Title

Brain-computer Interface Controlled Functional Electrical Stimulation As A Novel Approach To Improving Foot-drop After Stroke

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Authors

Do, An H
Wang, Po T
King, Christine E
et al.

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Abstract TP94: Brain-computer Interface Controlled Functional Electrical Stimulation As A Novel Approach To Improving Foot-drop After Stroke

An H Do, Po T Wang, Christine E King, Andrew Schombs, Zoran Nenadic, and Steven C CramerUniv of California, Irvine, Orange, CA

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Abstract

INTRODUCTION: Foot-drop commonly affects gait after stroke, and current physiotherapy is incompletely effective. Orthoses are often used but benefits disappear on removal. The post-stroke brain has enormous potential to undergo plasticity in support of behavioral recovery. The current study builds on this, using an electroencephalogram (EEG) based brain-computer interface (BCI) to control a functional electrical stimulation (FES) system. Here, motor signals from intact motor cortex are detected then directly applied to the paretic limb to move it, bypassing the stroke. This reinforcement of motor cortex activation with supramaximal neuromuscular stimulation may promote Hebbian learning and lead to enduring changes in CNS organization and gait. The current report describes the safety of this system.

METHODS: An integrated BCI-FES system for ankle dorsiflexion was developed by the authors. EEG was recorded as subjects alternated between idling and attempted paretic foot dorsiflexion for 10 mins. A prediction model was generated from this data and used to classify online EEG into idling or dorsiflexion states. This model facilitates brain control of the FES device by producing dorsiflexion when a subject's intent to dorsiflex is detected. Subjects operated the BCI-FES system by idling or attempting to elicit BCI-FES mediated dorsiflexion in response to alternating 10-sec cues. Each run was 200 sec long and was repeated over 1-2 hours, with breaks. Subjects underwent 3 weekly sessions.

RESULTS: Two patients with stroke (ages 38-60, 22-25 mo post-stroke, NIHSS score 4-9), who had foot-drop for which each used a commercial FES system were enrolled and completed the regimen. There were no adverse events and no safety concerns. Both subjects achieved purposeful control of

the BCI-FES system. Active range of motion for dorsiflexion after the BCI-FES regimen increased from 5 to 8° in S1 and from 0 to 3° in S2.

CONCLUSIONS: The current study examined a BCI-FES system that aims to promote CNS plasticity based on Hebbian theory. The results provide preliminary evidence that BCI-FES therapy is safe and may lead to neurological improvement. Therapy based on BCI has the potential to help a wide range of patients, particularly those with severe impairments.

Footnotes

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