Physical activity in elderly

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Abstract

Aging is a multifactorial irreversible process associated with significant decline in muscle mass and neuromuscular functions. One of the most efficient methods to counteract age-related changes in muscle mass and function is physical exercise. An alternative effective intervention to improve muscle structure and performance is electrical stimulation. In the present work we present the positive effects of physical activity in elderly and a study where the effects of a 8-week period of functional electrical stimulation and strength training with proprioceptive stimulation in elderly are compared.

Key Words: older age, physical activity, sarcopenia, electrical stimulation, proprioceptive stimulation

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The world population is getting older and the percentage of elderly people is continually increasing. In 2010 the percentage of elderly persons above 65 years was approximately 8% of the global population. The projection for 2050 is approximately 16%, which will present around 1.5 billion people.[1] It is well known, that aging causes gradual changes in the organism, which leads to loss of function, weakness, disease and death.[2] There is also evidence that older people are among the most sedentary and physically inactive segment of societ.[2] Focusing at the aged muscles, we know that there is a loss of muscles mass of 0.5%-1% per year resulting in a decrease of strength[3] and decline of rapid force production, so crucial for preventing falls in elderly.[3]

All these negative changes lead to many problems of performing daily activities. For example, around 42% of elderly Americans have difficulties walking two to three blocks or transferring from the chair.[4] They are reported to have problems regarding their slow gait when crossing the street before the traffic light changes.[5] Another group of consequences are falls. Statistics show that 30% of seniors (over 65 years) fall at least once per year and in the older group (over 80 years and elderly in nursing houses) the number is increased up to 50%.[6-8] The average duration of a hospitalization is between 5 – 20 days with costs over Euros 3000.[9] The prediction for the future is that the number of falls will double by 2030.[10]

Therefore one of the main questions regarding elderly is: can we stop the negative changes in the body? No, we cannot stop it, but we can counteract or slow down the decrease of physical fitness and functional capacity. We know that, together with proper and balanced nutrition, physical activity represents the most effective way to counteract the decline of functional capacity related to aging. [11]

The World Health Organization (WHO) published guidelines on the importance of physical activity in elderly people.[11] According to these guidelines, exercise is an efficient and cost-effective way of preventing the decline of older people’s functional capacity. Physical activity can help in preventing and managing certain chronic diseases and conditions. Strength, balance and flexibility exercises are the most effective strategies to prevent falls among older adults. The positive effects of physical activity are longer independency in self-care activities, higher self-esteem, better quality of life, higher life expectancy, and decreased mortality. Also 42% decrease of risk of falling is another positive effect for older people.

Other guidelines with the description of type and amount of physical activity were published by WHO and other organizations.[12] Today we know that some

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Fig 1. *Computer controlled, linear motor powered leg press dynamometer.*

Fig. 3 *Surface electrical stimulation: the processing unit and electrodes.*

activity is better than none and that it is never too late to start. This means that also elderly will benefit from activity even when they were inactive for the majority of their life. Important findings are that even the minimal recommended physical activity amount provides 30-50% of health benefits.[13] More activity, up to a certain point (300 min/week), is better than shorter activity duration. Recommendations are 150 minutes of moderate-intensity physical activity in a week or 75 minutes, if vigorous-intensity is applied or an equivalent combination.[12]

The WHO recommendations don't divide training sessions during one week. There is no prescription in amount of training sessions but the minimal bout duration is 10 minutes.[12] For additional health benefits 300 minutes of moderate training or 150 minutes of vigorous-intensity or an equivalent are required. WHO recommends resistance exercises 2 or more days per week targeting major muscle groups. Elderly with poor mobility should perform exercises to enhance balance and prevent falls on 3 or more days per week. Also, elderly with health limitations should be as physically active to the point their abilities and conditioning allow.

The American College of Sport Medicine (ACSM) together with the American Heart Association (AHA) published recommendations with some more detailed

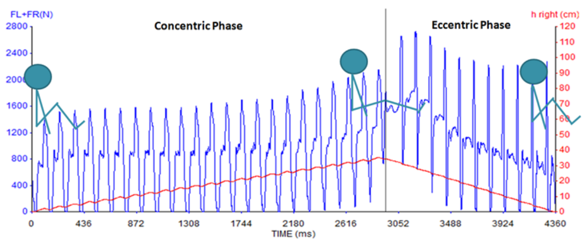

Fig 2 *Force curve during a single repetition of proprioceptive stimulation mode*

descriptions. For aerobic activities 30 minutes 5 times per week of moderate-intensity or 20 minutes 3 x week of vigorous-intensity or an equivalent combination with minimal bout duration of 10 minutes are recommended[14] Strength training should be included twice a week consisting of 8-10 exercises with 10-15 repetitions and 1-2 series. In Austria, the recommendations were published in 2010 by Gesundheit Österreich GmbH.[15]. These guidelines are inspired with both WHO and ACSM/AHA. According Austrian recommendations, 150 minutes of moderate-intensity and per week and 75 minutes of vigorous-intensity or an equivalent combination, 4 times a week with a minimum duration of 10 minutes each training session are recommended. Strength training is recommended twice a week on major muscle groups. Exercises to enhance balance and to prevent fall are recommended. However, there is no precise prescription for balance training within Austrian recommendations.

Clinical study

Beside the published recommendations scientist keep still looking for a more effective way of training in healthy and weak elderly. This was also the main

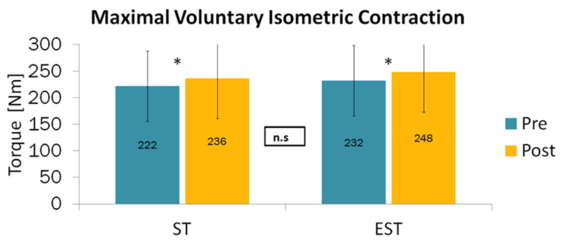

Fig 4 *Change in peak torque during MVC following strength training (ST) and electrical (FES) stimulation. Statistical significance indicated by asterisks (*p<0.05).*

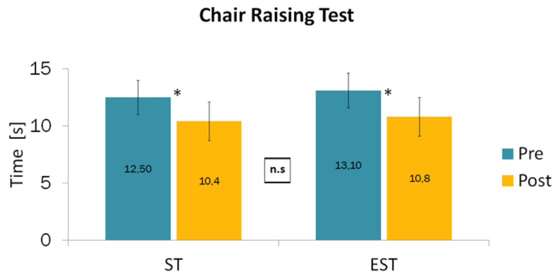

Fig 5. *Change in sit-to-stand time following strength training (ST) and electrical stimulation (FES). Statistical significance indicated by asterisks (*p<0.05)*

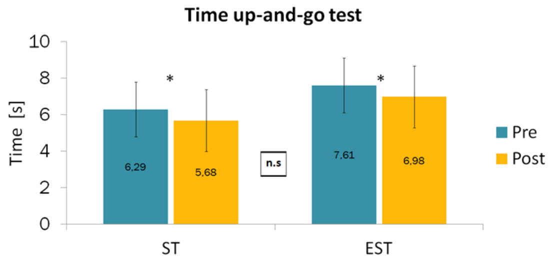

Fig 7. *Time to completion in time up-and-go test* following strength training (ST) and electrical stimulation (FES). Statistical significance indicated by asterisks (*p<0.05).

frequency of the force peaks of 16 Hz and 14 Hz in the concentric and eccentric phase respectively (Figure 2). The training session of the ST consisted of 5 sets with 12 – 14 second contraction time (first two weeks 4 sets of 8 – 10 sec.), performed with a maximal effort.

FES (n= 14, 70.2 ± 3.26 years) underwent transdermal surface electrical stimulation of both knee extensors muscles, using a custom build programmable voltage-controlled stimulator,[16] three times per week (Figure 3) with an additional load placed on ankles (1 to 2.5kg). One training session of the FES consisted of 3 sets of 10 minutes (first two weeks 3 sets of 6 minutes) of stimulation. The intervention period lasted 8 weeks in both groups.

Subjects were tested for lower extremity isometric muscle strength, habitual and maximal walking speed over 10 m and chair-rising test both before and after the intervention.

We observed that post-training maximum voluntary isometric contraction measured on training-non specific force chair increased after both training methods (Figure 4). Similar results were found in functional tests. Both groups improved in sit to stance performance (chair rising test) (Figure 5), maximal gait speed (Figure 6) and time up-and-go test (Figure 7). They both improved with no real significance between

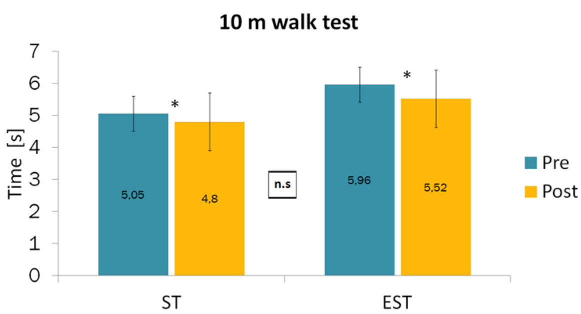

Fig 6. *Time to completion in maximal walking speed test following strength training (ST) and electrical stimulation (FES). Statistical significance indicated by asterisks (*p<0.05).*

the groups. The only difference was in the postural stability test, in which only the leg press group increased significantly.[17]

Conclusions

In conclusion, we found that both strength training with proprioceptive stimulation and functional electrical stimulation similarly improve the maximal strength and motor function in elderly. Strength training seems to be more beneficial for postural control in elderly. Both methods represent an effective and safe way to improve strength and functional capabilities in sedentary elderly people.

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