

The Muscular Benefits of 13 Weeks of Functional Electrical Stimulation Cycling After Spinal Cord Injury

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BACKGROUND: Functional Electrical Stimulation (FES) is a technique that can use electrical currents to activate nerves innervating extremities affected by paralysis. Previous studies have shown that FES can enhance skeletal muscle strength and endurance in people with complete and incomplete spinal cord injury (SCI) [1,2,3]. However, the rate and the extent of improvement in strength and endurance from prolonged FES-assisted exercise have not been well documented.

PURPOSE: Our study focused on the changes in muscular strength, endurance and exercise capacity that can be achieved with extended FES cycling therapy over the course of approximately three months.

METHODS: Eleven (N=11) people with SCI participated in this study. An initial assessment of quadriceps muscle strength and fatiguability was performed on each subject using a dynamometer (BIODEX 3) and an electrical stimulator (GRASS dual-channel stimulator). Subjects' quadriceps muscles were stimulated isometrically 60 times over two minutes while knee extension torque was recorded. Then, subjects entered into a 13-week regimen (40 training sessions) of FES-assisted exercise consisting of approximately three sessions per week of FES cycling (RT-300, Restorative Therapies Ltd). Stimulation was applied to the quadriceps, hamstrings, and gluteal muscles bilaterally. The FES cycle was programmed to modulate stimulation current up to a maximum of 140 mA to maintain 45 rpm of cycling. The exercise capacity of each session was determined as the length of time a test subject could cycle before dropping to 35 rpm multiplied by the pedal resistance. Resistance was increased between sessions whenever a subject was able to successfully cycle for one hour in duration at the current resistance level. The assessment of muscle strength and fatiguability was repeated at the end of the 13-week exercise regimen.

RESULTS: All subjects demonstrated significant increases in quadriceps strength and fatigue resistance. The quadriceps muscle assessments demonstrated a greater ability to produce and sustain knee extension torque after the 13-week FES cycling program. Most subjects experienced a dramatic improvement in their exercise capacity during the initial six weeks, however these improvements appeared to slow after that point (Figure 1). Ten of the eleven subjects showed dramatic improvements in their exercise capacity, as early as two weeks into their rehabilitation.

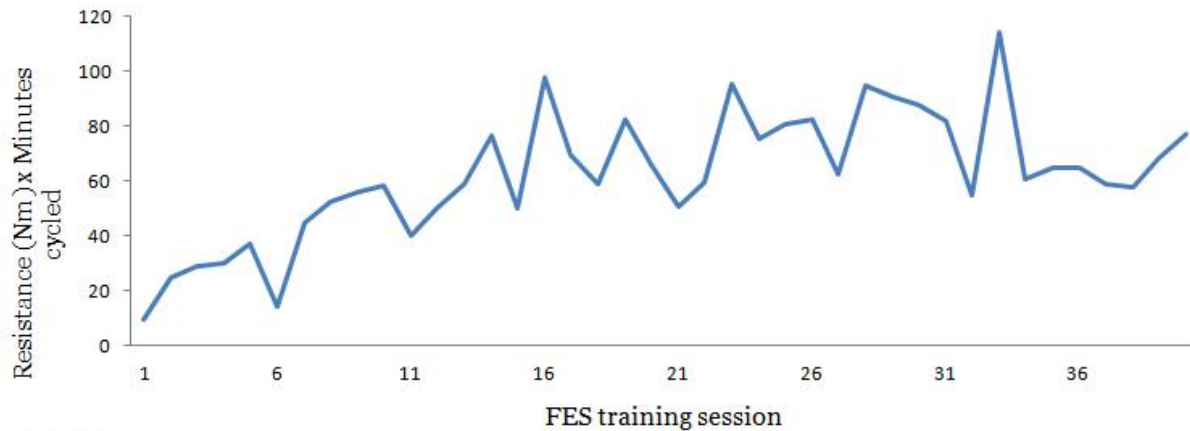


Figure 1

A composite average of all test subjects. Subjects averaged three sessions per week of rehabilitation.

CONCLUSION: The results of this study suggest that prolonged FES-assisted exercise can increase the muscular strength and endurance well beyond the levels shown in previous short duration experiments; with the gains in function favoring muscular endurance over strength. These preliminary results suggest a reexamination of the therapeutic strategy in patients with subacute SCI in favor of prolonged FES-assisted activity. Further studies may be necessary to determine the most effective protocol as well as underlying mechanisms for continuous improvement.

REFERENCES:

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