EFFECTS OF NEUROMUSCULAR ELECTRICAL STIMULATION ON STATIC AND DYNAMIC ABDOMINAL STRENGTH AND ENDURANCE IN HEALTHY MALES

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Neuromuscular electrical stimulation (NMES) has reportedly increased quadriceps femoris isometric strength by 20-25% over a 28-35 day period (Currier and Mann, 1983: Balogun et al., 1993). Lower abdominal strength is important for stability of the lumbar spine and pelvis during exercise, and it is postulated that limb musculature efficiency is increased when the lumbar spine and pelvis are stable. Weak lower abdominal muscle may lead to compensatory action by other muscle groups, which may become prone to injury as a result. The aims of this study were to investigate the effects of a NMES program on static and dynamic abdominal strength and endurance. Subjects were 16 male volunteers, 10 were randomised to the stimulation group and 6 served as control. All subjects underwent medical examination pre-randomisation to out-rule abdominal musculature insufficiency. Static isometric strength (MVC in N) and endurance (time to exhaustion at 66% MVC in s) at hip angles of 0 and 10° were assessed using a calibrated 500 kg load cell and strain gauge amplifier and interfaced to a MacLab data recording system on a purpose built test-bed. Dynamic endurance was assessed using the incremental abdominal curl conditioning test, data (in s) were recorded as time to volitional exhaustion. Abdominal skinfold thickness (sum of 4 transverse abdominal sites in mm) were recorded using a Harpenden skinfold callipers, lower abdominal girth (cm) was recorded using a tape measure. Data were collected pre-randomisation (day 0) and at 14, 28 and 42 days post-randomisation. The stimulation group underwent 30 min daily muscle stimulation (intermittent stimulation 15s on-15s off) pulse width 250 (s, frequency 50Hz for 42 days, the control group undertook no specific abdominal training). All post-randomisation static endurance tests at hip angles 0 and 10° were at a force equivalent to 66% of the individual MVC recorded on day 0. Results across time were analysed using ANOVA for repeated measures. Values of $P<0.05$ were considered statistically significant. Post-hoc analysis of significant differences were investigated using the Student-Newman-Keuls multiple comparison test. Day 0 data across groups were compared using the Welch test.

No significant between group differences were observed pre-randomisation. Results across time showed that the stimulation group increased significantly ($P<0.01$-0.001) in terms of both static (0 and 10°) and dynamic endurance, and static isometric strength (0 and 10°) following 28 days NMES. At day 28, mean ± SEM increase in static strength were (131 ± 30 and 107 ± 29 N, in static endurance were 47 ± 15 and 45 ± 14 s at 0 and 10° respectively, increase in dynamic endurance was 42 ± 9 s. For static strength and endurance, no significant increases across time were observed for the control group, except for endurance at 10° ($P<0.01$) at day 28 and 42 compared with pre-randomisation, mean increase were 52 ± 14 and 62 ± 15 s, dynamic endurance showed no significant increase across time. No significant changes were recorded across time for either group for abdominal girth or skinfold thickness. For the muscle stimulation group at day 28, mean increases in isometric strength were equivalent to 28 and 17%, in isometric endurance to 154 and 114% at 0 and 10° respectively, mean increase in dynamic endurance was equivalent to 33%.

The significant increases recorded in the muscle stimulation group support the hypothesis that NMES can cause an increase in the strength and endurance of the abdominal musculature. The percentage increases recorded were of a similar order of magnitude to that reported by Balogun et al. (1993) for the quadriceps femoris. From a longitudinal viewpoint our data suggests that the increases tend to plateau after 28 days.

REFERENCES

Balogun J.A. et al. (1993): Arch Phys Med Rehabil 74, 910-916.

Currier D.P. and Mann R. (1983): Phys Ther 63, 915-921.

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