Short-Term Immobilization Promotes a Rapid Loss of Motor Evoked Potentials and Strength That Is Not Rescued by rTMS Treatment

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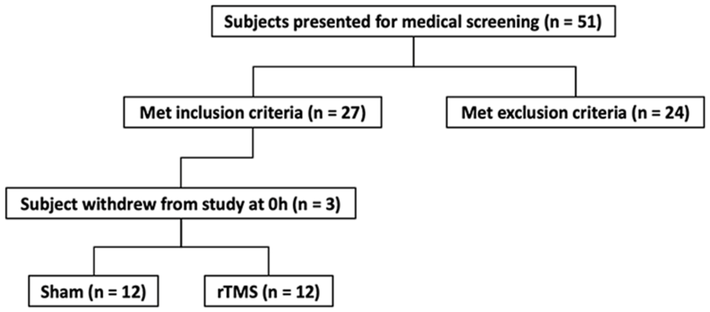
Background

- Immobilization of a limb prevents movement from injury, promoting loss of muscle strength and mass [1].
- Limb immobilization causes a decrease in excitability of motor cortex (M1) after 8 h: a concern if bed-bound, or older with reduced mobility [2].
- Limb immobilization promotes a decrease in the cortical thickness of the left M1 and reduces fractional anisotropy of white matter tracts associated with the right hemisphere M1, suggesting a reorganization of motor systems in the brain with immobilization [3].
- 20 Hz rTMS can significantly increase excitability in the motor pathway to the hand by increasing motor evoked potential (MEP) amplitudes [4].

Aim: **To determine the neurophysiologic basis of immobilization-induced skeletal muscle decline, and if 20 Hz rTMS to M1 can protect against it and facilitate cortical excitability.**

Subjects



- 24 recreationally active young males participated. Subjects were (mean ± SEM) 20.7 ± 0.5 year, 69.1 ± 1.8 kg body mass, and had a BMI of 22.1 ± 0.5 kg/m2.
- Subjects were randomized into either a Sham or an rTMS group prior to data collection, as seen in the flow chart above.

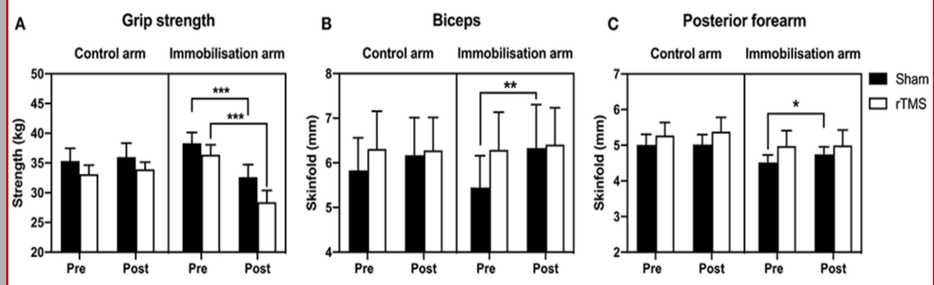
Hypotheses

- Rapid declines in strength with immobilization will be underpinned by a loss of excitability within the motor pathway to the hand, indexed as a reduction in magnitude of MEPs.
- Stimulating M1 using 20 Hz rTMS would attenuate the decline of motor excitability and decline of skeletal muscle, which would have significant implications for prehabilitation or rehabilitation.

Procedure

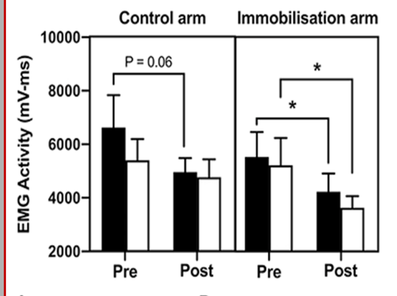
- Parallel design (Sham vs. rTMS groups) immobilizing the dominant arm using a shoulder sling for 72 hours. Before and after immobilization, maximal grip strength, volume-displacement plethysmography, skinfold-callipers, and circumference measurements were taken.
- Electromyography (EMG) of the FDI was taken with maximal grip strength. MEPs were recorded from left and right resting FDI via single-pulse TMS before immobilization, and at 24, 48, and 72 hours after immobilization.
- rTMS group received 6 × 1.5 s 30-pulse trains of 20 Hz biphasic rTMS with inter-train-intervals of 60s to the hand area of left M1 before immobilization, and at 24, 48, and 72 hours to promote cortical plasticity during immobilization.
- Sham group received an identical rTMS protocol, but the coil was held 3–4 cm away from the head. Cortical excitability was evaluated using MEPs from the FDI elicited by single-pulse TMS, at 0, 24, 48, and 72 hours.

Effects of rTMS on Strength and Arm Composition

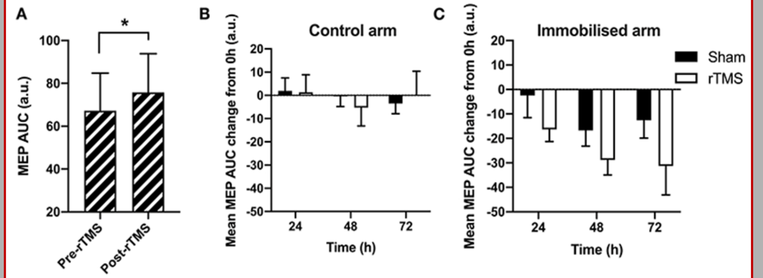


- Arm immobilization induced a significant decrease in grip strength in both the Sham group (10% loss) and rTMS group (22% loss) (**A**).
- In the Sham group, there was an increase in biceps skinfold (**B**; $p < 0.01$) and posterior forearm skinfold (**C**; $p < 0.05$) of the immobilized arm. Such changes in arm composition were not observed in the rTMS group.

Effects of rTMS on EMG and MEP Activity



In the control arm, EMG activity was reduced in the Sham group across the 72 h but not in the rTMS group. In the immobilized arm, there was a loss of EMG activity in the Sham group and this was not prevented with rTMS.



- There was a significant effect of rTMS on MEPs at 0 h (**A**).
- In the control arm, there was no significant change in MEP size across time or between Sham and rTMS (**B**).
- In the immobilized arm, there was a decrease in MEPs across time, which did not differ between Sham and rTMS (**C**).

Conclusion

- Significant reduction in MEPs within 48 hours of immobilization.
- Whilst it enhanced motor excitability at baseline, 20Hz rTMS did not protect against immobilization-induced loss of motor excitability, loss of EMG activity, or maximal grip strength.
- rTMS may have modulated factors such as fluid retention or fat accumulation during immobilization, as there was no increase in skinfold thickness at the biceps and posterior forearm following rTMS.

References:

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