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Effects of dual transcranial direct current stimulation over primary motor cortex with fMRI

Yong-Il Shin, Kyung Lim Joa and Ji Hong Min
Pusan National University School of Medicine, Korea

Background: Transcranial direct current stimulation (tDCS) has been reported as an effective method for manipulating human brain exciatbility through continuous application of a weak direct current on the scalp. The effect of tDCS varies depending on the polarity of the electrode; anodal polarization increases cortical excitability, whereas cathodal polarization decreases it. Also, simultaneous dual tDCS produced an additive effect to facilitate motor performance in the hand. In this study, we observed modulation of motor networks induced by dual tDCS in healthy subjects using functional MRI (fMRI).

Methods: Twelve right handed healthy participants (Mean age: 25.6 years, 6 male) underwent two stimulation conditions: 1) Real dual-hemisphere-with anodal tDCS over right primary motor cortex (M1) 2) Sham tDCS. Before and after tDCS, fMRI were performed while both finger tapping task were performed in a conventional block design. Participants performed a finger-sequencing task with the non-dominant hand before and after real and sham stimulation outside MR scanner.

Results: In the real tDCS session, there was similar activation pattern before and after stimulation during right hand task. When fMRI images between the real and sham tDCS sessions were compared, there was no significant interaction in motor network. In the real tDCS session, there was increased activation in right M1 and decreased activation in left M1 and both SMA during left hand task. When fMRI images between the real and sham tDCS sessions were compared, the real tDCS session showed significantly increased activation in the both SMA and left M1 in motor network after applying tDCS. After real tDCS, there was significant improvement in reaction time and movement accuracy in finger-sequencing task ($p<0.05$).

Conclusions: Simultaneously dual tDCS over bilateral M1 modulated functional motor networks during motor task. Effective modulation of functional networks by dual tDCS might be a determinant to obtain functional improvements in healthy persons by direct or distant effect.

Key Words: tDCS, transcranial direct current stimulation, functional MRI, cortical excitability

rmshin01@gmail.com