ISB 2013 BRAZIL
XXIV CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS
XV BRAZILIAN CONGRESS OF BIOMECHANICS

KINEMATIC GAIT INDICATORS OF ELDERLY WOMEN IN RESPONSE TO STRENGTH OR POWER TRAINING

[1]João Pedro Pinho, [1]Lucas Sália dos Santos, [1]Rogério de Camargo Santos,
[1]Daniel de Cápua, [1]Bruno Mezêncio, [1]Júlio Cerca Serrão, [1]Alberto Carlos Amadio
[1] Laboratory of Biomechanics, School of Physical Education and Sport, University of São Paulo, Brazil
Email: pinhojp@usp.br

SUMMARY

Some authors suggests that strength and power training are the two most feasible strategies to solve the muscle atrophy and strength loss problems in the elderly population [1,2]. These interventions may allow the elderly population to regain their functional performance, contributing for an enhanced quality of life.

This study corroborated their recommendations by finding meaningful alterations in the kinematic gait parameters of elderly women after 12 weeks of strength and power training.

INTRODUCTION

The inexorable decline in motor skills during aging provides us with an elderly population with various functional limitations. Among these, the ability to walk, being associated with the risk of falling has been studied by several authors.

The adoption of strength and power training as an intervention strategy to reduce the negative effects arising from the physiological or pathological process of aging has been widely discussed in these studies. However, the effects of these interventions on biomechanical gait indicators have not been fully debated yet.

Therefore, this study aimed to compare the effects of these two training protocols on biomechanical gait parameters of elderly women.

METHODS

Three female groups, homogenized by age, body mass index and physical activity level, were formed: the control group (CG: n=8, 69±4 years old), the strength training group (STG: n=6, 67±4 years old) and the power training group (PTG, n=7, 68±4 years old).

No extra activity was induced to CG's routine. Meanwhile, STG and PTG underwent 12 weeks of strength and power training, respectively, with three weekly sessions. Both experimental groups execute the same eight exercises: the squat, the leg extension, the seated leg curl, the vertical calf raise, the resisted ankle dorsiflexion, the pec deck, the lat pulldown and abdominal exercises. While STG performed the exercises with moderate speed (70-90% of 1RM), the PTG executed them in fast speed (40-60% of 1RM). Between sets and exercises the participants rested for 60 seconds and for about 2 minutes, respectively. To avoid peripheral fatigue the exercises of upper and lower extremities were offered in an alternated order, and a 1:2 (instructor/participant) ratio was maintained.

The kinematic gait evaluation was conducted prior and after the intervention period using a digital camera (Casio EX-ZR10) with 120Hz of sampling frequency and 1/1000s shutter speed. Seven reflective markers were placed on anatomical landmarks of interest: right acromion-clavicular joint, the outer surface of the prominence of the right greater trochanter, lateral epicondyle of the right femur, right lateral malleolus, head of the fifth metatarsal of the right foot, right heel and left calcaneus.

The coordinates of these markers were obtained by the Ariel Performance Analysis System (Ariel Dynamics), and the kinematic variables calculated by mathematical routines developed for the Matlab program, version 7.10.0, Mathworks, Inc.

Statistical analysis was performed with SigmaStat for Windows, version 3.5, from Systat Software, Inc. We applied the Komolgorov-Smirnov test to verify the normality of the data distribution and the Levene test to verify the homoscedasticity.

To compare the effects of the interventions we performed an analysis of variance with two factors (group and time) for repeated data in the second factor. Tukey's test, with significance level of 0.05 was used as a multiple comparison test of means and the effect size Hedges g, adjusted to small sample size, was used to verify the magnitude of observed changes [3].

RESULTS AND DISCUSSION

While the CG showed no significant changes after 12 weeks of intervention, the STG and the PTG showed a heel velocity reduction (g=-0.58 and g=-1.18, respectively) and a braking heel reduction (g=-1.27 and g=-1.35) before the initial contact. The PTG also showed an important increase in the toe clearance (g=1.49).

The PTG showed an almost statistical difference between the before and after values of the toe clearance parameter (g=1.49 com IC_{95}=0.31 a 2.68) (Figure 1).

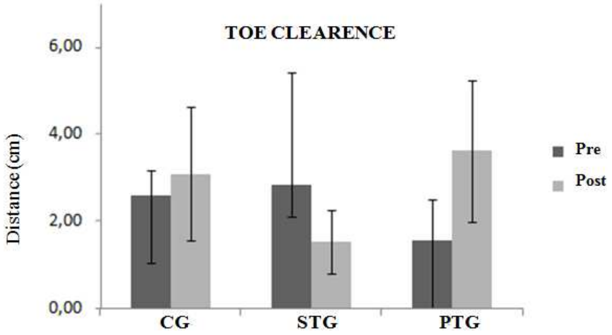

Figure 1: Values of the vertical distance of the forefoot to the ground (cm) in the swing phase, before and after the intervention period in the three groups.

Winter [4] states that this is a falling indicator in which lower values represent a greater chance to stumble. This data suggests that the power training induces an improvement which is consistent with a safer pattern of movement.

We also saw an improvement in the horizontal heel velocity parameter (Figure 2).

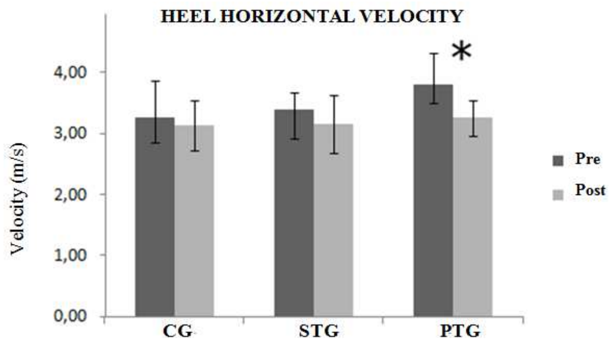

Figure 2: Values of the horizontal heel velocity (m/s) immediately before initial contact, before and after the intervention period in the three groups.

Fast heel speed immediately before initial contact is also a falling indicator in which higher values represent a greater chance to stumble [5]. The significant change (g = -1.18) in this parameter by the PTG suggests a positive change of the power training protocol.

The horizontal velocity of the heel after contact with the ground is determined by the horizontal acceleration of the heel in the terminal swing phase. Therefore, this parameter can be used as an indicator of the risk of falling as well [6]. In Figure 3 we can see an improvement, after the intervention period, of both experimental groups in this parameter:

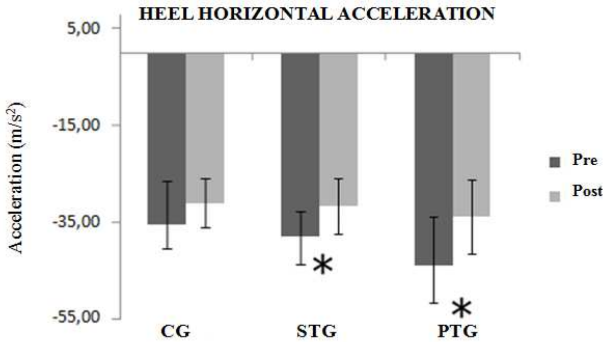

Figure 3: Values of the horizontal hell acceleration peak (m/s^2) immediately before initial contact, before and after the intervention period in the three groups.

We believe that the experimental groups developed strategies to attenuate the horizontal velocity of the heel, rather than assume an abrupt deceleration of the segment.

We speculate that it was a modification towards a safer gait and with a less risk of falling.

CONCLUSIONS

The data showed that the power training group, even having performed with a lesser training volume, was as effective as the strength training group in promoting functional improvements in the gait of elderly women, consistent with a safer pattern of movement. We suggest that both training protocols constitute a viable training option for this population.

REFERENCES

1. Hazell, T. et al. Functional benefit of power training for older adults. *J Aging Phys Activ*, **15**: 349-59, 2007.
2. Cyarto, E.V. et al. Updating the evidence relating to physical activity intervention studies in older people. *J Sci Med Sport* **7**: 30-8, 2004.
3. Hedges L.V. Distribution theory for Glass's estimator of effect size and related estimators. *J Educ Stat* **6**:107-128, 1981.
4. Winter, D.A. *The Biomechanics and Motor Control of Human Gait: Normal, Elderly and Pathological*. **2ª ed.**, Waterloo, Canadian Cataloguing in Publication Data, 1991.
5. Lockhart, T.E. et al. Effects of aging on the biomechanics of slips and falls. *Hum Fact*, **47**: 708-29, 2005.
6. Lockhart, T.E.; Kim, S. Relationship between hamstring activation rate and heel contact velocity: factors influencing age-related slip-induced falls. *Gait Posture*, **24**: 23-34, 2006.