TASK SPECIFIC OVERGROUND LOCOMOTOR TRAINING IS ASSOCIATED WITH IMPROVED GAIT AND BALANCE IN INCOMPLETE SPINAL CORD INJURY: CASE REPORT

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INTRODUCTION

Ambulation is often one of the primary goals following spinal cord injury (SCI) [1]. However, there is currently no consensus in the optimal method, timing, intensity, and frequency of locomotor training following incomplete SCI [2].
Motor-learning promotes control of the forces necessary to initiate stepping, overground movement, and practice to improve performance [3]. Lemay et al. describes the lack of postural control as a limiting factor in controlling the center of pressure (COP) during dynamic balance and gait [4]. The theoretical framework for this novel task specific performance based training (TSPbT) protocol was based on motor learning theory, with an increased focus on the conditions of task and activity practice [3].

The purpose of this case study was to determine gait and balance responses to a novel Overground Locomotor Training protocol (OLT), founded on principles of motor learning, task-specificity, and progressive overload in chronic incomplete spinal cord injury (iSCI). We hypothesized that clinical functional ambulation scores would increase as a result of TSPbT due to a reduction in stance time indicating greater control of the COP.

METHODS

One male, 20 years old at the onset of training, injury to C4 to C5, American Spinal Injury Association Impairment Scale (AIS) category C, and greater than 1 year post-SCI, participated in 30-weeks of OLT (approximately 90 minutes per week.) Sessions were built on principles of motor learning including practice variability, progressive overload (movement complexity), resistance, velocity, task demand (imposed by postures from supine to kneeling to standing, and volume), and training specificity to the task using volitional control. Sessions were comprised of volitional muscle activation, task-isolation, task-integration, and activity rehearsal. Sessions alternated between uniplanar and multi-planar gait mechanics. Outcome measures were collected at baseline, 15-week, and 30-week time points following the onset of the TSPbT intervention and included: Stance time (duration in seconds) and stance time asymmetry ratios (stance $time_{max\ limb}$/ stance $time_{min\ limb}$) were calculated from pressure data using pressure sensitive insoles (100Hz, Novel Pedar-X, Munich, Germany). Clinical measures included the Berg Balance Scale (BBS) and the Spinal Cord Injury-Functional Ambulatory Index gait parameters (SCI-FAI).

RESULTS AND DISCUSSION

Results of Clinical Measures

Functional ambulation was scored 10 at the onset of training peaked at 19 after 15 weeks, and 17 after 30-weeks of training (Figure 1). Functional gains demonstrated in the BBS (Figure 2) and SCI-FAI were directly related to the transition from a walker for community mobility during baseline assessment, then transitioning to bilateral loftstand crutches for community ambulation after 15-weeks of training.

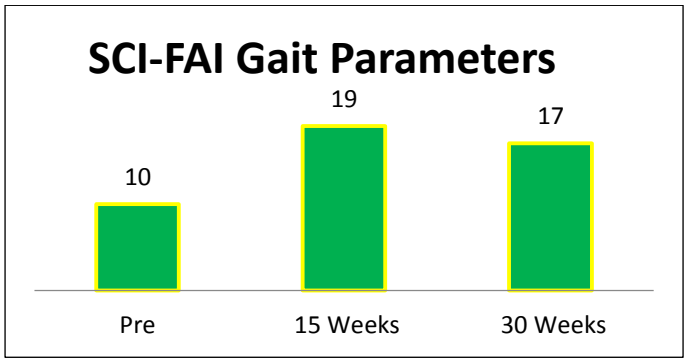

Figure 1: SCI-FAI measures at each time point.

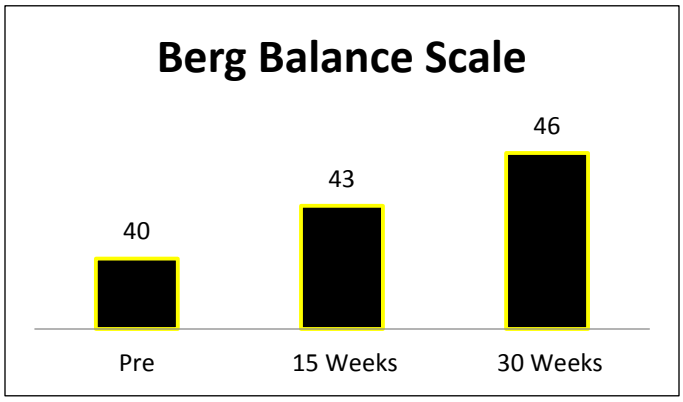

Figure 2: BBS measures at each time point.

Results of Overground Temporal Measures

Overground stance phase data were collected with (Table 1) and without (Table 2) the use of assistive devices.

At baseline, the locomotor assessment was conducted using a walker. Stance time of the left limb averaged 1.42 seconds while the right limb stance phase was 1.44 seconds (asymmetry of 1.02). Additionally, overground walking at baseline was assessed using loftstrands with the left limb stance phase of 1.24 seconds and right limb stance phase of 1.32 seconds (asymmetry of 1.06). At the 15-week gait assessment ambulation using the loftstrands was collected as the participant no longer used a walker. COP showed decreased stance time with the left limb in stance for 1.05 seconds and the right limb for 1.12 seconds (asymmetry of 1.07). After 30-weeks following training, both the left and right limbs showed a decrease in stance time left limb stance phase of 1.02 seconds and right limb stance phase of 1.01 seconds (asymmetry of 1.01).

Table 1: Overground stance time using assistive devices

Assisted			
	Left Stance	Right Stance	Asymmetry
Pre (walker)	1.42	1.44	1.02
Pre (Loft Strands)	1.24	1.32	1.06
15 weeks (Loft Strands)	1.05	1.12	1.07
30 weeks (Loft Strands)	1.02	1.01	1.01

Unassisted overground ambulation was also collected before, 15-weeks and 30-weeks following the onset of the intervention. At the onset of training left stance phase was 1.12 seconds, right stance phase was 1.34 seconds (asymmetry of 1.19). 15-weeks into training, time during stance phase decreased on both limbs, left limb in stance for 1.02 seconds, right limb in stance for 1.15 seconds (asymmetry of 1.13). After 30-weeks of training, stance phase decreased to left limb in stance for 0.93 seconds and right limb in stance for 1.03 seconds (asymmetry 1.10).

Table 2: Overground stance time asymmetry ratios with no assistive device

Unassisted			
	Left Stance	Right Stance	Asymmetry
Pre	1.13	1.34	1.19
15wks	1.02	1.15	1.13
30wks	0.93	1.03	1.10

CONCLUSIONS

After 30 weeks of task specific performance based training, functional assessments of ambulation and temporal measures of gait improved in one individual with incomplete spinal cord injury. The emphasis on volitional overground gait initiation and termination during training may allow for greater focus on destabilizing and stabilizing forces to control posture during the phases of gait leading to functional improvement. Future enrollment and analyses of additional iSCI participants in this novel TSPbT will further our understanding of the implications this novel training protocol has on functional ambulation in this population.

REFERENCES

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