

Epidural Electrical Stimulation of the Lumbosacral Spinal Cord Improves Trunk Stability During Seated Reaching in Two Humans With Severe Thoracic Spinal Cord Injury

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Abstract

© Copyright © 2020 Gill, Linde, Fautsch, Hale, Lopez, Veith, Calvert, Beck, Garlanger, Edgerton, Sayenko, Lavrov, Thoreson, Grahn and Zhao. Background: Quality of life measurements indicate that independent performance of activities of daily living, such as reaching to manipulate objects, is a high priority of individuals living with motor impairments due to spinal cord injury (SCI). In a small number of research participants with SCI, electrical stimulation applied to the dorsal epidural surface of the spinal cord, termed epidural spinal electrical stimulation (ES), has been shown to improve motor functions, such as standing and stepping. However, the impact of ES on seated reaching performance, as well as the approach to identifying stimulation parameters that improve reaching ability, have yet to be described. Objective: Herein, we characterize the effects of ES on seated reaching performance in two participants with chronic, complete loss of motor and sensory functions below thoracic-level SCI. Additionally, we report the effects of delivering stimulation to discrete cathode/anode locations on a 16-contact electrode array spanning the lumbosacral spinal segments on reach distance while participants were seated on a mat and/or in their wheelchair. Methods: Two males with mid-thoracic SCI due to trauma, each of which occurred more than 3 years prior to study participation, were enrolled in a clinical trial at Mayo Clinic, Rochester, MN, USA. Reaching performance was assessed, with and without ES, at several time points throughout the study using the modified functional reach test (mFRT). Altogether, participant 1 performed 1,164 reach tests over 26-time points. Participant 2 performed 480 reach tests over 17-time points. Results: Median reach distances during ES were higher for both participants compared to without ES. Forward reach distances were greater than lateral reach distances in all environments, mat or wheelchair, for both participants. Stimulation delivered in the caudal region of the array resulted in improved forward reach distance compared to stimulation in the rostral region. For both participants, when stimulation was turned off, no significant changes in reach distance were observed throughout the study. Conclusion: ES enhanced seated reaching-performance of individuals with chronic SCI. Additionally, electrode configurations delivering stimulation in caudal regions of the lumbosacral spinal segments may improve reaching ability compared to rostral regions.

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Keywords

epidural spinal electrical stimulation, modified functional reach test, neuromodulation, neurorehabilitation, paralysis, reach distance, spinal cord injury, trunk stability

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