Movement Amplification to Improve Gait Stability in Spinal Cord Injury: A Case Series

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Background and Purpose

- Individuals with chronic incomplete spinal cord injury (SCI) have gait instability that may result in injury1,2.
- This case series used principles of error augmentation to challenge gait stability with a robotic device that amplified lateral velocity of the center of mass (COM) to encourage exploration of new dynamic balance strategies3,4.
- Training parameters were adjusted to maintain high intensity.
- Our purpose was to determine the feasibility and effectiveness of movement amplification training (MAT) for improving gait stability in individuals with chronic SCI. We hypothesized MAT is feasible and will improve gait stability.

Case Description and Methods

Participants:

- Three individuals with American Spinal Injury Association Impairment Scale D.

Training Protocol:

- Trained with MAT on a treadmill 16-19 45-minute sessions over 9 weeks.

Outcomes

Training Parameters:

- Average total walking time varied across sessions: 32.04, 27.43, and 28.52.
- Subjects increased peak treadmill speeds throughout training by 0.67, 0.27, and 0.63 m/s.

Clinical Outcome Measures:

- The most consistent improvements were on the 10MWT, WHOQOL-BREF, and reactive postural control items from the Mini Balance Evaluation Systems Test.
- Subjects increased fast 10MWT by 0.1-0.22 m/s. Subject B and C increased self-selected 10MWT by 0.15-0.2 m/s. Subject B increased WHOQOL-BREF by 55 points.
- Subject A and C each improved reactive balance scores by 2-4/6.
- Subject A reported improved urogenital and sexual function. Subject B reported improved urogenital function.

Laboratory Measures:

- Preferred treadmill speed increased for all subjects by 0.13-0.27 m/s. Subjects B and C reduced COM excursion by 31-35%.
- Step width and MOS decreased for Subjects B and C and increased for Subject A.
- Correlations between COM and foot placement (FPE) significantly increased post-training.

Discussion

MAT challenged dynamic balance and has potential to improve gait stability.

- Subject A increased control of COM motion post training. This was accomplished through decreased step variability and increased lateral MOS, suggesting the use of passive stabilization strategies.
- Subjects B and C also increased control of COM motion post training; however, were able to do so through increased active control given they could maintain stability with a decreased step width and decreased lateral MOS. Correlation between COM motion and foot placement locations also suggest improvements in active control strategies.

Conclusion:

Overall, subjects improved control of COM, decreased step placement variability, increased walking speed, and two subjects improved ability to react to perturbations. MAT is a feasible intervention where both active and passive strategies can be trained to improve gait stability and may positively impact QOL. More research is needed to further understand how to target underlying mechanisms (active or passive strategies) for improving gait stability.

References and Acknowledgments