Optimizing transcranial direct current stimulation for motor recovery from severe post-stroke hemiparesis

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Background: Transcranial direct current stimulation (tDCS) is a form of non-invasive brain stimulation that can modulate neuroplasticity. tDCS modulation occurs in a polarity-dependent manner: anodal stimulation increases cortical excitability, whereas cathodal stimulation diminishes it. Previous studies have yielded valuable evidence about the use of tDCS to improve motor performance in both healthy subjects and those with mild to moderate post-stroke motor deficits. However, no research has addressed the extent to which this evidence may generalize to subjects with severe post-stroke hemiparesis.

Purpose: determine the best electrode configuration for the delivery of tDCS to enhance UE motor function in subjects with severe post-stroke hemiparesis.

Hypothesis: Subjects with severe post-stroke hemiparesis in the cathodal group will have significantly more improved motor function post-intervention than anodal and sham groups.

Methods: We conducted a randomized, double-blind, placebo-controlled trial to investigate which tDCS configuration may best enhance outcomes of UE motor training for people with chronic, severe hemiparesis after cortical stroke. Subjects (n=19) were randomized to receive 10 daily sessions of anodal, cathodal, or sham tDCS preceding intensive task-oriented training. Upper extremity movement function was assessed using Action Research Arm Test, Fugl-Meyer Assessment and Stroke Impact Scale at baseline, immediately post-intervention, and at 1-month follow-up.

Results: Pre-post change in Action Research Arm Test indicated significant between-groups differences favoring cathodal tDCS compared with anodal tDCS (95% CI, 1.9-8.1; p=0.004) and sham tDCS (95% CI, 2.7-9.0; p=0.001). Likewise, 1-month follow-up evaluation indicated significant between-groups differences favoring cathodal tDCS compared with anodal tDCS (95% CI, 0.5-6.5; p=0.026) and sham tDCS (95% CI, 1.1-7.2; p=0.01). Between-groups analysis of pre- post change in Fugl-Meyer Assessment score revealed that cathodal tDCS led to significantly greater improvement than sham tDCS (95% CI, 0.25-9.8; p=0.04) but not anodal tDCS. At 1-month follow-up, neither sham tDCS nor anodal tDCS were significantly different from cathodal. Between-groups analysis of Stroke Impact Scale revealed no significant differences in change from baseline between cathodal and anodal tDCS or sham tDCS at post-intervention or at 1-month follow-up.

Conclusions: Contralesional cathodal tDCS appears to optimize outcomes of upper extremity motor training after stroke in cases of severe hemiparesis.