Ludwig Boltzmann Institute
Electrical Stimulation and Physical Rehabilitation

WILHELMINENSPITAL

MEDIZINISCHE UNIVERSITÄT WIEN

ELECTRICAL STIMULATION OF SEDENTARY SENIORS, COUNTERACT MUSCLE DECLINE

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INTRODUCTION

The decline in function and restriction of adaptability of skeletal muscle is a hallmark of aging in mammals. The characteristic loss in muscle mass, coupled with a decrease in strength and force output, known as sarcopenia, has been associated with a selective reduction in muscle fiber size, shift in fiber composition, modulation in gene expression, and alterations in numerous metabolic and physiological parameters.

It is well documented that exercise training and regular exercise can attenuate the pathological signs of sarcopenia, increasing muscle strength while decreasing fall risk. Moreover, satellite cells activation represents a physiological response to voluntary resistance exercise, preparing the muscle for adaptation and for the generation of new myonuclei to facilitate muscle fiber hypertrophy. Nevertheless, certain pathologic conditions (e.g. osteoarthritis) limit the ability to perform physical exercise and therefore the benefits from it.

An alternative effective intervention to improve muscle recovery is electrical stimulation (ES). The effects of Electrical stimulation on seniors with normal life style were analyzed.

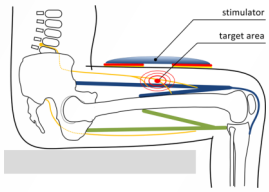
METHODS

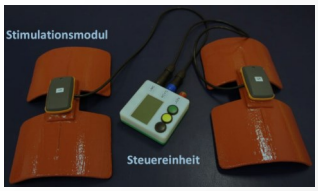
All subjects who participated in the study were healthy and declared not to have any specific physical/disease problems.

Before and after a period of 9 weeks of Training the subjects underwent a measurement assessment. The assessment included functional tests (10m-walking test, Chair Rise test, TUGT and Stair-test) and force measurement of the thigh muscles (M. quadriceps) on a specific Force Chair. Volunteers also did a muscle biopsy of the thigh muscle (M. vastus lateralis).

The subjects were divided into two groups:

- control group: received no special training
- electrical stimulation group: trained with a home based electrical stimulation protocol three times a week.

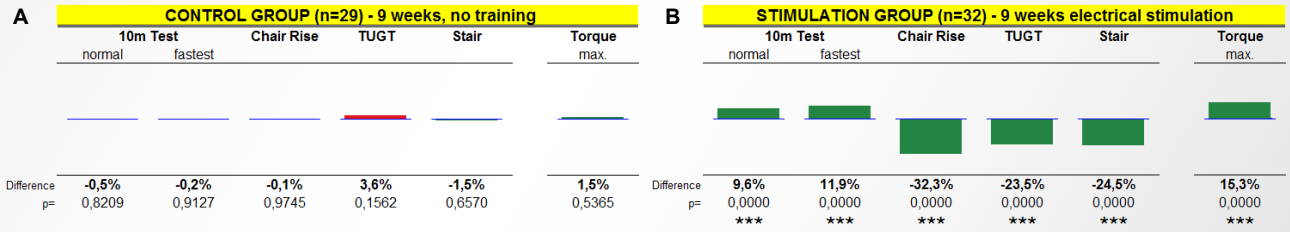




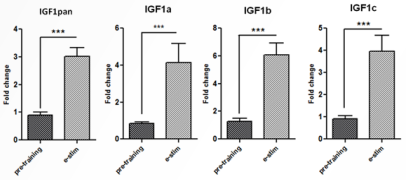
Subjects were exposed to regular neuromuscular ES training (swelling current) for a period of nine weeks, 2-3 times 20 to 30 minutes each session, per week. ES training was performed with a two channel custom-built battery-powered stimulator at home by the subjects themselves after a detailed instructions.
Each repetition was evoked by a 3.5 s train (60 Hz) of electrical pulses (rect., biphasic, 0.6 ms). Consecutive contractions of the same thigh were separated by 4.5 s off intervals.

RESULTS

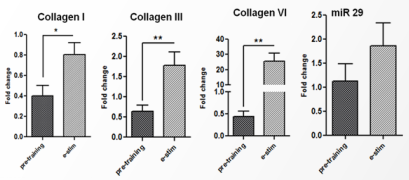
The control group **A** (no training) had, as expected, no changes of their functional performances or maximal voluntary contraction torque of their extensor thigh muscles. The electrical stimulation group **B** was able to perform the functional tests (10m-walking test, chair rise, TUGT and Stair-test) after only 9 weeks of training much faster than before and the maximal voluntary contraction of the extensor thigh muscles increased about 15 %. ***p < 0.001



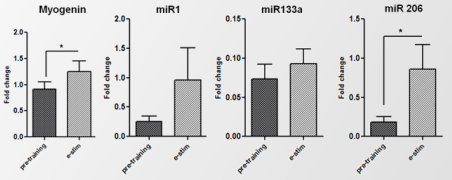
At molecular level, electrical stimulation induces overexpression of IGF-1 isoforms and of relevant biomarkers of satellite cells differentiation, such as miRNA 206 and miRNA 1. Interestingly, we also observed extracellular matrix (ECM) remodeling, which might guarantee shape and mechanical forces of trained skeletal muscle as well as maintenance of satellite cell function.



*Expression analyses of genes controlling muscle mass and metabolism. Real time PCR analysis for the expression of IGF-1 isoforms (total IGF-1pan, IGF-1Ea, IGF1Eb, IGF-1Ec) Data are represented as average ± SEM. n = 13. ***p< 0.0005*



*ES promotes ECM remodeling. Real time PCR analysis for Collagen I, Collagen III, Collagen VI and miR-29 (B). Data are represented as average ± SEM. n = 13. *p< 0.05; **p< 0.005*



*ES promotes satellite cell differentiation. Real time PCR analysis for myogenin, miR1, miR133a and miR-206. Data are represented as average ± SEM. n = 17. *p< 0.05*

CONCLUSION

Altogether, the molecular data support our clinical findings that neuromuscular ES positively influences excitability and recruitment of stimulated muscle fibers resulting in greater force and better coordination guaranteeing, activities of daily living, exercise programs and rehabilitation strategies.

The data provide evidence that Electrical Stimulation is a safe and effective method to counteract muscle decline associated with aging by stimulating seniors only 3 times a week.

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