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Abstract title (20 Words)

BRAIN-MACHINE-INTERFACE BASED NEUROREHABILTATION INDUCES PARTIAL NEUROLOGICAL RECOVERY IN PARAPLEGIC PATIENTS

Abstract text (limited to 300 words, figures counts as 10 words, Objectives, Methods, Results, Conclusions)

Objectives: We aim at developing a novel neurorehabilitation approach to restore sensory-motor functions in patient with severe spinal cord injury (SCI). For the past decade, brain-machine interfaces (BMIs) have been heralded as a potential new assistive tool, aimed at restoring mobility in paralyzed patients by allowing them to control prosthetic limbs using only their voluntary motor brain activity.

Methods: A multi-steps training paradigm that we refer as the Walk Again Neurorehabilitation paradigm (WANR) including immersive virtual reality, artificial tactile feedback, EEG controlled robotic actuator and training with a custom lower limb exoskeleton was tested with eight paraplegic patients (7 ASIA A, complete SCI, 1 ASIA B, sensory incomplete SCI), suffering from chronic SCI (5-13 years).

Results: Overall 3 ASIA A patients (42%) progressed to ASIA C (motor incomplete SCI) and 1 patient moved from ASIA B to ASIA C. Neurological improvement was paralleled by cortical plastic adaptations measured by EEG.

Conclusions: These results provide the first clinical demonstration that long-term BMI-based training may induce partial neurological recover in SCI patients. These findings significantly enhance the potential future impact of BMI-based therapies and the range of patients who may benefit from them.

Figure legend:

Walk Again Neuro-rehabilitation training paradigm and cumulated number of hours for all patients 1) Brain controlled 3D avatar with tactile feedback when patient is seated on a wheelchair or 2) in an orthostatic position on a stand-in-table. 3) Gait training using a robotic body weight support (BWS) system on a treadmill. 4) Gait training using an overground BWS system. 5-6) Brain controlled robotic gait training integrated with the sensory support of the tactile feedback at gait devices (BWS system on a treadmill or a custom-built exoskeleton).