Rehabilitation of hemiplegic hand function during sub-acute stage of recovery using automated FES-assisted exercise therapy

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1. Introduction

This is a randomized placebo-controlled study of the efficacy of automated FES-assisted exercise therapy in improving hand function in sub-acute stroke patients. Precisely we reported preliminary results in chronic stroke patients (Gritsenko et al., 2001). See Neuroscience 125, 20-29.

Study hypotheses:
1. Subjects in the treatment group will achieve better hand function than subjects in the control group after FES-assisted exercise therapy.
2. The improvements will carry over to unpractised tasks.
3. The difference between the treatment and the control groups will be maintained 3 and 6 months later.

2. Methods

An exercise station with instrumented objects was designed and built during the study. It allowed the user to practice tasks similar to activities of daily life and provided kinematic data.

Subjects
11 subjects were recruited in the study. They were randomised into control and treatment groups. Inclusion criteria: 1) stroke occurred only in the affected hemisphere; 2) stroke occurred between 4-8 weeks prior to the study; 3) normal premorbid hand function; 4) brain maps (for the hand) for the hemisphere between 2 and 4. Exclusion criteria: 1) severe cognitive impairment; 2) Mini-Mental Examination score <20; 3) severe sensory impairment of the affected hemisphere; 4) haemorrhage. Subjects in the treatment group showed larger improvements in the use of objects on the workstation.

Intervention
Subjects in the treatment group showed larger improvements in the use of objects on the workstation. Mean slopes of regression lines for task 1 were 0.009 and 0.008 for the treatment and the control groups respectively. Mean slopes for task 2 were 0.022 and 0.017 for the treatment and the control groups respectively. However, the differences did not reach significance when assessed by a t-test (P=0.25, P=0.33 for task 1 and 2 respectively).

3. Results

Kinematic measures:

Subjects in the treatment group showed larger improvements in the use of objects on the workstation. There was no difference in volumes of maps between the control and treatment groups. At the follow-up, there is a tendency for the subjects in the treatment group to show larger increases in map volumes.

Outcome measures:

Subjects in the treatment group showed larger improvements in the use of objects on the workstation. There was no difference in volumes of maps between the control and treatment groups.

Clinical measures:

There were no differences in volumes of maps between the control and treatment groups. At the follow-up, there is a tendency for the subjects in the treatment group to show larger increases in map volumes.

4. Conclusions

1. The kinematic data indicate that FES-assisted exercise therapy improves hand function of sub-acute stroke patients.
2. The improvements were transferable to unpractised tasks as shown by the Wolf Motor Function test.
3. The clinical data suggest that the improvements immediately following the treatment are not large enough to be clinically relevant. However, only when all follow-up assessments are completed, the long-term impact of the therapy will be revealed.

The study was supported by:

5. Appendix. TMS

Methods
In 4 out of 11 subjects, sensor cortices of both the affected and unaffected hemispheres were magnetically stimulated. The coil was oriented at a 45 deg angle to the midline with the handle pointing toward the back of the head. Example of a motor map from one of the subjects. Each of the colors represent the amplitude of the most responsive to TMS at this location.

Thresholds stimulate output values that exceed 100% of the Mmax.

Conclusion:

There was no difference in volumes of maps between the control and treatment groups. At the follow-up, there is a tendency for the subjects in the treatment group to show larger increases in map volumes.

TMS Results:

There was no difference in volumes of maps between the control and treatment groups.