



## ORIGINAL PAPER

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# Balance evaluation after Russian current on the femoral rectus of healthy individuals

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## ABSTRACT

**Introduction.** A technique used in physiotherapy, but still underinvestigated, is the use of the Russian current as an aid in the improvement of balance.

**Aim.** To verify the influence of the Russian current applied to the rectus femoris on balance in healthy and sedentary individuals.

**Material and methods.** A cross-sectional clinical trial was performed at the Universidade Estadual do Oeste do Paraná – Unioeste, in the city of Cascavel – PR. The sample consisted of 20 healthy female subjects aged between 18 and 25 years, equally divided into two groups where group 1 was placebo and group 2 treatment. Initially, the proprioceptive evaluation was performed by means of a functional test (the Star Excursion Balance Test (SEBT)) and stabilometry using a baropodometer. Russian current was then applied to the femoral rectum of both limbs simultaneously for 2 weeks, 5 days a week.

**Results.** No significant differences were found analyzing the variables, but the elevated effect size points to clinical relevance of Russian Current in functional assessment.

**Conclusion.** The use of the Russian current in the rectus femoris did not present significant alteration on balance.

**Keywords.** knee, physical therapy, proprioception, range of motion

## Introduction

A property that, when diminished, is related to an increased risk of injury is proprioception, defined as a somatic sensation that encompasses the knowledge of

joint movement (kinesthesia) and also of joint position (joint position sense), corpuscles of Paccini and Meissner, muscle spindles, Ruffini terminations, and the Golgi tendon organ are musculoskeletal afferent structures

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responsible for sensation, and physical exercise through muscle contraction can alter their responses.<sup>1-3</sup>

Within the physiotherapeutic field, a form of electrical stimulation gained popularity from reports by the Russian physiologist Yakov Kots, who argued that the medium frequency current at 2500 Hz, modulated at low frequency, increased the recruitment of motor units during muscle contraction, gaining over 40% of what would happen in a voluntary contraction. Because of its relatively high frequency, one of the main advantages is its better tolerability, however, the literature is not clear if it actually produces greater gains than low frequency stimulation.<sup>4,5</sup>

When the muscle contraction is used therapeutically, it is sometimes interesting the phenomenon of reciprocal inhibition, which occurs when the agonist muscle group of a certain movement is activated, the antagonist group undergoes a relaxation, this may aid in the gain of muscular extensibility, altering the agonist-antagonist contraction ratio.<sup>6-8</sup> Furthermore, the use of electrostimulation has shown to be promising in peripheral nerve lesions and also as a factor to improve proprioception in central nervous lesions.<sup>9,10</sup>

Considering that the Russian current is not yet a fully exploited form of electrostimulation, especially with respect to alterations in balance, the objective of this article was to verify if its use on the rectus femoris muscle could generate changes in the balance of healthy and sedentary youngsters.

## Material and methods

This study is characterized as a random clinical trial, transverse, with a quantitative character. The study was carried out at the Centro de Reabilitação Física (CRF) of the Universidade Estadual do Oeste do Paraná – Unioeste. The sample, selected for convenience, by direct invitation, consisted of 20 healthy young women, 18 to 25 years were recruited to evaluate. These were divided equally, by means of an opaque envelope, into two groups: a placebo group (PG) and treatment group (TG).

The inclusion criteria were: not to practice physical activity regularly; have no contraindication to electrostimulation and agree to voluntarily take part in the research. The exclusion criteria were as follows: alcoholism and/or smoking; having fractured lower limbs; low back pain; practice stretching; neurological deficits; have any contraindication to the use of electric currents and lack any collection. The application of the Russian Current occurred for two weeks, 5 days each week. The participants were assessed on the first day before the application of the current (EV1), after one week of intervention (EV2) and at the end of the second week (EV3). After two weeks of follow-up, the participants were re-evaluated (EV4). They were also made aware of the research procedures and signed a Free and Informed

Consent Term, previously approved by the Research Ethics Committee of Unioeste under number 2,162,807.

The proprioceptive evaluation was performed through a functional test, the Star Excursion Balance Test (SEBT) and stabilometry using a baropodometer. The SEBT is a test that evaluates the dynamic postural equilibrium, requiring that the unipodal balance be maintained while performing pre-determined range movements with the contralateral limb.<sup>11</sup> As a guide, adhesive tapes were glued to the ground in 8 directions, each one 120 cm long. The lines were arranged in a star at 45° and were named according to their direction from the inferior support member (intersection of lines): anterolateral (AL); anterior (ANT); anteromedial (AM); medial (MD); postero-medial (PM); posterior (PO); posterolateral (PL) and lateral (LAT).

To perform the test initially the volunteers remained at the point of intersection of the eight lines in bipodal support. They were then instructed to touch lightly with the toe of the contralateral limb (free limb) as far as possible on each of the eight lines (directions), and return to bipodal support, this distance being recorded. It was discarded if the volunteer removed the lower support limb from the center of the figure, or was unable to keep balance during the test. Before the individual performed the test, the examiner performed the explanation and demonstration of the procedure, and it was done bilaterally in three attempts, noting the highest value reached. All participants began with their left foot in the central position of the intersection of the lines.

Static balance was evaluated by the baropodometer through stabilometry that documents the analyzes with images of plantar pressure points in a modular platform constituted by electronic sensors that recognize the information of the support, conserving the natural mobility, and analyzed through the Footwork program®. Quantifying the anteroposterior and lateral oscillations of the body, per cm<sup>2</sup> and load in %. It was performed with the subject in the orthostatic posture on the platform, in bipodal support, the upper limbs in the prolongation of the body.<sup>12,13</sup>

In the interventions, they were submitted to the Russian current for 10 minutes, using the following parameters: a carrier frequency of 2500 Hz, modulated frequency of 50 Hz. Sine wave with synchronized stimulation, rise and fall time equal to 1 second, contraction time (On) of 6 seconds with a timeout of 7 seconds. The intensity of the stimulus was adapted according to the maximum tolerable level, always with visible muscular contraction. The current was applied bilaterally with the participant in dorsal decubitus (DD), with knee extension and without associated voluntary contraction. An electrode was placed in the femoral rectus muscle at 5 cm above the upper edge of the patella and the other electrode was placed on the motor point of the

same muscle of each patient (individually tested prior to the start of electrostimulation, as the point obtained the more vigorous contraction with the same intensity). Positioning was similar for the placebo group, but no flow was achieved.

The data analysis was quantitative and the data were analyzed through descriptive and inferential statistics. Unidirectional ANOVA was utilized and the normality of the data was observed by the Shapiro-Wilk test. Quantitative variables were characterized by mean and standard deviation. In all cases, the accepted level was 5% ( $p < 0.05$ ). The effect size (ES) analysis of Cohen was also carried out in accordance with the following classification:  $<0.2$  trivial;  $0.2-0.5$  small;  $0.5-0.8$  moderate;  $>0.8$  large. ES assessments were always based on EV1 within their own group.

## Results

Twenty volunteers met the study inclusion criteria, two of them being excluded because they did not attend the data collection, and 9 volunteers remained in each group. The mean age of participants was  $21.33 \pm 1.7$  years.

For the SEBT test, there were no significant intra-group differences in row or mean direction as well as in the same direction between groups ( $p > 0.05$ ). However, when checking Cohen's analysis, it was possible to observe that most of the effect sizes were trivial or small for PC, whereas in the treated group there were a predominance of moderate and large effect sizes (table 1).

Data for the analysis of mean pressure (kPa), maximum pressure (kPa), surface (cm), previous distribution (%), posterior distribution (%) and pressure center position (COP in centimeters) acquired by the baropodometry data analysis in each evaluation, also did not present differences ( $p > 0.05$ ) intra or between groups; and overall effect sizes were trivial and small for both groups (table 2).

## Discussion

In the present study, we attempted to test the isolated action of the Russian current on part of the quadriceps (femoral rectus), in a possible production of proprioception changes, both by functional evaluation and by an instrumentalized evaluation method (baropodometry). It was not possible to observe any significant change over time, or in comparison with a control group, but with larger effect sizes for the evaluation of the SEBT for the treated group, indicating clinical effects for the current. The Russian current despite reports of higher gains in muscle strength, has not shown to be advantageous over other forms of electrostimulation for the production of torque, force gain or even pleasantness.<sup>5,14-21</sup>

Evaluation of proprioception, which is part of the body balance, is a complex and difficult activity, since many factors can influence changes in postural stability under normal and pathological conditions.<sup>22</sup> One of the

ways to evaluate is the SEBT instrument, because it is a balance test considered as current tool, easy to handle, non-instrumental and cost-effective.<sup>11</sup> Peres et al. evaluated 11 healthy volleyball athletes through the SEBT, after a four-week proprioceptive training program, observing improvement in six directions on the right ankle and five on the left ankle.<sup>23</sup> Braga et al. proposed a proprioceptive training, with Nintendo Wii or proprioceptive disc, for young and healthy women, evaluated by the SEBT, both of which showed an improvement in the performance of the SEBT.<sup>24</sup>

In relation to the use of the baropodometer in sedentary young adults, it is an instrumentalized way of evaluating pressure distribution of the foot and pressure center, in which several variables can be measured, such as static balance and proprioception.<sup>13</sup> Da Silva et al. used this instrument to evaluate the effect of the low-power infrared laser, applied to the muscles of the posterior leg compartment, not observing proprioceptive changes for the sample.<sup>12</sup> Alfieri, Teodori and Guirro observed that a program of regular physiotherapeutic intervention in the elderly was able to increase the area of plantar distribution and reduction of peak pressure in bipodal support.<sup>25</sup>

According to Hara the improvement of motor function in patients after stroke, is most effective when the electrostimulation is initiated by electromyographic signal than when used spontaneously.<sup>26</sup> Since functional electrical stimulation (FES) induces greater muscle contraction when compared to voluntary contraction. Still, proprioceptive feedback may play a significant role in this FES assisted therapy. Bustamante et al. stimulated FES (50 Hz, 300  $\mu$ s) flexor and wrist extensor muscles, a patient with 11-month sequelae of hemorrhagic stroke for 1 hour daily for 10 days, associating FES assisted workout movements.<sup>10</sup> They evaluated proprioception through the joint position sense test, and report that there was improvement in both angles and time to carry out the task for the electrostimulated wrist. It should be emphasized that when comparing with the present study, there was no activity other than electrostimulation for the quadriceps, and yet, the volunteers were all healthy, and a possible positive effect of electrostimulation on proprioception may depend on a deficit since according to Christensen and Grey the electrical stimulation is used as a therapeutic modality in motor rehabilitation to effect movements that could be difficult to perform by voluntary activation only.<sup>27,28</sup>

Thus, it is observed as a limitation that the population of the present study is composed only by healthy youngsters, which also limits the action of the electrostimulation; another limitation of the present study was the small sample size used, which may have interfered with the presented results of the statistical analysis; and it is therefore suggested that new studies should address with larger sample sizes and populations with some type

**Table 1.** Mean values and standard deviation for the SEBT evaluation of the Placebo group (PG) and Treatment (TG), distance measured in centimeters, according to the different moments of evaluation (EV), below the mean values the effect size values are presented, based on the EV1 of the same group

	PG				TG			
	EV1	EV2	EV3	EV4	EV1	EV2	EV3	EV4
ANT	57.6±5.1	57.2±5.4 0.33	57.5±7.1 0.08	56.0±4.5 -0.02	56.4±6.3	58.8±5.4 0.41	59.6±3.8 0.62	60.9±4.1 0.85
AL	58.5±5.4	58.5±5.3 0	59.4±6.7 0.15	56.4±4.3 -0.43	57.8±4.7	59.7±4.9 0.40	61.4±3.7 0.85	61.1±4.2 0.74
LAT	58.9±4.7	59.0±4.7 0.02	58.4±6.6 -0.09	56.5±3.8 -0.56	57.8±5.5	58.9±5.4 0.20	61.5±4.6 0.73	60.5±4.9 0.52
PL	57.0±6.0	57.0±5.9 0	59.9±6.0 0.48	57.8±3.9 0.16	58.8±4.8	59.3±5.6 0.10	61.4±5.4 0.51	59.9±4.8 0.23
POS	55.0±5.7	55.0±6.0 0	58.3±5.7 0.58	54.5±5.3 -0.09	52.9±4.4	57.0±5.9 0.79	58.0±5.5 1.02	57.4±4.8 0.98
PM	53.0±9.3	53.2±9.3 0.02	57.8±6.5 0.60	53.9±7.1 0.11	48.3±6.4	54.8±5.9 1.06	55.9±5.7 1.25	56.0±4.2 1.42
MED	47.9±6.6	47.9±7.0 0	51.9±5.6 0.65	49.0±4.4 0.20	47.6±6.8	50.9±4.7 0.56	52.2±7.1 0.66	51±4.9 0.57
AM	55.3±5.6	55.3±6.0 0	56.6±6.6 0.21	54.2±4.7 -0.21	54.7±7.0	56.2±5.2 0.24	57.0±5.5 0.37	57.3±4.9 0.43
Mean	55.4±4.9	56.0±4.1 0.13	57.5±5.4 0.41	54.8±3.7 -0.14	54.3±4.5	55.9±4.5 0.36	58.4±4.3 0.93	58.0±3.6 0.91

ANT – anterior; AL – anterolateral; LAT – lateral; PL – posterolateral; PO – posterior; PM – posteromedial; MD – medial; AM – anteromedial

**Table 2.** Mean and standard deviation values for the baroscopic evaluation of the Placebo (PG) and Treatment (TG) groups, according to the different moments of assessment (EV), below the mean values the effect size values are presented, based on the EV1 of the same group

	PG				TG			
	EV1	EV2	EV3	EV4	EV1	EV2	EV3	EV4
AP	31.4±7.2	31.0±4.7 -0.07	30.3±7.1 -0.15	31.4±5.4 0	32.7±6.3	32.8±7.0 0.02	31.8±6.8 -0.14	33.6±6.6 0.14
PMáx	105.9±40.3	107.8±25.6 0.06	118.1±37.8 0.31	117.1±30.6 0.31	107.8±24.1	115.6±28.5 0.26	104.4±21.3 -0.13	113.6±22.4 0.22
Sup	67.2±13.4	72.5±13.7 0.39	72.0±15.5 0.33	78.6±14.7 0.81	59.0±9.0	62.5±8.6 0.40	62.1±11.5 0.41	70.9±11.7 1.14
AD	20.5±9.3	22.5±6.2 0.25	21.2±8.6 0.08	20.8±4.8 0.04	20.9±6.6	19.4±8.2 -0.20	20.9±6.4 0	21.2±4.4 0.05
PD	29.5±7.9	27.5±7.5 -0.26	28.5±10.1 -0.11	29.2±7.2 -0.04	29.1±7.6	30.6±9.4 0.18	29.0±8.3 -0.01	28.8±5.2 -0.05
COP	8.5±2.4	8.9±1.5 0.20	8.9±1.9 0.18	8.7±1.8 0.09	8.6±1.2	8.9±1.9 0.19	8.5±1.7 -0.07	8.4±1.1 -0.17

AP – average pressure (kPa); MaxP – Maximum pressure (kPa); Sup – Superficies (cm<sup>2</sup>); AD – anterior distribution (%); PD – posterior distribution (%); COP – center of pression (cm)

of motor deficiency and the repercussion of the Russian current on samples of these. The results showed that the use of the Russian current in the rectus femoris muscle did not show significant changes in knee proprioception, but clinically presented functional results superior to placebo.

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