Transcranial direct current stimulation to improve motor function

Elena Pavlova, Rehabveckan, 2015.05.20
tDCS reduces motor deficits in stroke

Fregni et al. 2005
Application in stroke

Control

M1  ↔  M1

Affected side

M1  ↔  M1

Anodal stimulation

Cathodal stimulation
PROJECTS

1. *Does transcranial direct current stimulation enhance the effect of hand motor training in patients with prior stroke?*

2. *Transcranial direct current stimulation of the premotor cortex aimed to improve hand motor function*
   

3. *Transcranial direct current stimulation of the premotor cortex in comparison with primary motor cortex in stroke patients*

4. *Comparison of one-session tDCS effect on fine motor control in sub-acute and chronic stroke patients*

5. *Transcranial direct current stimulation of the premotor cortex: impact of personality*

6. *Optimising electrodes size for transcranial direct current stimulation*
Project 1: Does transcranial direct current stimulation enhance the effect of hand motor training in patients with prior stroke?

- **The goal of the study** is to investigate the effect of motor training (Visuomotor grip force tracking) combined with tDCS on hand motor function of chronic stroke patients.

- **Baseline examinations**: neurological examination, quantification of sensory function, Upper Extremity Fugl-Mayer assessment and Box and Blocks tests. Everyday activities are assessed by Abilhand questionnaire.

- **Matched random sampling** into Active and Sham groups. Two training sessions of twenty minutes combined with (active or sham) anodal tDCS (0.5mA) to the contralateral primary motor cortex (affected hemisphere) is performed daily during 20 consecutive days.

- **Outcome assessments**: Upper Extremity Fugl-Mayer assessment, Box and Blocks and Abilhand questionnaire.
Performance of visuomotor grip force tracking task
Maximal voluntary contraction

FM-UE before and after the treatment

Grip strength change, kg

FM-UE, a.u.

Mean
Mean+SE
Mean+1.96*SE
Median
25%-75%
Min-Max
Upper Extremity Fugl-Mayer assessment score in individual patients before and after training

Active

Sham
Conclusions project 1

• Improvement in the hand function can be achieved in the chronic stage of stroke
• Can be non-specific to the trained task
• Shows high inter-individual variability
Project 2. Transcranial direct current stimulation of the premotor cortex aimed to improve hand motor function

• Cross-over, semi-balanced, randomized study

• Types of stimulation: anodal or cathodal stimulation of either right or left dorsal premotor cortex, and sham stimulation.

• Parameters of stimulation: 0.5mA, 10 minutes; electrodes: 2,5X6 cm

• One week interval between sessions

• Subjects were blind to experimental conditions

• The spring compression task (Valero-Cuevas FJ et al. J Biomech. 2003 Feb;36(2):265-70) was trained on a separate day. On the stimulation days, the test was performed for 10 minutes before and 10 minutes during tDCS sessions. 30 spring compressions were recorded during each interval.
Performance of the spring compression task
Stimulation effect vs type of stimulation

% change

L-anodal    L-cathodal      sham      R-anodal   R-cathodal

Stimulation type

Mean
Mean+SE
Mean+1.96SE

L-anodal    L-cathodal      sham      R-anodal   R-cathodal

Stimulation type
Inter-hemispheric inhibition

![Graphs showing inter-hemispheric inhibition](image)
Anodal stimulation

Premotor cortex

M1

Cathodal stimulation

Premotor cortex

M1
Groups

- **group 1** - improvement in response to the L cathodal stimulation
- **group 2** - improvement in response to the L anodal stimulation
- **group 3** - others
Conclusions project 2

• Stimulation of the left but not the right premotor cortex improves the performance in healthy right-handed individuals
• Motor responses to the stimulation of the premotor cortex depend on the motor task performance
• These responses show presence of interhemispheric inhibition
Project 3. Transcranial direct current stimulation of the premotor cortex in comparison with primary motor cortex in stroke patients

- **The aim** of the present study is to investigate the effect of tDCS (both anodal and cathodal) of the unaffected and affected dorsal premotor cortex, anodal tDCS of the affected M1, cathodal tDCS of unaffected M1 and sham stimulation on performance of the spring compression test.

- **The hypothesis** is that anodal stimulation of the affected premotor cortex will have greater effect on performance in stroke patients compared with other types of tDCS.
Project 4: Comparison of one-session tDCS effect on fine motor control in sub-acute and chronic stroke patients

Cross-over, balanced, randomised study on 12 sub-acute stroke patients,
Jebson-Taylor test
10 times training before tDCS
3 times baseline, 5 times during sham/acute tDCS, one week interval

![Graphs showing data comparison between sham and active sessions](image1.png)

Sham first
Active first
Conclusions project 3

- Significant improvement during anodal tDCS of the primary motor cortex on the affected side in sub-acute stroke patients is observed
- The size of the improvement depends on learning stage
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