Shepherd Center

Anti-Gravity Treadmill Training Improves Walking in a Person with Severe Multiple Sclerosis

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BACKGROUND

The vast majority of people with multiple sclerosis (MS) experience a combination of motor and sensory impairments including weakness, decreased balance, and fatigue that ultimately lead to walking dysfunction.[1] Recent evidence also suggests that skeletal muscle function, specifically muscle oxidative capacity, is also impaired in people with MS (PwMS),[2-3] which could be related to walking dysfunction as well.[4] Exercise and rehabilitation interventions have been shown to improve walking function as well as motor impairments such as strength and balance in PwMS.[5,6,7] However, few studies have evaluated exercise mediated adaptations to skeletal muscle function and the contribution of skeletal muscle plasticity to these improvements.[8,27] Understanding the underlying mechanisms of walking dysfunction and the relationship between impairments and changes in walking function after training would provide valuable insights into the design of interventions for improving walking in PwMS.

Overground gait training is one way to improve walking function in PwMS, but presents limitations for people greater walking disability. Body-weight supported treadmill training (BWSTT) can provide needed support during training and has been shown to be effective for those with MS and greater walking disability.[5-7, 9-17] Anti-gravity treadmill training is a novel form of BWSTT that utilizes lower-body positive pressure technology to unweight the lower extremities. This approach may provide the safety, task-specificity, repetition, feedback, body-weight support (BWS) needed to improve walking for PwMS and higher levels of disability. Training in the anti-gravity treadmill has been shown to improve balance and walking in people with stroke,[18] Parkinson's disease,[19] and cerebral palsy,[20] but has not yet been examined in PwMS.

The purpose of this case report is to present data demonstrating changes in walking function, strength, balance, fatigue and muscle-related impairment in one person with moderate MS who participated in a pilot study examining the efficacy of anti-gravity treadmill training.

METHODS

The participant was a 56 year-old female diagnosed with relapsing-remitting MS with an Expanded Disability Status Score (EDSS) of 6.5. Participant was not on any medication except Vitamin D3, was medically stable, willing to remain consistent with pre-intervention exercise and medication regimen, and did not exhibit any cardiovascular, neurological, or orthopedic comorbidities.


http://www.recoversportsmed.com.au/alter-g-treadmill.html

Figure 1. AlterG Anti-Gravity Treadmill (AlterG, Inc., Freemonth, CA).

The Intervention was designed and overseen by a trained physical therapist and consisted of 24-minutes of walking (2 minute warm-up, 20 minutes of the intervention, and 2 minute cool down) on the AlterG Anti-Gravity Treadmill (AlterG, Inc., Freemont, CA) (Figure 1), 2-times per week for 16 sessions. Ongoing visual feedback of her gait was provided via 3 cameras placed anteriorly, posteriorly, and laterally. A trained physical therapist or exercise specialist gave verbal cueing for improved gait mechanics (e.g. increased heel strike or hip flexion). If gait mechanics were adequate, the trainer increased speed or decreased body-weight support (BWS) to challenge the participant and progress toward real-world walking conditions.

The following **outcome measures** were collected by trained evaluators pre and post the 16 session intervention.

- Walking Speed: Timed 25-Foot Walk Test (T25FWT)[21]
- Walking Endurance: Two-Minute Walk Test (2MWT)[22]
- Lower Extremity Strength: Hand-Held Dynamometry[23]
- Balance Confidence: Activities Balance Confidence Scale (ABC)[24]
- Perceived Fatigue: Modified Fatigue Impact Scale (MFIS)[25]
- Medial Gastrocnemius (MG) Muscle Endurance: Accelerometer-based mechanomyography during 9-minutes of twitch electrical stimulation at 2Hz, 4Hz, and 6Hz (3 min/stage)
- MG Oxidative Capacity (Figure 2): Near-Infrared Spectroscopy calculated as the rate of recovery of oxygen metabolism (O2Hb) following 15-20 seconds electrical stimulation[26]

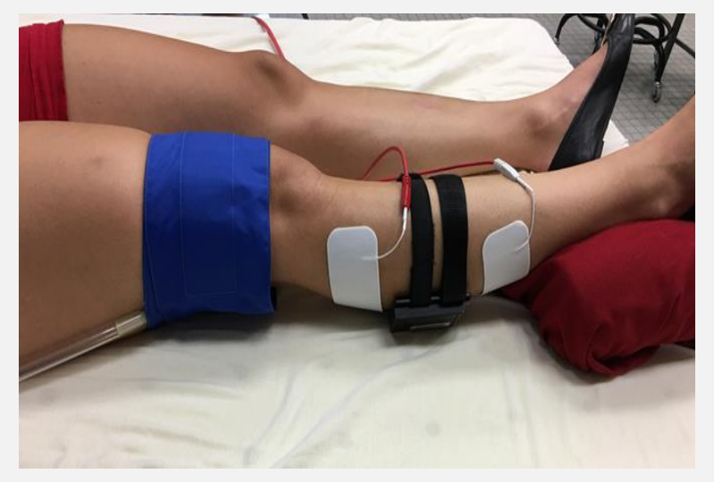


Figure 2. Set-up for muscle oxidative capacity test.

Statistical Analysis included descriptive statistics to evaluate means and percent changes within each session and over all 16 sessions.

RESULTS

The participant completed all 16 training sessions over a period of 9 weeks. She was able to safely train with no adverse events. 2MWT distance improved by 65m or 212.00% (Figure 3). The change in walking endurance was clinically significant.[33] T25FWT speed decreased by 3.74 ft/sec or 25.00% (Figure 4).

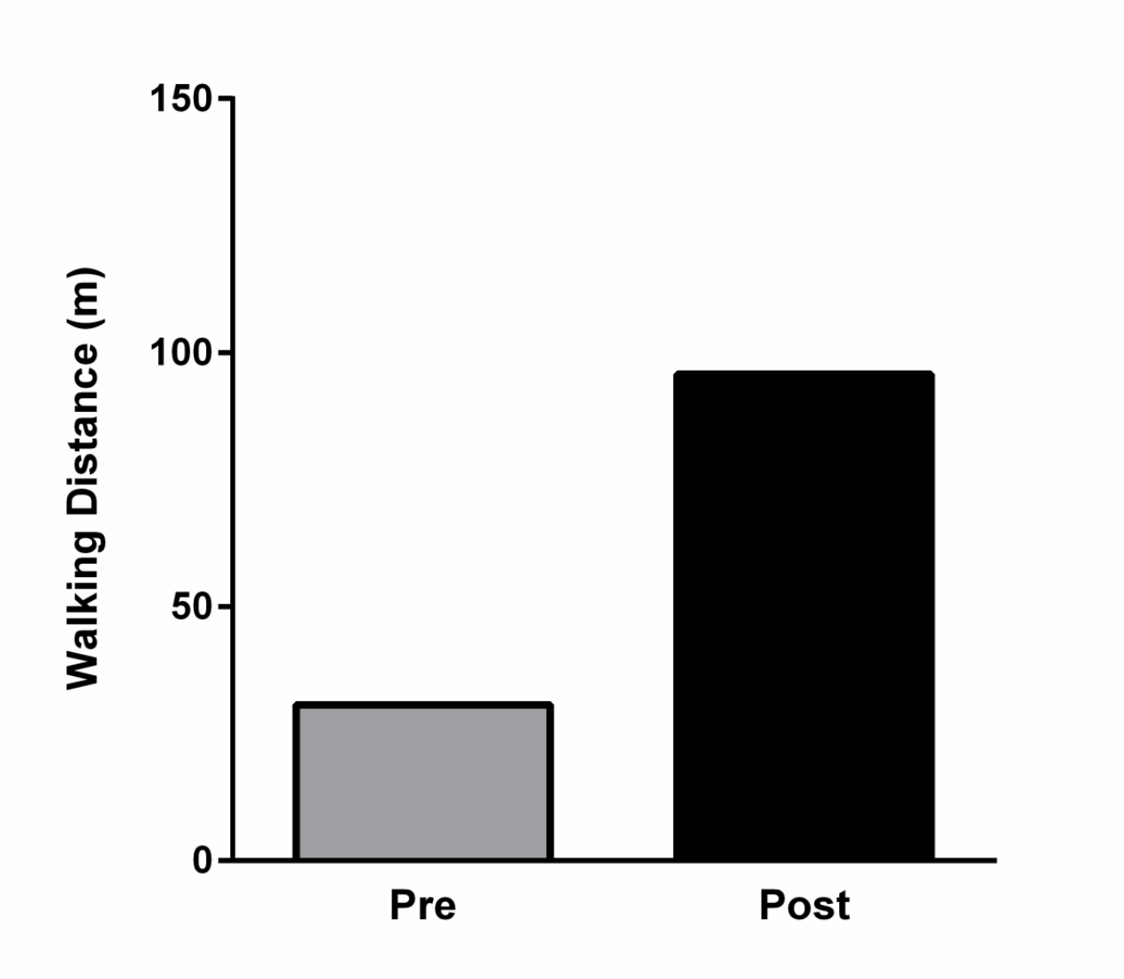


Figure 3. 2MWT distance pre and post-intervention.

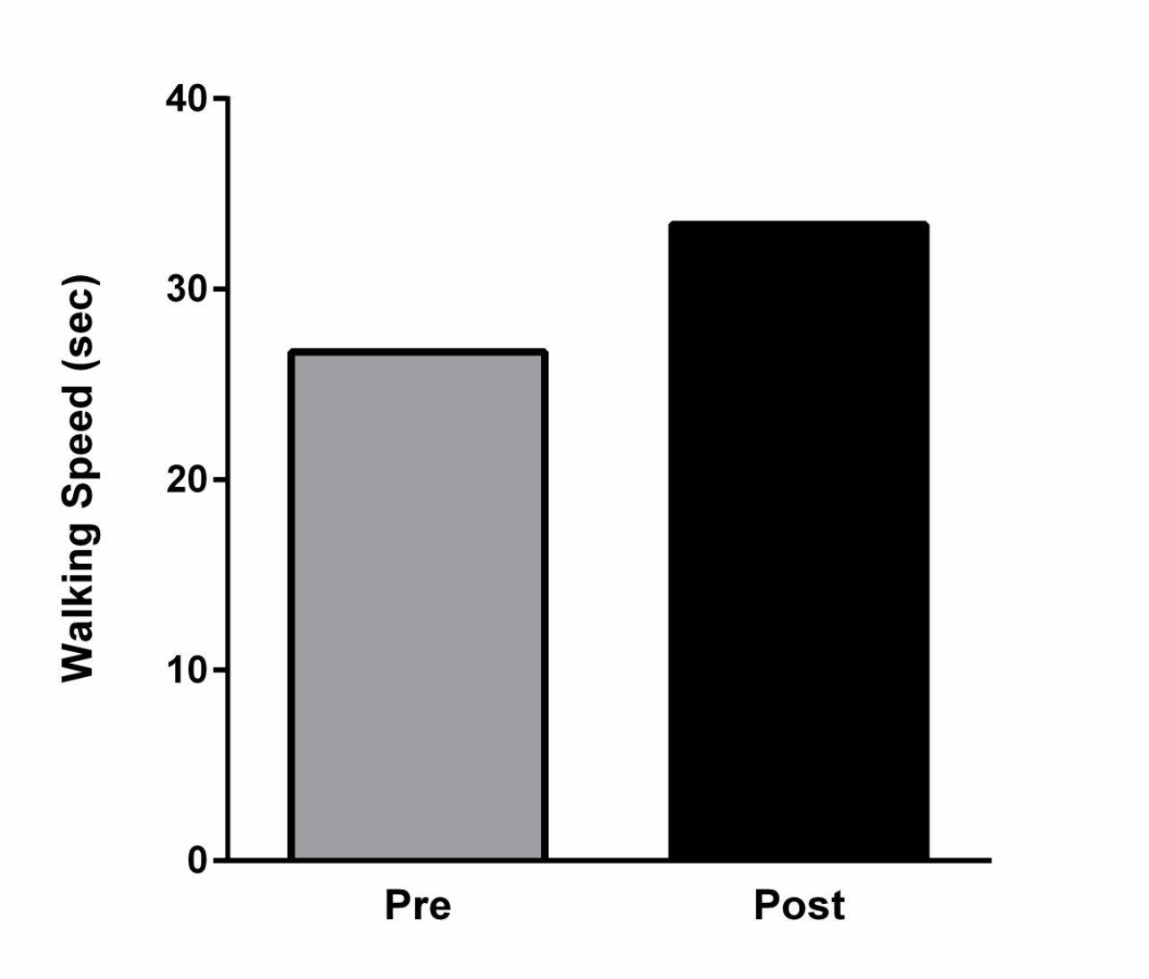


Figure 4. T25FWT speed pre and post-intervention.

Lower extremity strength improved an average of 6.5lbs or 3.00% (Figure 5), MFIS score increased by 10.00% (Figure 6) and ABC score improved by 71.4% (Figure 7) .

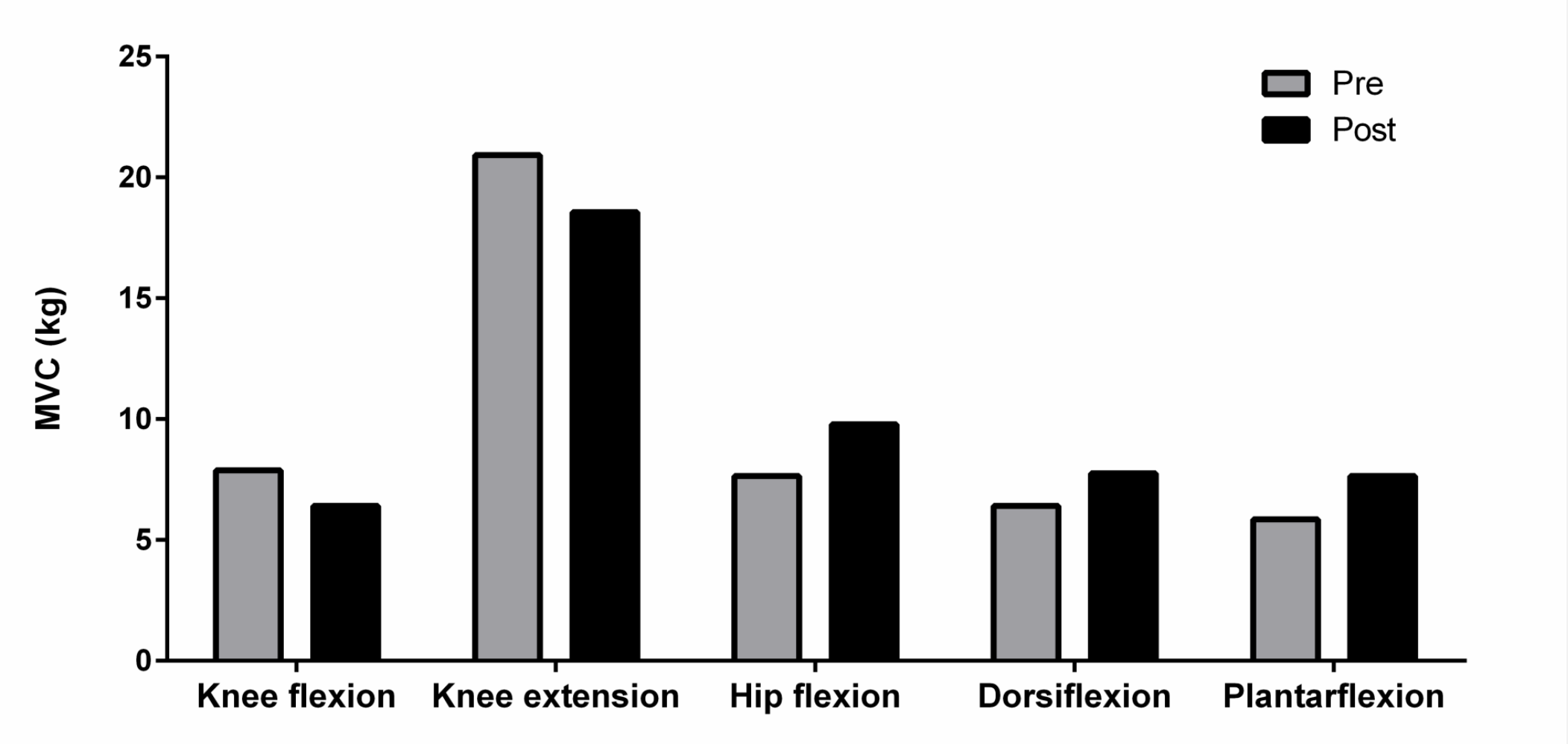


Figure 5. Knee flexion, knee extension, hip flexion, dorsiflexion, and plantar flexion strength (HHD) pre and post-intervention.

Figure 6. MFIS score pre and post-intervention.

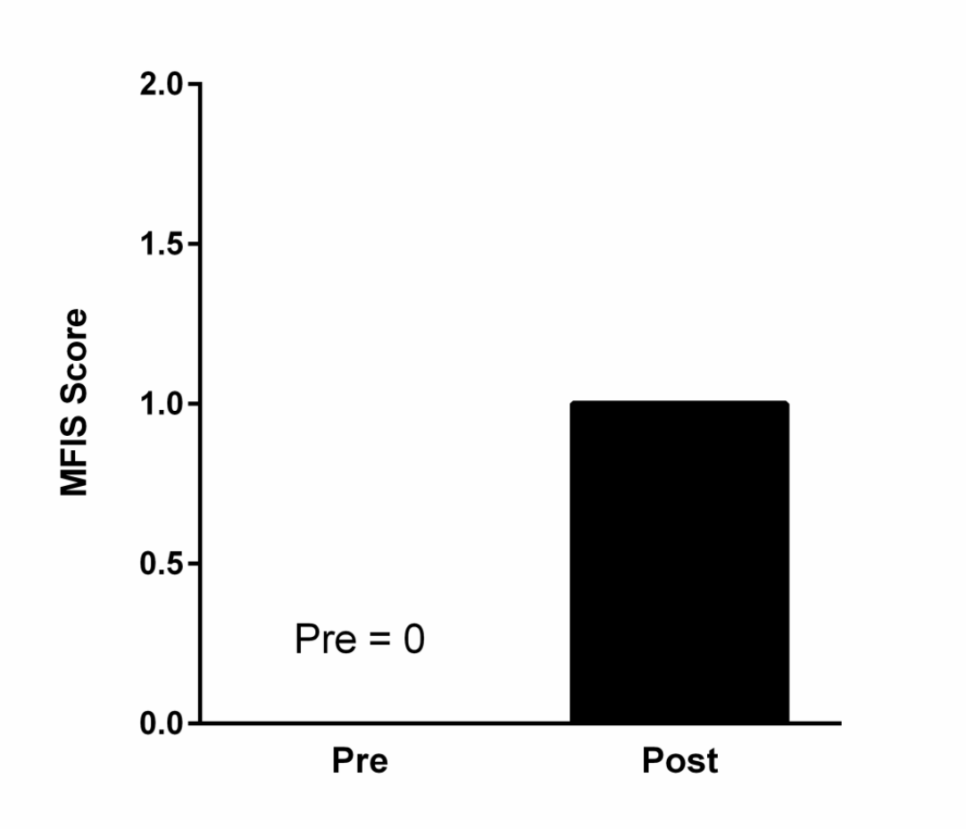
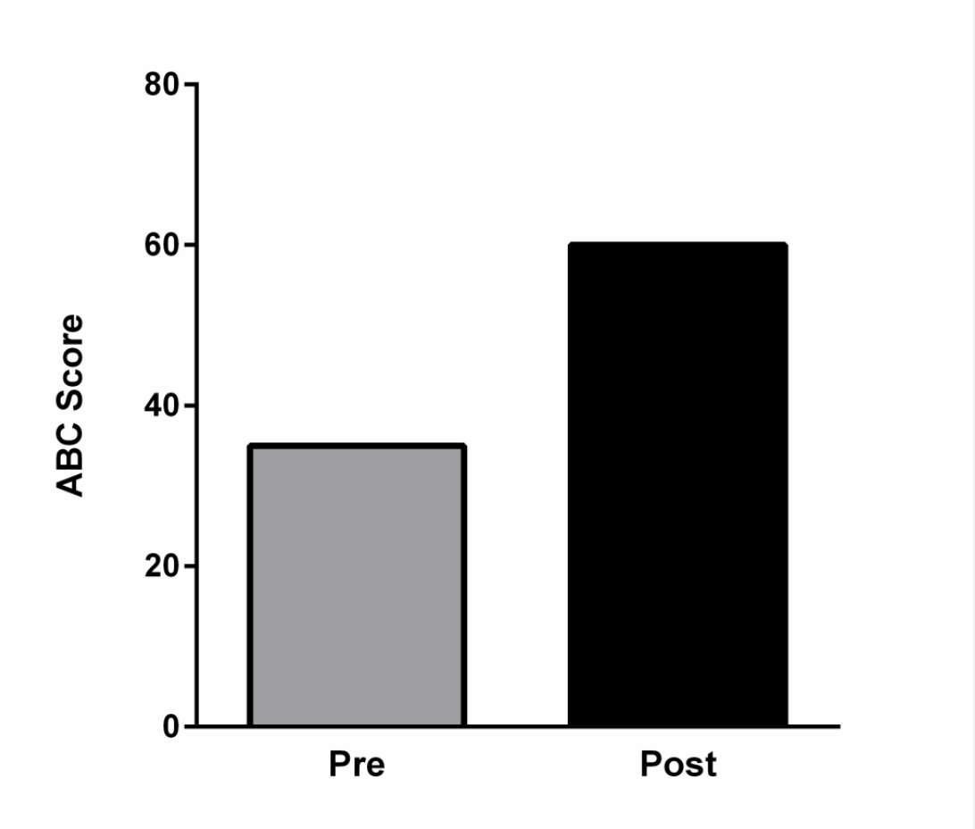


Figure 7. ABC score pre and post-intervention.



Muscle oxidative capacity increased by 47.90%, (Figure 8) and muscle endurance increased by 8.10% at 2Hz, 8.40% at 4Hz, and 31.20% at 6Hz (Figure 9).

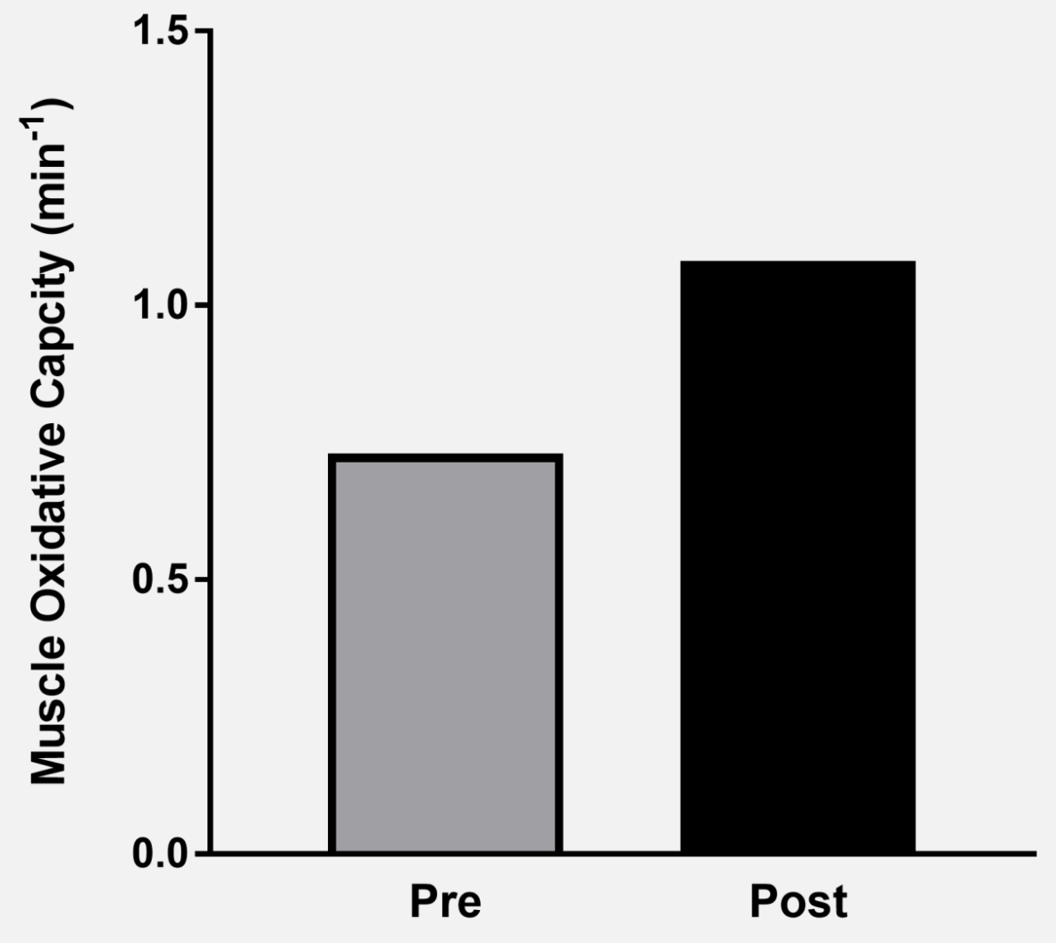


Figure 8. Muscle oxidative capacity pre and post-intervention.

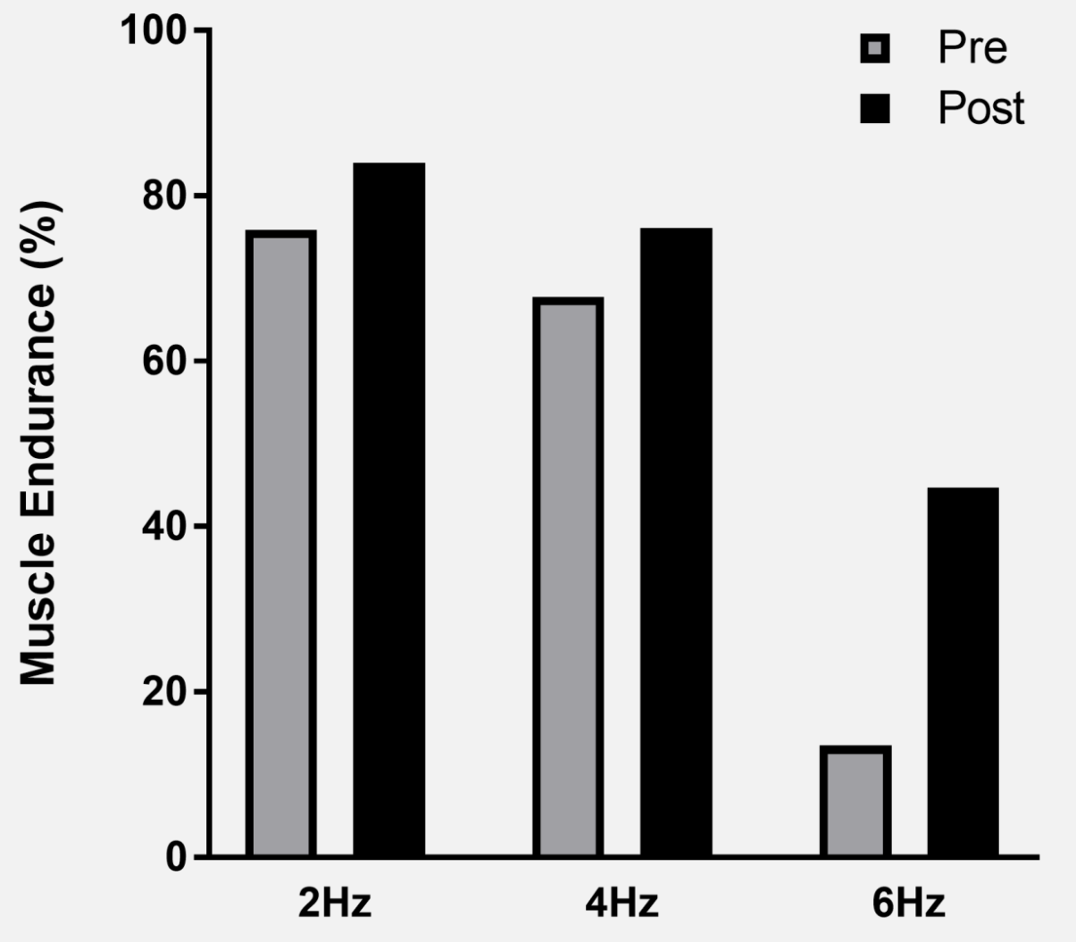


Figure 9. Muscle endurance at 2, 4, and 6Hz pre and post-intervention.

DISCUSSION

To our knowledge, our study is the first to examine the use of anti-gravity treadmill training with PwMS and to demonstrate that walking function, balance, strength, and muscle endurance and oxidative capacity can improve in an anti-gravity treadmill environment for some PwMS who have moderate disability. In addition, our study is the first to demonstrate exercise-mediated adaptations in muscle-specific oxidative capacity in a person with MS and how these changes may be related to walking function.

The participant walked a clinically meaningful and significantly[32] longer distance post-intervention. Increased walking endurance after training is consistent with other studies examining BWSTT in people with moderate MS.[5-6,9-13,15] The improvement in walking endurance may have been associated with improved balance confidence, lower extremity strength, and muscle endurance and oxidative capacity. Other BWSTT studies have shown similar improvements in balance[16] and lower extremity strength[15,16] that coincide with improvements in walking endurance in PwMS. The increases in muscle endurance and oxidative capacity are consistent with other studies examining muscle adaptations to exercise in PwMS[8,28] as well. Our findings suggest that increased walking endurance after anti-gravity training may result from improvements in motor impairments as well as from adaptions at the muscular level. By targeting these impairments and adaptations, clinicians may be able to increase the effectiveness of their gait training interventions.

One unexpected outcome was a decrease in walking speed post-intervention. This may have been due to the nature of the verbal cueing during training that emphasized improving gait quality e.g. spatiotemporal aspects of gait, and not on increasing gait speed. Because of this, our participant may have been focused on walking correctly and safely rather than walking fast and safely during the T25FWT. Our participant also experienced an increase in perceived fatigue post the 16-session intervention, which may have been due to addition of exercise on the treadmill. It is of note that fatigue did not increase by a clinically significant amount,[29] and this suggests that the participant could train without significantly exacerbating fatigue. This is consistent with other BWSTT studies that also show non-significant changes in fatigue after training.[6-7,10,12,30]

CONCLUSION

The results from this case study suggest that people with moderate MS may be able to improve walking function with anti-gravity treadmill training, and changes in muscle function, balance, and lower extremity strength may contribute to improvements in walking function. Further research with a larger number of participants is necessary to further explore these findings. Understanding if and why people improve will help physical therapists optimize their gait training interventions to produce the greatest functional gains. Increasing or maintaining walking function may decrease the economic burden, improve quality of life, and mitigate the risk for comorbidities associated with secondary deconditioning. The information from this study will be used to inform our ongoing pilot study as well as future, larger scale trials examining anti-gravity treadmill training in PwMS.

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