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Comparative Study on Transcranial Direct Current Stimulation (tDCS) Combined with Task-Oriented Training vs Conventional Therapy on Hand Function Recovery in Post-Stroke Patients

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ABSTRACT

Background: Hand function recovery after stroke remains a major rehabilitation challenge. Transcranial direct current stimulation (tDCS) is a noninvasive neuromodulation technique that may enhance cortical excitability and motor learning when paired with task-oriented training (TOT). This comparative study protocol aims to evaluate whether tDCS combined with TOT improves hand function more than conventional therapy in post-stroke patients.

INTRODUCTION

Stroke is a leading cause of long-term disability worldwide, with msuarnvyivors experiencing persistent upper limb and hand deficits that impair activities of daily living. Emerging evidence suggests that combining brain stimulation such as tDCS with intensive, task-specific rehabilitation may produce additive or synergistic effects on motor recovery. This document follows the structure of a research protocol and literature review to support a randomized controlled comparative trial.

REVIEWOF LITERATURE

tDCS and Upper Limb Recovery: Systematic reviews and meta-analyses have reported that tDCS, when combined with rehabilitation, can improve upper limb and hand function after stroke, although effects vary by stimulation parameters and study quality. Cortical targeting (anodal over ipsilesional M1 or cathodal over contralesional M1) and timing relative to therapy influence outcomes.

Task-Oriented Training (TOT): Task-oriented training emphasizes repetitive, meaningful tasks that mimic daily activities and has demonstrated efficacy for improving hand function and manual dexterity in chronic stroke patients. Higher doses (>20 sessions) have shown greater benefits for hand outcomes in several trials.

Combined Interventions: Recent systematic reviews indicate that combining tDCS with active motor training—particularly task-oriented or robot-assisted training—can enhance gains in arm/hand function compared to sham stimulation or conventional therapy alone. However, heterogeneity in protocols (stimulation intensity, session number, TOT content) limits definitive conclusions and points to the need for high-quality RCTs.

OBJ ECTIVES OF THE STUDY

1. Primary Objective: To compare the effect of tDCS combined with task-oriented training (tDCS+TOT) versus conventional therapy on hand function recovery in post-stroke patients as measured by the Box and Block Test (BBT) and Fugl-Meyer Assessment for Upper Extremity (FMA-UE).

2. Secondary Objectives:

- To compare changes in grip strength, Nine-Hole Peg Test (9HPT), and Motor Activity Log (MAL).

- To evaluate changes in activities of daily living (Barthel Index).

- To assess cortical excitability changes (optional TMS measures) and safety/ tolerability of combined intervention.

HYPOTHESIS

Null Hypothesis (H0): There is no difference in hand function recovery between patients receiving tDCS+TOT and those receiving conventional therapy.

Alternative Hypothesis (H1): Patients receiving tDCS+TOT will show superior improvement in hand function compared to those receiving conventional therapy.

MATERIALS AND METHODS

Study design: A single-blind (assessor-blinded), randomized controlled trial with two parallel arms: (1) tDCS combined with task-oriented training (tDCS+TOT) and (2) Conventional therapy (standard occupational therapy focusing on passive/ active ROM, strengthening, and non-task-specific practice).

Participants: Inclusion criteria: adults aged 18–80 with first-ever ischemic or hemorrhagic stroke (subacute or chronic phase defined as >2 weeks post-stroke), residual unilateral hand weakness (FMA-UE hand score < 60), medically stable, able to follow simple commands. Exclusion criteria: implanted electronic devices, active seizures, severe cognitive impairment, skin lesions at stimulation sites, other neurological disorders.

Intervention:

- tDCS+TOT group: Anodal tDCS over ipsilesional primary motor cortex (M1) at 1–2 mA for 20 min immediately preceding or during task-oriented training; TOT consists of 45–60 min of task-specific, repetitive practice focusing on grasp, release, manipulation, and ADL tasks, 5 sessions/week for 4 weeks (total 20 sessions).

- Conventional therapy group: 45–60 min of usual care occupational therapy focusing on impairment-based exercises, ROM, strengthening, and non-specific practice, with same frequency and duration (20 sessions).

Outcome measures and assessment timeline:

- Primary: Box and Block Test (BBT), Fugl-Meyer Assessment—Upper Extremity (FMA-UE) at baseline, post-intervention (4 weeks), and 3-month follow-up.

- Secondary: Nine-Hole Peg Test (9HPT), grip strength (dynamometer), Motor Activity Log (MAL), Barthel Index, adverse events. Optional cortical excitability via TMS in a subset.

Randomization and blinding: Computer-generated randomization with allocation concealment. Outcome assessors blinded to group allocation.

Sample size estimation: Based on prior meta-analytic effect sizes for combined tDCS and rehabilitation on upper limb function (SMD ~0.3–0.6), a sample size of 60 participants per group (total n=120) would provide 80% power to detect a moderate effect (alpha=0.05), allowing for 15%dropout.

Statistical analysis: Intention-to-treat analysis. Between-group differences assessed using mixed-model repeated measures ANOVA, adjusting for baseline covariates. Effect sizes (Cohen's d) and 95%confidence intervals reported.

EXPECTED OUTCOMES

We expect the tDCS+TOT group to demonstrate greater improvements in hand function (BBT, FMA-UE) relative to conventional therapy at post-intervention and follow-up, with acceptable safety and tolerability. Evidence of cortical excitability changes may support mechanistic effects of tDCS.

ETHICAL CONSIDERATIONS

Study approval will be obtained from the institutional ethics committee. Written informed consent will be obtained from all participants. Adverse events related to tDCS (mild tingling, skin irritation, headache) will be monitored and reported. The trial will be registered in a public clinical trials registry.

CONCLUSION

Combining tDCS with task-oriented training is a promising therapeutic strategy to augment hand recovery after stroke. This comparative RCT protocol aims to provide higher-quality evidence regarding efficacy, dosing, and practical implementation forclinical neurorehabilitation.

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