - Lower extremity weakness: primarily in hips
  - Low back pain: primarily on right side
  - Scoliosis
  - Posture: forward head, rounded shoulders typically for Parkinson’s
  - Decreased Cardiovascular endurance
  - Decreased gross coordination
  - Decreased balance recovery strategies

- Environmental Factors
  - Front wheeled walker
  - Curbs/ramp

- Personal Factors
  - Feels steady on feet with walking and standing
  - Fear of falling
  - Fatigue
  - Decreased safety awareness

- Participation (Restrictions)
  - Community ambulation
  - Going to the grocery store
  - Household tasks i.e. cleaning/tidying bedroom
  - Long distance walking trips/outings
Table 1: List of Medications

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dosage</th>
<th>Dosage Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pravastatin</td>
<td>29 mg</td>
<td>Daily</td>
</tr>
<tr>
<td>Carbidopa-levodopa</td>
<td>25-100 mg</td>
<td>Four times a day</td>
</tr>
<tr>
<td>Alendronate sodium</td>
<td>70 mg</td>
<td>Once weekly</td>
</tr>
<tr>
<td>Synthroid</td>
<td>75 mg</td>
<td>Four times a week</td>
</tr>
<tr>
<td>Synthroid</td>
<td>50 mg</td>
<td>Three times a week</td>
</tr>
<tr>
<td>Vitamin D3</td>
<td>Not provided</td>
<td>Daily</td>
</tr>
<tr>
<td>Vitamin B-12</td>
<td>Not provided</td>
<td>Daily</td>
</tr>
<tr>
<td>Aspirin</td>
<td>81 mg</td>
<td>Daily</td>
</tr>
<tr>
<td>PreserVision AREDS 2</td>
<td>Not provided</td>
<td>Twice a day</td>
</tr>
<tr>
<td>Calcium Citrate-Vitamin D</td>
<td>Not provided</td>
<td>Twice a day</td>
</tr>
<tr>
<td>Tramadol HCL</td>
<td>50 mg</td>
<td>Every 4 hours as needed</td>
</tr>
<tr>
<td>Tylenol extra strength</td>
<td>500 mg x 2</td>
<td>Every 6 hours</td>
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