Neuromuscular Electrical Stimulation Does Not Affect Echo Intensity During Short-Term Knee Immobilization

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Background

Knee joint immobilization is a common clinical intervention that can compromise muscle quality, which can be an indication of function and strength. Echo intensity (EI) is an emerging tool for assessing muscle quality in research. While neuromuscular electrical stimulation (NMES) has been proposed as a strategy to preserve muscle function, its effectiveness in preventing EI changes due to short-term disuse remains unclear.

The purpose of this study was to investigate whether NMES preserves EI of quadriceps muscles during one week of knee joint immobilization.

Methods

Participants: Twenty-one healthy, college-aged adults (11 males: mean±SD age=22±4 years; height=182.40±7.17 cm; mass=82.60±16.27 kg; 10 females: age=20±1 years, height=160.55±5.43 cm; mass=60.82±9.67 kg) were randomized into two groups: Immobilization-only (IMM; n=9), and Immobilization + NMES (NMES; n=12).

Protocol: All participants wore a knee brace on the left leg locked at 90° flexion for seven days.

The NMES group performed twice-daily NMES of the knee extensors, resulting in visible quadriceps contraction. Transverse echo intensity of the vastus lateralis (VL EI) and rectus femoris (RF EI) muscles was measured with B-mode ultrasonography PRE- and POST-immobilization.

Methods

Figure1. Ultrasound assessment of the quadriceps to measure echo intensity (EI) before and after immobilization.

Statistical analysis: Separate ANCOVA analyses were conducted for each muscle, with Bonferroni post hoc comparisons when appropriate (α = 0.05). PRE data served as the covariate in the analyses. Within group changes were determined with paired samples t-tests.

Results

After controlling for covariates, there were no significant differences between groups at POST:

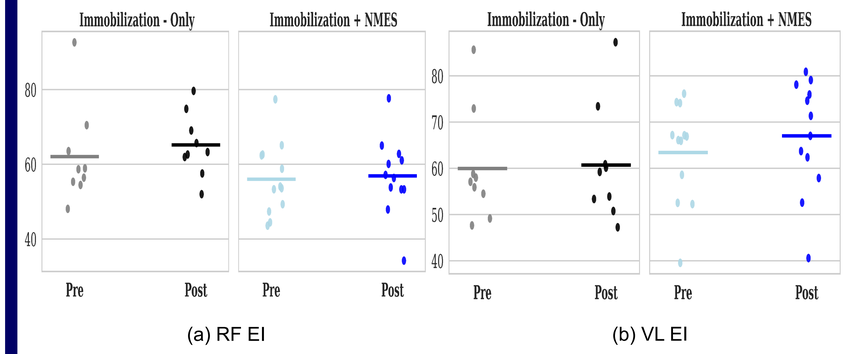
- VL EI: $F(1,18)=2.748$ AU, $p = 0.115$
- RF EI: $F(1,18)=2.759$ AU, $p = 0.114$

Both groups exhibited increased EI after immobilization, indicating a decline in muscle quality.

Within-group percent increases:

- IMM: VL EI = +1.1%, RF EI = +5.0%
- NMES: VL EI = +5.8%, RF EI = +1.6%

Results



(a) RF EI (b) VL EI

Figure 2. Individual participant data for (a) Rectus femoris and (b) Vastus lateralis transverse echo intensity. Horizontal bars indicate group means.

Conclusions

Contrary to our hypothesis, the short-term protocol did not preserve EI during immobilization, possibly due to:

1. Predominant Type II fiber recruitment
2. Variability in NMES intensities causing microtrauma
3. The short study duration, which may not have been sufficient to effectively preserve muscle quality.

Practical Applications

Interventions using only NMES may not prevent muscle quality loss during short-term immobilization. Future studies should explore optimized NMES parameters and combined interventions to improve preservation.

References

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