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Brain-Computer Interface System for Lower Extremity Rehabilitation of Chronic Stroke Patients

Authors : Marc Sebastián-Romagosa, Woosang Cho, Rupert Ortner, Christy Li, Christoph Guger

Abstract : Neurorehabilitation based on Brain-Computer Interfaces (BCIs) shows important rehabilitation effects for patients after stroke. Previous studies have shown improvements for patients that are in a chronic stage and/or have severe hemiparesis and are particularly challenging for conventional rehabilitation techniques. For this publication, seven stroke patients in the chronic phase with hemiparesis in the lower extremity were recruited. All of them participated in 25 BCI sessions about 3 times a week. The BCI system was based on the Motor Imagery (MI) of the paretic ankle dorsiflexion and healthy wrist dorsiflexion with Functional Electrical Stimulation (FES) and avatar feedback. Assessments were conducted to assess the changes in motor improvement before, after and during the rehabilitation training. Our primary measures used for the assessment were the 10-meters walking test (10MWT), Range of Motion (ROM) of the ankle dorsiflexion and Timed Up and Go (TUG). Results show a significant increase in the gait speed in the primary measure 10MWT fast velocity of 0.18 m/s IQR = [0.12 to 0.2], P = 0.016. The speed in the TUG was also significantly increased by 0.1 m/s IQR = [0.09 to 0.11], P = 0.031. The active ROM assessment increased 4.65º, and IQR = [1.67 - 7.4], after rehabilitation training, P = 0.029. These functional improvements persisted at least one month after the end of the therapy. These outcomes show the feasibility of this BCI approach for chronic stroke patients and further support the growing consensus that these types of tools might develop into a new paradigm for rehabilitation tools for stroke patients. However, the results are from only seven chronic stroke patients, so the authors believe that this approach should be further validated in broader randomized controlled studies involving more patients. MI and FES-based non-invasive BCIs are showing improvement in the gait rehabilitation of patients in the chronic stage after stroke. This could have an impact on the rehabilitation techniques used for these patients, especially when they are severely impaired and their mobility is limited.

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