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## Motor imagery-assisted brain-computer interface for gait retraining in neurorehabilitation in chronic stroke

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*Introduction/Background* Stroke is the most common cause for physical disability and impairments to lower limb function remain one of its most debilitating symptom. Motor imagery (MI), as a safe, self-paced technique, has been shown to effectively facilitating the effects of motor practice. When combined with brain-computer interface (MI-BCI), it also demonstrates an improvement in stroke motor recovery. A feasibility trial was carried out to investigate the effect of MI-BCI neurofeedback in chronic hemiplegic lower limb rehabilitation. The neurophysiological correlates to clinical outcomes was also studied by using, transcranial magnetic stimulation (TMS).

*Material and method* Subjects ($n = 13$) with more than 9 months post-stroke and Functional Ambulation Category 3–4 underwent 12 sessions of MI-BCI gait training, at a frequency of thrice a week. Subjects were instructed to perform a MI task whereby they imagined themselves walking properly with both legs. If the MI task is performed correctly as detected via electroencephalography acquisition, a pair of cartoon footprints in the monitor will be activated to walk forward. Each MI-BCI session includes 160 MI trials with resting interval every 40 trials. Timed up-to-go test and 10 meter walk test, as well as the resting motor threshold measured by TMS were performed before, after and 6 weeks after MI-BCI gait training.

*Results* It was shown that MI-BCI was safe and well tolerated by stroke subjects. Both walking speed and balance improved after MI-BCI gait training (Fig. 1). This was in line with an increase in the corticospinal activity in the contralesional M1 motor cortex (Fig. 2).

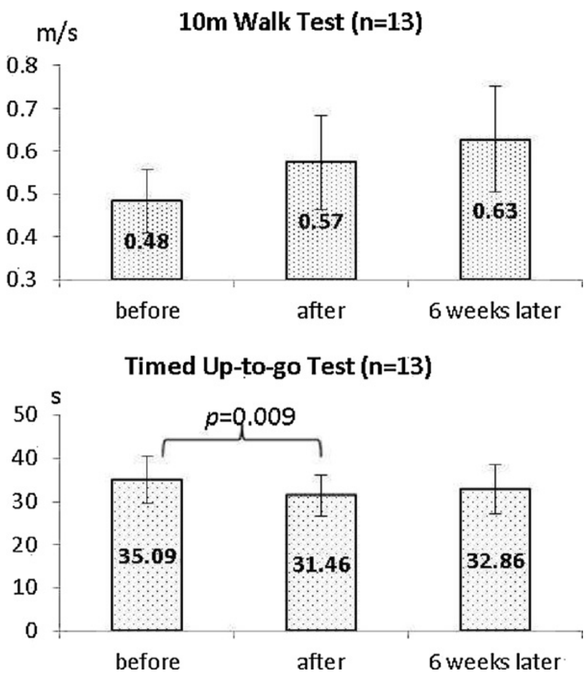


*Fig. 1*

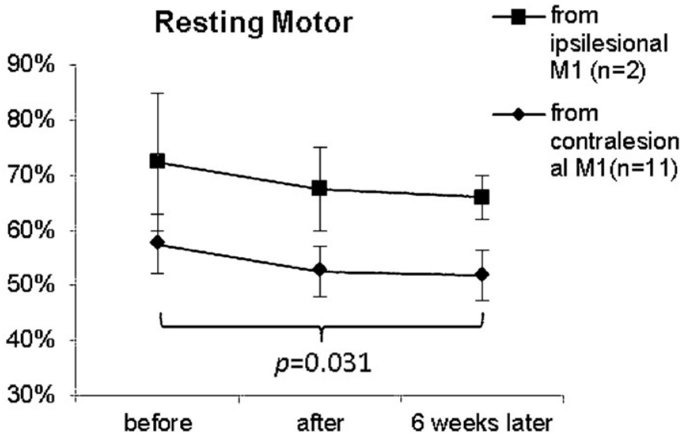


*Fig. 2*

*Conclusion* MI-BCI could improve mobility in chronic stroke patients with residual mobility impairment. The study also suggested that the contralesional motor cortex is involved in the recovery of mobility.

*Keywords* Stroke; Brain-computer interface

*Disclosure of interest* The authors declare that they have no competing interest.

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## Effects of non-invasive brain stimulation for upper limb rehabilitation in acute stroke patients - A controlled clinical trial

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*Introduction/Background* This study was conducted in Tuen Mun Hospital (TMH) to evaluate the effects of rTMS and tDCS on upper limb functional recovery in acute stroke patients.

*Material and method* Patients with acute stroke were randomly assigned to rTMS, tDCS or control group. For rTMS group, patient received 1 Hz rTMS at 90% of resting motor threshold to M1 of the unaffected hemisphere for 1200 pulses. For tDCS group, patient received 1 mA anodal stimulation to hand area of the affected hemisphere for 20 minutes. Five consecutive sessions of rTMS or tDCS together with intensive physiotherapy upper limb training were given. For control group, only intensive physiotherapy upper limb training were given. The upper extremity section of Fugl–Meyer Scale (UE-FM) was used as outcome measure.

*Results* Twenty-nine patients (17 female and 12 male) were assigned to the rTMS ($n = 9$), tDCS ($n = 11$) and control ($n = 9$) group. The mean age was 62.7 ± 12.0 years old and the mean time between stroke onset and the first UE-FM assessment was 9.14 ± 3.30 days. There was no statistically significant difference in mean age, baseline UE-FM mean score, mean time between stroke onset and the first UE-FM assessment among three groups [$X^2(2) = 4.81$, $P = 0.09$] [$X^2(2) = 1.56$, $P = 0.457$] [$X^2(2) = 0.04$, $P = 0.98$]. No adverse effects of rTMS or tDCS were reported. For between-group comparison, the changes in mean score of UE-FM in rTMS (20.8 ± 6.59) and tDCS group (16.1 ± 4.97) were statistically significantly larger than that in control group (10.6 ± 4.13) (U = –2.97, $P = 0.002$) (U = –2.29, $P = 0.02$). However, there was no significant difference between rTMS and tDCS group (U = –1.49, $P = 0.152$).

*Conclusion* Findings of the present study showed that both rTMS and tDCS could augment physiotherapy treatment in enhancing