

Ankle electromyography among the young and the elderly

Roberta Sillis¹, Lucas Barbosa de Souza², Leslie Andrews Portes³, Fabio Marcon Alfieri⁴

ABSTRACT

Aging changes the musculoskeletal function and affects gait and body balance. **Objective:** To compare the electromyographic activity (EMG) of the ankles of physically active older and younger people. **Method:** Forty subjects of both genders considered physically active through the International Physical Activity Questionnaire - IPAQ (short format) participated in this study. Those with some kind of medical condition that could affect balance and muscle contraction did not participate in the study. We evaluated the electromyographic activity (EMG) of the tibialis anterior and triceps surae in bipedal stance (BS) and single-leg (US) with eyes open. To capture the EMG, monopolar Ag/AgCl surface electrodes from KENDALL (MEDITRACTM 200) were used. The Student *t* test was used for comparison between groups. The level of significance adopted was $p < 0.05$. **Results:** Elderly individuals exhibited higher values regarding the frequency of action potentials in 3 of the 4 conditions assessed. **Conclusion:** The older volunteers in this study exhibited a higher firing rate and recruitment of motor units of the ankle muscles to maintain the bipedal and unipedal stance, as compared to the younger.

Keywords: Electromyography, Postural Balance, Aged

¹ Fisioterapeuta, Pós-graduanda em Reabilitação Cardiorrespiratória - InCor-USP.

² Fisioterapeuta, Pós-graduado em Ortopedia e Traumatologia pelo IOT-USP.

³ Educador Físico, Docente do Curso de Mestrado em Promoção da Saúde, Centro Universitário Adventista de São Paulo - UNASP.

⁴ Fisioterapeuta, Coordenador do Curso de Mestrado em Promoção da Saúde, Centro Universitário Adventista de São Paulo - UNASP.

Mailing address:

Centro Universitário Adventista de São Paulo - UNASP

Fabio Marcon Alfieri

Estrada de Itapeperica, 5859

CEP 05858-005

São Paulo - SP

E-mail: fabioalfieri@usp.br

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INTRODUCTION

The aging process results in musculoskeletal alterations characterized by functional impairments in the gait and in maintaining balance, which increases the risk of falling.¹ Muscle weakness and peripheral sensory loss among the aged impair the function of dorsiflexor and plantar flexor muscles² in addition to gradually reducing ankle control in the sagittal plane, making postural control more difficult as they are the primary muscles triggered in a situation of anteroposterior disturbance in an erect posture.^{2,3} Evidence indicates that a physically active style of life interferes positively in the muscular function of the elderly.^{4,5} In addition, there is the question of evaluating postural control by evaluating the musculoskeletal components, since these are also related to balance control and, therefore, to falling.^{2,3}

OBJECTIVE

To compare the electromyographic activity (EMG) in the ankle region of physically-active older and younger subjects.

METHODS

This cross-sectional study was approved by the Committee on Ethics in Research of the Centro Universitário Adventista de São Paulo (Protocol No. 87/2012). Participating in the study were 40 individuals of both genders recruited from the community who signed the terms of free and informed consent. The volunteers were considered physically active according to the International Physical Activity Questionnaire - IPAQ (short form),⁶ which is an international system of measuring the level of physical activity.

Not participating were those with previous surgeries in the lower limbs, those who may be taking medications that could affect their balance or muscle contraction systems, and those who used support to walk. Their height and body weight were measured and the body mass index (BMI) was calculated. The EMG activity was evaluated in the tibialis anterior and triceps surae in the bipedal (BS) and unipedal (US) stance with eyes open.^{7,8} For that, monopolar Ag/AgCl surface electrodes from KENDALL (MEDITRACE™ 200) with diameters of 3cm and a capture area of 1cm were used.

The electrodes were positioned in pairs, with an interelectrode distance of 5cm on the probable motor points, perpendicular to the fibers of the tibialis anterior (TA) and triceps surae (T) muscles.⁸ The electromyographic signals at each position were captured for ten seconds. To reduce any possible interference in transmitting the stimulus, the skin was cleaned over the muscles in question and the subjects held a ground wire in their hands. The four-channel data acquisition model PowerLab 26T was used (ADInstruments) with a sampling rate of 2,000, a high-pass filter of 2kHz, a low-pass filter of 0.5 Hz, and an activated main filter.

The EMG activity was analyzed at the position in which functional stability could be evaluated in the bipedal stance with eyes open (BS). This same evaluation was done on the same muscles, but with the individuals in the unipedal stance (US) in order to check the muscle activity behavior in this position, for in it a better balance performance is necessary from the volunteers. In all positions the volunteer was instructed to remain as static as possible.

The variables analyzed were: EMG BA TA: the firing frequency of the tibialis anterior muscle in bipedal stance; EMG BA T: the firing frequency of the triceps surae muscle in bipedal stance; EMG UA TA: the firing frequency of the tibialis anterior muscle in unipedal stance; and EMG UA T: the firing frequency of the triceps surae muscle in unipedal stance. Data analysis was performed using the GraphPad Prism version 6.0 statistical package for Windows (www.graphpad.com). The results were given as average \pm standard-deviation. The Student's *t*-test was used to compare between groups. The level of significance adopted was $p < 0.05$.

RESULTS

As expected, the average age differed between the groups. However, the proportion of men and women and the BMI were similar, as shown in Table 1. As to the electromyographic activity of the evaluated muscles, the older volunteers showed statistically higher levels in 3 of the 4 conditions suggesting higher firing rates for the same postural stances.

DISCUSSION

Adequate muscle control of the ankle region can result in adequate postural control.^{5,9} In this study, it was observed that in bipedal as well as unipedal stances, even

these older volunteers who were as physically active as the younger group needed greater recruitment of muscle fibers to maintain the same stance, which helps explain why older people have difficulty maintaining postural control and, hence, have more body sway than younger people.^{1,10} Although this study did not evaluate body sway, the finding that young people are able to maintain an orthostatic position with fewer nerve firings and recruitment of fewer motor units than older people reinforces the ideas about the aging process and its marked negative impact on the recruitment rate of motor units in maintaining one's posture.¹¹

Since the aging process is associated with proprioceptive losses and visual, vestibular, and musculoskeletal alterations,^{1,2,3} the use of strengthening and proprioceptive exercises for the ankle region-for purposes of helping the elderly maintain postural control-must exert a positive impact so that older people do not depend so much on the ankle muscles, or that this postural control strategy, which is the first to be used, should remain ready to assist in postural control, whether static or dynamic.

One study¹² comparing younger and older men who were independent and who participated in recreational activities also verified that, in the tibialis anterior and triceps surae muscles, the older subjects showed more electromyographic activity than the younger ones. These authors reported that, for older people to maintain the same displacement of center of pressure as younger ones, greater electromyographic activity was needed in these muscles. Probably in this study¹² as well as the present study, the older people showed these results due to the fact that their muscle fibers were weaker than those of the younger subjects.¹³ Therefore, the differences encountered in the electromyographic activity between the older group of volunteers and the younger may be due to the action of different postural control strategies.¹²

Studies done with sensory exercises and strengthening of ankle musculature have found better muscular adjustments regarding this control strategy as well as in the reduction of body sway in the elderly.^{5,14} One study made that submitted the elderly to a balance training found that, after the intervention, these older subjects showed a reduced muscle coactivation between the tibialis anterior and the soleus muscles while maintaining postural control, demonstrating that older people who do exercises can develop an efficient control strategy of this capacity.¹⁵

Table 1. General characteristics of the groups: older and younger subjects and the electromyographic data from the tibialis anterior and triceps surae muscles

	Idosos	Jovens	P
N	22	18	0.53*
W/M	17/5	27/5	
Age (years)	67.0 ± 5.2	20.6 ± 2.0	< 0.01
BMI (Kg/m ²)	21.9 ± 3.8	19.9 ± 2.4	0.06**
EMG BS TA (Hz)	44.2 ± 19.2	23.8 ± 13	< 0.01**
EMG BS T (Hz)	43.3 ± 10.8	29.2 ± 14.3	< 0.01**
EMG US TA (Hz)	34.0 ± 8.7	26.6 ± 7.7	< 0.01**
EMG US T (Hz)	37.5 ± 10.0	34.2 ± 9.8	0.30**

Values given as averages ± standard deviations. P: Level of significance; * Exact Fisher test; ** T-test; BMI: Body mass index; Kg: Kilograms; m: Meters; M: Men; W: Women; EMG: Electromyography; BS: Bipedal stance; US: Unipedal stance

CONCLUSION

The conclusion is that even physically active seniors show a higher firing rate and recruitment of ankle muscle motor units to maintain bipedal and unipedal stances in comparison to younger people, therefore it is believed that these individuals must develop specific actions in regards to the motor training of this joint.

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