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Using Body-Weight-Supported-Treadmill-Training for Improving Gait Kinematics in a Patient with a Chronic C5-C6 Motor-Incomplete Spinal Cord Injury: A Case Report

Background:
There are 294,000 people living in the United States with spinal cord injury (SCI), of which, 47.2% are classified as incomplete tetraplegia.[1] Up to 80% of patients with motor-incomplete injuries will demonstrate functional ambulation recovery[2]. Greatest gains are made in the acute phases of rehabilitation, yet, research demonstrates continued improvement into the chronic phase with high intensity stepping practice such as seen with the use of body-weight-supported treadmill training (BWSTT).[3–7] Core outcome measures typically used within this population include the six-minute walk test (6MWT) and the ten-meter walk test (10MWT).[8] Few studies have examined the effects of rehabilitation on lower extremity (LE) gait kinematics (GK) using 3D motion capture systems in the chronic SCI population[4,9–11]. This case report describes the physical therapy (PT) interventions and outcomes using standardized outcome measures and 3D motion analysis in a 42-year-old male with chronic C5-C6 ASIA (American Spinal Injury Association) Impairment Scale-C motor incomplete-SCI.

Methods:
The patient was seen in the on-campus outpatient PT clinic twice weekly for 60-minute sessions over 13 weeks with two student physical therapists developing and executing his plan of care with licensed therapist oversight. Upon initial evaluation, strength, sensation, balance, and functional testing were performed. The patient was independent with all transfers, stair negotiation, and community ambulation with use of a straight cane (SC), demonstrating compensatory patterns. Gait speed and endurance were measured using the 10MWT and 6MWT using a SC. LE GK data was processed using Visual 3D and compared to a gender and height-matched, non-pathologic control. One session per week was devoted to BWSTT with use of the LiteGait system and manual facilitation at provided at the LEs and pelvis followed by overground gait training. Emphasis was placed on increasing speed and reducing body weight support. The second weekly session focused on improving functional strength and transfer techniques. The patient was given a home exercise program (HEP) focusing on motor imagery training, intentional ambulation, and LE strengthening.

Results:
The patient attended a total of 24 sessions. His 6MWT improved by 123 feet and his 10MWT speed improved by 0.05 meters/second. His recorded speed at discharge without a SC was the same as evaluation with a SC. Upon analysis of his LE kinematics, the data suggests an average percentage of change towards non-pathological values by 49% in the LE sagittal and pelvic coronal planes. The greatest improvements were at the pelvis in the coronal plane and the sagittal right hip, reflecting a 94% and 107% change towards typical walking values, respectively. It is important to note some values did demonstrate further atypical presentation at the left hip and

right ankle joint. Subjectively, the patient reported increased bouts of ambulation with improved confidence and decreased use of his cane.

Discussion:

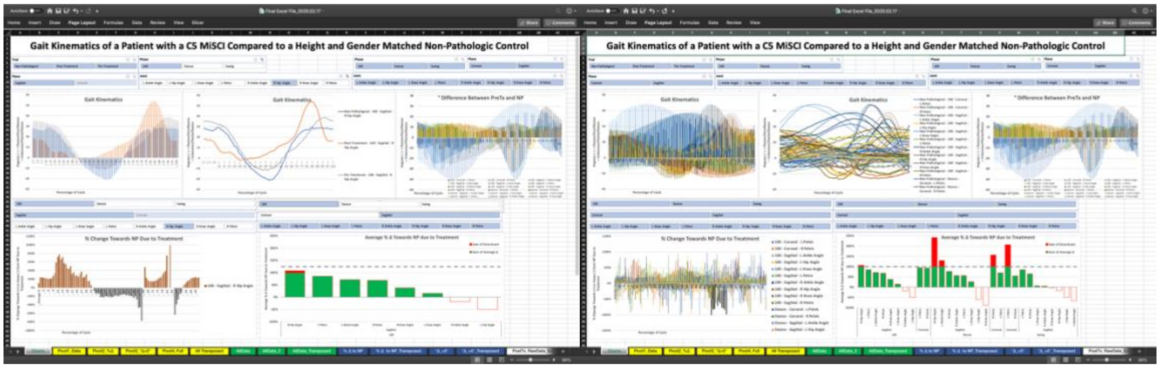
This case report outlines the importance of considering other means of measurement, such as 3D kinematic analysis, to demonstrate positive gait changes outside of traditional outcome measures, which may lack sensitivity in chronic patient populations. Improved kinematics are a result of more typical joint motions, reducing the risk of long-term joint damage and injury.[12] Although kinematic changes were generally positive, this analysis allowed clinicians to uncover increased compensatory strategies at other joints which could help to guide future intervention. BWSTT with traditional therapy has demonstrated effectiveness in this population as it promotes task-specific training which can lead to improvements in gait quality and speeds.[4,5] Furthermore, a motor imagery program as part of an HEP may increase carryover from clinical intervention to out-of-clinic practice, as it has been shown to improve movement patterns.[13–16] This can also initiate improvements in patient self-efficacy[17], implicating a greater patient role in long-term health, an essential aspect to wellness in more chronic patient populations.[18] Although motion capture systems are costly and data analysis can be tedious, they can be used to compliment traditional measures to demonstrate positive changes in patients, and thus justify the continued need for services in patients with chronic neurologic conditions.

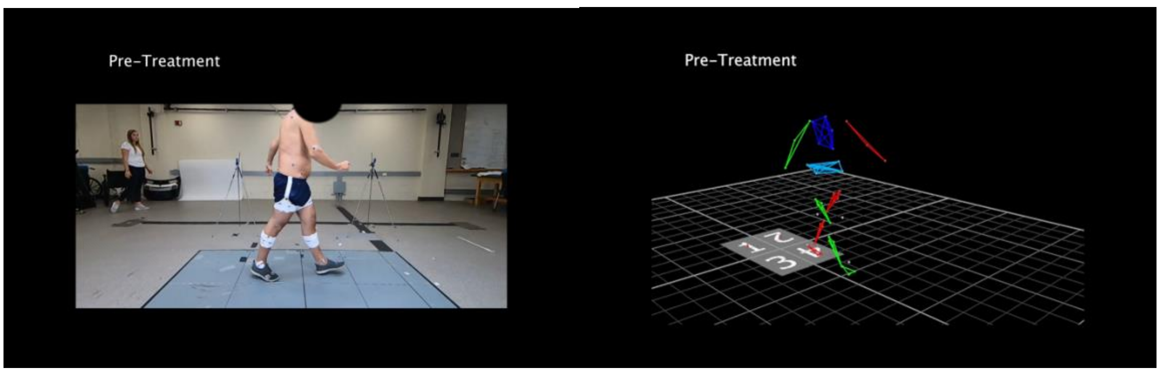
Word Count: 649/700 words

References:


1. *Spinal Cord Injury Facts and Figures at a Glance 2020 SCI Data Sheet*.; 2020. www.msktc.org/sci/model-system-centers. Accessed February 25, 2020.
2. Burns SP, Golding DG, Rolle WA, Graziani V, Ditunno JF. Recovery of ambulation in motor-incomplete tetraplegia. *Arch Phys Med Rehabil*. 1997;78(11):1169-1172. doi:10.1016/S0003-9993(97)90326-9
3. Brazg G, Fahey M, Holleran CL, et al. Effects of Training Intensity on Locomotor Performance in Individuals With Chronic Spinal Cord Injury: A Randomized Crossover Study. *Neurorehabil Neural Repair*. 2017;31(10-11):944-954. doi:10.1177/1545968317731538
4. Lucareli PR, Lima MO, Lima FPS, De Almeida JG, Brech GC, D'Andréa Greve JM. Gait analysis following treadmill training with body weight support versus conventional physical therapy: A prospective randomized controlled single blind study. *Spinal Cord*. 2011;49(9):1001-1007. doi:10.1038/sc.2011.37
5. Nooijen C, Ter Hoeve N, Field-Fote E. Gait quality is improved by locomotor training in individuals with SCI regardless of training approach. *J Neuroeng Rehabil*. 2009;6(1). doi:10.1186/1743-0003-6-36
6. Wessels M, Lucas C, Eriks I, de Groot S. Body weight-supported gait training for restoration of walking in people with an incomplete spinal cord injury : a systematic review. *J Rehabil Med*. 2010;42(6):513-519. doi:10.2340/16501977-0525
7. Louis S. Clinical Practice Guideline to Improve Locomotor Function Following Chronic Stroke, Incomplete Spinal Cord Injury, and Brain Injury. 2020;44. doi:10.1097/NPT.0000000000000303
8. Moore JL, Potter K, Blankshain K, Kaplan SL, O'Dwyer LC, Sullivan JE. A core set of

outcome measures for adults with neurologic conditions undergoing rehabilitation. *J Neurol Phys Ther*. 2018;42(3):174-220. doi:10.1097/NPT.0000000000000229
9. Pérez-Sanpablo AI, Quinzaños-Fresnedo J, Loera-Cruz R, Quiñones-Uriostegui I, Rodriguez-Reyes G, Pérez-Zavala R. Validation of the instrumented evaluation of spatio-temporal gait parameters in patients with motor incomplete spinal cord injury. *Spinal Cord*. 2017;55(7):699-704. doi:10.1038/sc.2017.4
10. Malik RN, Eginyan G, Lynn AK, Lam T. Improvements in skilled walking associated with kinematic adaptations in people with spinal cord injury. *J Neuroeng Rehabil*. 2019;16(1). doi:10.1186/s12984-019-0575-z
11. Geiger M, Supiot A, Pradon D, Do M-C, Zory R, Roche N. Minimal detectable change of kinematic and spatiotemporal parameters in patients with chronic stroke across three sessions of gait analysis. 2019. doi:10.1016/j.humov.2019.01.011
12. Favre J, Jolles BM. Gait analysis of patients with knee osteoarthritis highlights a pathological mechanical pathway and provides a basis for therapeutic interventions. *EFORT Open Rev*. 2016;1(10):368-374. doi:10.1302/2058-5241.1.000051
13. Gajewski PD, Falkenstein M. Physical activity and neurocognitive functioning in aging - a condensed updated review. *Eur Rev Aging Phys Act*. 2016;13(1):1-7. doi:10.1186/s11556-016-0161-3
14. Yoxon E, Welsh TN. Rapid motor cortical plasticity can be induced by motor imagery training. 2019. doi:10.1016/j.neuropsychologia.2019.107206
15. Meers R, Nuttall HE, Vogt S. Motor imagery alone drives corticospinal excitability during concurrent action observation and motor imagery. 2020. doi:10.1016/j.cortex.2020.01.012
16. Pheung-phrarattanatrai A, Bovonsunthonchai S, Heingkaew V, Prayoonwiwat N, Chotik-anuchit S. Improvement of Gait Symmetry in Patients with Stroke by Motor Imagery. *J Med Assoc Thai*. 2015;98 Suppl 5:S113-8. http://www.ncbi.nlm.nih.gov/pubmed/26387421. Accessed February 25, 2020.
17. Wright BJ, Daniel O'halloran P, Stukas AA. Enhancing Self-Efficacy and Performance: An Experimental Comparison of Psychological Techniques. doi:10.1080/02701367.2015.1093072
18. Dietz V;, Müller R, Dietz V, Müller R. Degradation of neuronal function following a spinal cord injury: mechanisms and countermeasures. 2004;127:2221-2231. doi:10.1093/brain/awh255


Gait Kinematics of a Patient with a C5 MiSCI Compared to a Height and Gender Matched Non-Pathologic Control
Gait Kinematics
% Change Towards NP Due to Treatment
Average % Δ Towards NP due to Treatment
Gait Kinematics of a Patient with a C5 MiSCI Compared to a Height and Gender Matched Non-Pathologic Control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