The Synergistic Effects of Transcutaneous Spinal Stimulation and Exoskeleton Assisted Walking after Spinal Cord Injury

Richard Henderson[1,2], Soshi Samejima[1], Abigail Schreier[1], Haley Coen[1], Annika Pfister[2], Siddhi Shrivastav[1,2], Kim Ingraham[2,3], and Chet Moritz[1,2,4,5]

[1] Department of Rehabilitation Medicine, University of Washington, Seattle, WA, USA, [2] Department of Electrical and Computer Engineering, University of Washington, Seattle, WA, USA
[3] Department of Mechanical Engineering, University of Washington, Seattle, WA, USA, [4] Center for Neurotechnology, Seattle, WA, USA
[5] Department of Neurobiology and Biophysics, University of Washington, Seattle, WA, USA

INTRODUCTION

We explored the immediate effects of transcutaneous spinal stimulation on exoskeleton-assisted walking after spinal cord injury (SCI).

We hypothesized that the addition of stimulation would acutely improve exoskeleton walking performance.

METHODS

- Six individuals with chronic (>1 year) SCI participated in the study.
- Participants used an exoskeleton mode appropriate for their level of motor function.
- Order of stimulation was counterbalanced across 4 sessions.
- Outcomes measured 2x/session, with and without stimulation.

ID	Age	Time since injury (yrs)	Injury level	Injury severity	LEMS (0-50)	Stimulation amplitude (mA)
1	32	10	T8	C	3/50	80-90
2	25	7	T12	C	12/50	30-35
3	58	15	C5	D	40/50	110
4	49	18	C5	C	7/50	110-140
5	55	3	T9	A	0/50	60-90
6	50	2	C8	D	47/50	30-50

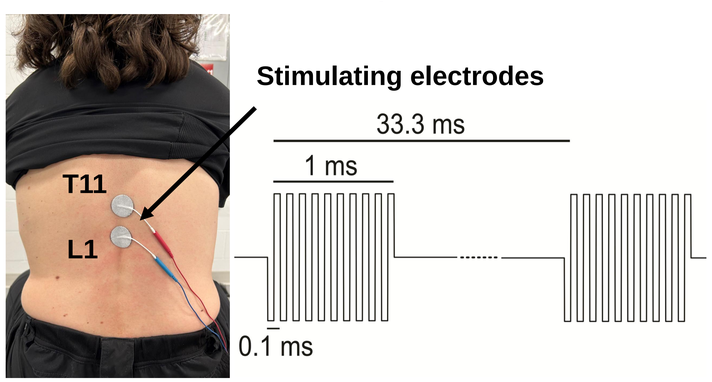
LEMS: Lower Extremities Motor Score

Two Different Exoskeleton Modes Used

Prostep+
High-degree of control over speed and path of step trajectory

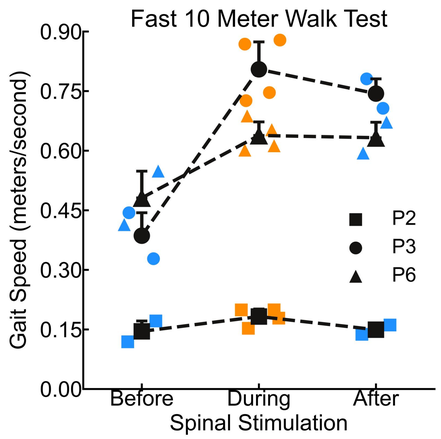
2Free
No control over step trajectory

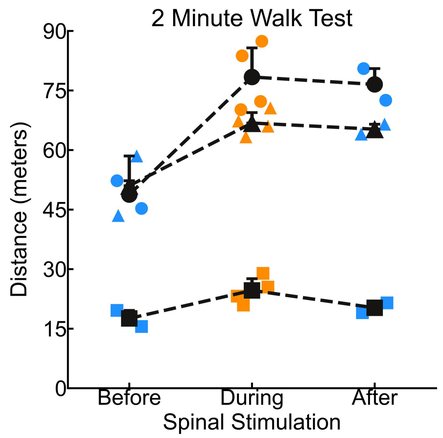
Stimulation Setup and Waveform



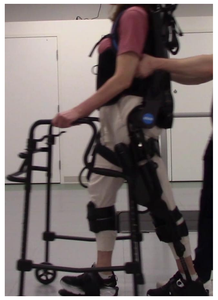
RESULTS

Stimulation Improves Gait Speed, Distance, and Kinematics





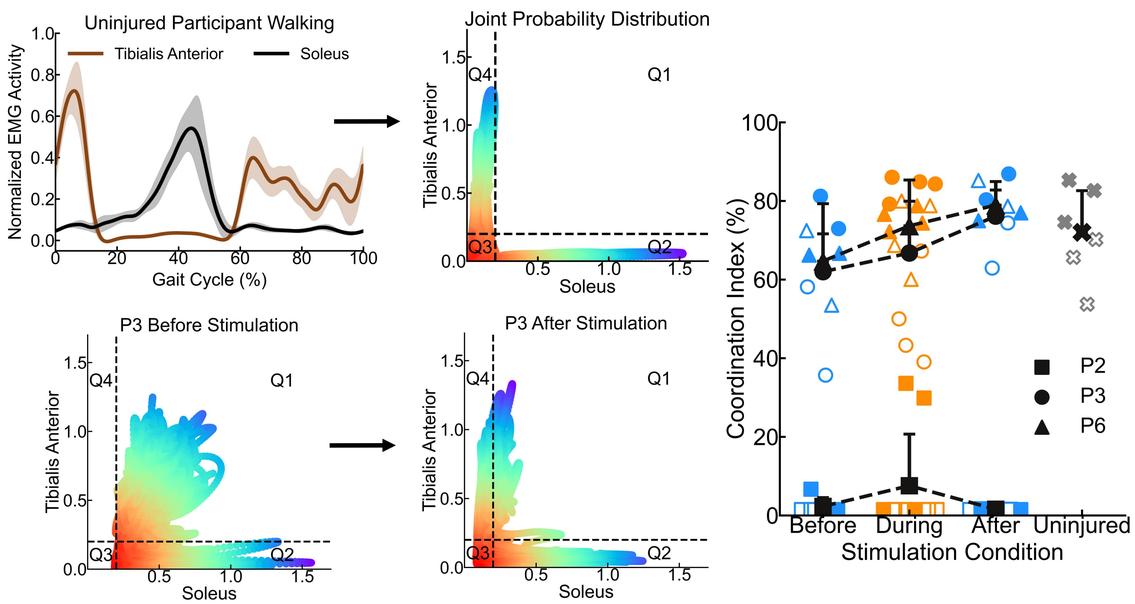
Stim Off



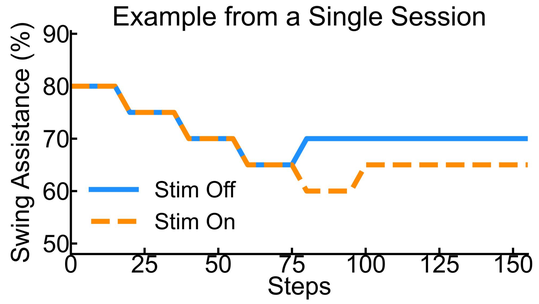
Stim On

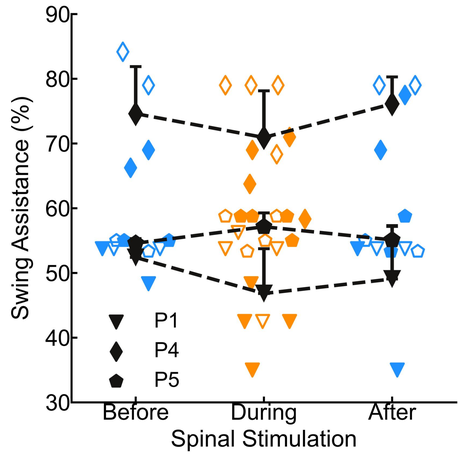
Video of faster walking during stimulation

Stimulation Improved Muscle Coordination During the 2MWT



Changes in Exoskeleton Assistance with Stimulation





CONCLUSION

Our results highlight the potential of enhancing robotic exoskeleton gait training with transcutaneous spinal stimulation for walking recovery after SCI.

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