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THE EFFECT OF AEROBIC TRAINING IN STROKE PEOPLE: THE EMG AND BALANCE CHANGE

[1,2,3]Aline Bigongiari, [1,2,3]Patrícia M. Franciulli, [1,3]Juliana V. Francica, [1,2,3]Flavia A. Souza, [1]Alberto C. Amadio, [1,3]Luis Mochizuki
[1]Laboratory of Biomechanics, School of Physical Education and Sport, University of São Paulo, [2]Laboratory of Biomechanics, São Judas Tadeu University, [3]Laboratory of studies in physical activity sciences, School of Art, Sciences and Humanities, University of Sao Paulo, Brazil

SUMMARY
The aim of this study is to examine the effects of aerobic training (treadmill and pool) in postural control and functional abilities in chronic stroke people. The participants were 12 adults with stroke who were able to walk without any external device. The clinical evaluation scales were applied: Berg balance test, sensorimotor assessment Fugl-Meyer test, and the timed up and go test. We analyzed the EMG of 10 muscles of the lower limb during the functional reach and elbow flexion. The aerobic training improved the agility and balance of people with stroke and modified the EMG signal during the postural adjustments.

INTRODUCTION
The stroke provokes several impairments. One of most important is the hemiparetic gait that impairs the mobility and the postural control and it increases the fall risk, promoting a sedentary lifestyle. Conventional rehabilitation care typically provides little or no structured therapeutic exercise. Nevertheless, should the cardiovascular training in chronic stroke people, performed in two different environments, affect the postural control and improve the functional abilities? The aim of this study is to analyze the effects of the gait training, for 30 min long per session performed onto a treadmill or into the pool, to the postural control and to the functional abilities.

METHOD
The participants were 12 adults with chronic stroke (more than one year) with front parietal ischemic lesion (table 1). The clinical evaluation scales were applied: Berg balance test, sensorimotor assessment Fugl-Meyer test, and the timed up and go test. We analyzed the electromyography activity of 10 muscles (right and left side, tibialis anterior, gastrocnemius lateral head, rectus femoris, vastus lateralis, biceps femoris long head) of the lower limb. The sampling frequency was 2 kHz. We attached an accelerometer at the wrist to have the information about the start and end of the movement and we use a footswitch to get the information about the end of the functional reach test. The training protocol was planned after the ergometric evaluation for the cardio respiratory condition screening and to choose the individual exercise load. After 27 training sessions (3 sessions/week), subjects underwent the same clinical and biomechanical analyses again. The participants performed two tasks: a) shoulder flexion – with both upper limbs and with extended elbows, they flexed their shoulder up to horizontal position as fast as they could; and b) functional reaching task – with the non paretic side upper arm standing side by the trunk, the participant should move it as fast as possible to press a button on a table in front of it. The biomechanical data were recorded when they performed those tasks. The biomechanical variables were calculated during three time windows: from 200 ms before the focal movement begging to 50 ms after it, named as the anticipatory postural adjustment (APA), from 50 ms after the movement begging until the end of the focal movement beginning, named as the online postural control (OPA), and from the end of the focal movement until 250 ms after it, named as the compensatory postural adjustment (CPA). The variables were: peak acceleration and velocity, root mean square (RMS), integrated electromyography signal (iEMG), median frequency (FM). The analysis of variance (ANOVA) was applied to all these variables, including the functional tests. The ANOVA's factors were group (treadmill and pool), side (paretic and non paretic sides) and intervention phase (before and after).

RESULTS AND DISCUSSION
There were no baseline differences for the demographic or Fugl-Meyer test, before intervention, between groups. Table 2 shows that the Berg balance test, Motor function in leg and coordination and velocity in leg of the sensorimotor assessment Fugl-Meyer test, and the timed up and go test scores increased after training ($F_{(1,286)}$=4.1 $p<0.05$).
ANOVAs show that all EMG parameters change after intervention. The RMS, iEMG and FM increased for the pool group and decreased for the treadmill group ($F_{(1, 2627)}>5$ $p<0.01$) (figure 1).
The increase in clinical scale's scores shows that aerobic training, pool or treadmill, modifies the motor skills in stroke people. Balance, agility and motor function in leg have improved since the training was able to bring about change peripheral (muscle, joint) and central (neural control) [1,2]. People with stroke have important lost of physical conditioning and muscle weakness, and they are more sensitive to changes after aerobic exercise [1,3]. The changes in biomechanical variables show that the training is effective and that different environments promote different changes in muscle activity.

The training at the pool is performed in such a microgravity situation because the buoyancy and viscosity, and thus alters muscle activity in comparison to the land. The training treadmill was more specific to the task of functional reach and therefore required less EMG activity [1,4,5]. But both groups were successful in accomplishing the task and increase in clinical scores and hence improved after training.

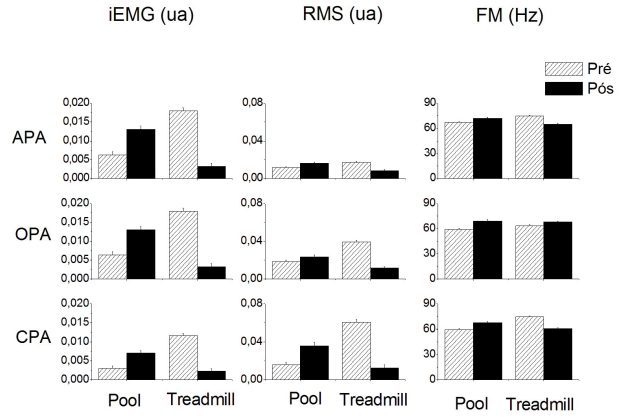

Figure 1: Median and standard error of the root mean square (RMS), integrated electromyographic signal (iEMG) and median frequency during anticipatory (APA), compensatory (CPA) and online postural adjustment (OPA).

CONCLUSIONS

The aerobic training improved the agility, balance and motor function of people with stroke and modified the basic mechanisms postural differently between groups, pool and treadmill, and it changed the postural adjustments.

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Table 1: Demographic and Medical Characteristics of the Study Population

People	Hemiparetic side	Age (years)	Weight (kg)	Height (m)	Gender	Behavior
1	Left	61	75	1.55	Female	Pool
2	Left	46	69	1.58	Female	Pool
3	Right	53	54	1.54	Female	Pool
4	Right	75	74	1.66	Male	Pool
5	Left	60	96	1.67	Female	Pool
6	Left	73	75	1.78	Female	Pool
7	Right	65	72	1.61	Female	Treadmill
8	Right	44	98	1.59	Female	Treadmill
9	Right	53	69	1.60	Male	Treadmill
10	Right	49	60	1.50	Female	Treadmill
11	Left	60	62	1.55	Female	Treadmill
12	Left	58	84	1.67	Female	Treadmill

Table 2: TUG, BERG and Fugl-Meyer scores, before and after intervention, to pool and treadmill groups.

	Pool		Treadmill		Fase	Group	Interaction
Functional evaluation	Pre	Pos	Pre	Pos	p [1]	p [2]	p [3]
	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)			
TUG	26.67 (14.56)	13.03 (7.52)	19 (2.37)	16.67 (1.86)	**0.02**	0.50	0.11
BERG	41.67 (6.38)	49.17 (4.31)	42.33 (4.55)	48 (4.31)	**0.00**	0.80	0.63
Motor function in leg	10.67 (3.76)	17.83 (4.57)	16.67 (5.01)	19.67 (5.09)	**0.03**	0.09	0.36
Coordination and velocity in leg	2.17 (1.33)	3.50 (1.05)	3.67 (1.03)	4.0 (1.26)	**0.05**	0.09	0.31