Amplifying Electrically-Evoked Contractions: Two techniques, one goal

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INTRODUCTION

Neuromuscular Electrical Stimulation (NMES)
Pulses of electrical stimulation delivered through the skin over a muscle or nerve can generate muscle contractions for individuals experiencing paralysis.

NMES-training
NMES-cycling

Transcutaneous Spinal Cord Stimulation (tSCS)
Pulses of electrical stimulation delivered through the skin over the spinal cord can help restore movement for people experiencing paralysis after a spinal cord injury.
For people with a spinal cord injury, this can improve voluntary movement in a single session, and, with repeated sessions, voluntary movement remains improved even when the tSCS is off.

We know that tSCS can increase the size of voluntary contractions, but the present experiments address if it can do the same for electrically-evoked contractions.

METHODS

Participants: Nine participants (ages 20-90, 2 women) with no history of neuromuscular injury or disease took part in a single 2-3 hour session. The size of M-reflexes was measured using electromyography and compared between control and test trials.

Protocol: Experiments were conducted in sets of control-test pairs.
Control = NMES only
Test = NMES + tSCS

A. Control trials (NMES only) & 5 single NMES pulses, then 6 NMES contractions (5x10% Mmax), 5 single NMES pulses, then 6 NMES contractions (5x10% Mmax)
B. Test trials (NMES + tSCS) 6 single NMES pulses, then 6 tSCS pulses, then 6 single NMES pulses, then 6 M-reflex contractions (5x10% Mmax), 6 single NMES pulses, then 6 M-reflex contractions (5x10% Mmax)

NMES electrodes are placed on the skin behind the knee to stimulate the tibial nerve and cause plantarflexion contractions.
Electromyography (EMG) electrodes are placed over the soleus calf muscle of the right leg.

HYPOTHESIS AND RATIONALE

Hypotheses:
(a) NMES + tSCS will produce larger M-reflexes than NMES alone.
(b) M-reflexes during NMES + tSCS will get bigger as tSCS intensity gets higher.

Rationale: We propose that tSCS "boosts" NMES-evoked contractions by increasing the excitability of spinal reflex pathways and thereby increasing the "reflexive" contribution to contractions produced by NMES.

PRELIMINARY RESULTS

no carrier (n = 4)

CONCLUSIONS & IMPLICATIONS

SUMMARY
1. Early data demonstrated increases in M-reflex amplitude and contraction size when tSCS was turned "on" compared to "off".
2. When the hypothesis is tested using more "standard" protocols for setting tSCS intensity, the effect seems to disappear.

CONCLUSION
TSCS may increase the size of M-reflexes and contractions, but perhaps only at higher relative intensity.

POTENTIAL IMPLICATIONS
- The ability to "boost" M-reflex amplitude with tSCS would:
  - Increase the "central contribution" to NMES contractions, making them larger and less fatigable.
  - Contribute to the ability to engage in longer and more efficient exercise for individuals with spinal cord injury.

CURRENT STATUS
Data collection is ongoing.