Potential negative effects of neuromuscular electrical stimulation: Does it affect static balance and proprioception?

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Purpose Neuromuscular electrical stimulation (NMES) is commonly used in clinics or homes for older adults to strengthen muscles and/or control pains by inducing muscle contraction artificially, and several research studies support its effectiveness in muscle strengthening and pain control (Nussbaum et al., 2017). Physiologically, however, the electricity-induced muscle contraction is quite different compared to voluntary contraction. For example, while the voluntary muscle contraction occurs with recruitment of motor units from small to large (Henneman's size principle), the artificial muscle contraction occurs with motor units near electrodes, resulting in a non-selective and synchronized pattern (thereby easily fatigued) (Binder-Macleod et al., 1995). Therefore, long-term use of NMES should change muscle contraction behavior. Furthermore, static balance is an ability to place the center of body mass within a base of support during standing, and lower extremity muscle contraction along with an ankle joint proprioception play a critical role in maintaining balance (Karakaya et al., 2015). Accordingly, the changes in muscle contraction behavior by NMES may affect balance. Our hypothesis was that if there was a potentially negative effect even in healthy adults, it was expected to affect balance in the elderly. In this study, it is expected that it can be used effectively even in the elderly by proving its safety. **Method** 44 young adults (22 males and 22 females) were randomly assigned to NMES and voluntary contraction (VOL) group. All participants performed one-leg standing on a force plate (AMTI, model OR6-7-2000, Waltham, USA) for 10 seconds with eyes open and eyes closed. Participants also sat on the BIODEX (Biodex, Shirley, NY, USA) to measure ankle proprioception. These measurements were done before and after an intervention, where electric pads (Klug, Daily & Co, Seoul, Korea) were placed on the tibialis anterior, gastrocnemius, and soleus muscles for 20-minute muscle contraction in NMES group, and co-contraction of the three muscles was conducted with five sets of 20-second contraction with 60-second rest in VOL group. Outcome variables included mean distance (MDIST), root mean square distance (RMS), total excursion (TOTEX), mean velocity (MVEL), 95% confidence circle area (AREA) acquired from center of pressure data, and absolute error of dorsi/plantarflexion. ANOVA was used to test whether these outcome variables were affected by group (NMES vs VOL), gender, vision, and time (pre vs post) with a significance level of alpha = 0.05. **Results and Discussion** ANOVA showed that all outcome variables were not associated with groups. ($F = 1.004$, $p>0.35$) (Figure 1a). However, all but plantarflexion error was associated with time ($F = 12.307$, $p<0.02$), and the area and mean velocity were 58.6 % and 22.6 % lower in post than pre in NMES group, respectively, and 95.4 % and 19.3 % lower in post than pre in VOL group, respectively (Figure 1b), suggesting the balance improves with NMES-induced muscle strengthening as well as voluntary contraction training without affecting balance.

References

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