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AUSSIE CURRENT IN MUSCLE STRENGTHENING IN WOMEN: A RANDOMIZED AND COMPARATIVE STUDY

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ABSTRACT

Among the several types of strengthening programs, the use of neuromuscular electrical stimulation in order to optimize the muscle gain is highlighted. Therefore, this study aimed at comparing the results obtained with resistance muscle strengthening alone versus the findings of its application when combined with Aussie current. It is a cross-sectional, analytical-descriptive trial, of experimental and comparative nature, controlled and randomized, with quantitative data analysis. The sample was non-probabilistic, composed of 9 women aged between 18 and 40 years old divided into two intervention groups: control group – CG; and strengthening combined with Aussie current group - SAG). Interventions were carried out 3 times a week totaling 12 sessions, where the CG members only performed resistance muscle strengthening and the SAG participants experienced the same exercise accrued by the Aussie current. The comparative analysis between the groups verified that there was a statistically significant difference for the maximal sustained load in 1RM ($p=0.004$), which was respective to 11.25kg of more gain for Aussie group. Hence, the use of Aussie current demonstrates to be an efficient method in potentialization and optimization of muscular strengthening.

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INTRODUCTION

Muscular strength is essential for the individual can do its daily activities. In that way, Physiotherapy has been an ally for the prevention of musculoskeletal disorders and for the recovery of patients who have lost muscular functionalities, as well as the muscular strengthening optimization in athletes. Strength training has conquered space as a rehabilitation procedure for both recovery and strengthening, besides for increasing muscle mass through mechanical and metabolic stimuli (SANTOS *et al.,* 2015). This type of training usually involves joint movement through concentric and eccentric muscle contractions, where by the mechanical stimulus is affected by the amount of resistance (weight) offered likewise the number of repetitions, which varies depending on the exercise program that the person takes part.

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Recent researches recommend that the number of repetitions be limited by the concentric failure (ALVES *et al.,* 2017; NASSER; NETO, 2017). Among the several types of programs for muscle strengthening, neuromuscular electrical stimulation must be highlighted. It consists of the employment of an electric current with therapeutic effect on the muscular tissue through the intact peripheral nervous system, inducing a muscular contraction and, consequently, leading to the strengthening of healthy or injured muscles due to hypertrophy of the tissue, triggered by the metabolic stress generated by contraction (SOUZA, 2014). Electrical stimulation resources are commonly applied to achieve optimized results in muscle strengthening as their usage tends to increase muscle oxidative capacity and the number of micro capillaries, besides to promote muscle fiber transformations (BARBOSA *et al.,* 2014). Another feature of the electrical stimulation is observed in the muscular treatment seeking hypertrophy through trainings of lower load and repetition (PERNANBUCO *et al.,* 2013). According to Costa *et al.* (2014), the combination of electrical stimulation with voluntary contractions generates potential aid in neural control and in the muscle physiological alterations, such as increment in strength, speed, resistance, and in muscle mass volume, since this technique acts by a different way in muscle recruitment and motor optimization. From the available neuromuscular electrical stimulation methods, the Aussie current must be remarked, which, unlike the other alternating currents, is burst-modulated and, therefore, considered more comfortable when compared to other options (DANTAS *et al.,* 2015). Despite the aforementioned techniques are widely utilized in physiotherapeutic treatment, the need for further studies that prove the effectiveness of the outcomes regarding muscular strengthening is argued. Hence, this work aimed at comparing the results obtained with the resistance muscle strengthening aloneversus the findings of its application when combined with the Aussie current, seeking to prove the realadvantage of the Aussie Current practice.

MATERIALS AND METHODS

It is a cross-sectional, analytical-descriptive study, of experimental and comparative nature, controlled and randomized, with quantitative data analysis. This research is a subproject of the study titled "Physiotherapeutic practice in orthopedic and sports dysfunctions". It was carried out in the electrotherapy and kinesiotherapy laboratory of the Physiotherapy course of a private college in the municipality of Vitória da Conquista, Bahia. This city is located in the Southwest Bahia, occupies a territorial area of 3204,257 Km^2, and has an estimated population of 346,069 inhabitants (IBGE, 2016). The sample was non-probabilistic by spontaneous demand, consisted of 9 volunteers who were subdivided into two intervention groups, with 4 participants in the control group (CG) and 5 in the strengthening Aussie group (SAG). Randomization was carried out by Matlab® software from Math Works Inc., by means of the rand function, which generates aleatory numbers, of equal probability between zero and one. Those who received numbers between 0 and 0.5 were allocated to the CG, and the ones who caught numbers between 0.51 and 1 were allocated to the SAG. Only females, who were 18 to 40 years old and who did not use to practice physical activity with the objective of quadriceps muscle strengthening, were included. The reason for this choice was to avoid the results underwent possible influences from the differentiated genetic characteristics that genders can generate on the muscular strengthening. By similar justification, age was limited to 40 years to prevent conflict in data interpretation. As well, the interference bias in treatment efficacy was refrain by allowing the participation only of subjects who did not perform other activities for the purpose of gaining muscle strength in quadriceps. Participants who during the selection period for the research intervention reported the following features were excluded: used of dietary supplementation, continuous-use anti-inflammatories or analgesics, presented cutaneous sensitivity in the quadriceps region, were in utilization of pacemakers, hadelectrical stimulation phobia, deep vein thrombosis, were in the gestational period, had recent musculoskeletal lesions in lower limbs (LL), presented neurological pathologies that lead to alterations in LL, sensorial perception or motor control, severe LL arthropathies that could interfere with the function and range of motion, and finally, LL amputations or severe heart diseases. The study variables were the evaluation of gain in quadriceps muscle strength bilaterally, through the maximal load in one maximal repetition (1MR) test and the vertical jump with countermovement (CMJ). The 1MR test was performed in the squat movement by using barbell with dumbbells supported in shoulder region. The CMJ was executed from the orthostatic position without any type of footwear, and with the right upper body on the wall side and hands on the hips. Initially, the lower limbs were in extension and the individual performed a knee-hip semiflexion (countermovement) up to 90 degrees, following by a vertical jump touching the wall with the right hand fingers, previously in contact with chalk powder. The highest point touched by the participant's fingers on the wall was recorded after 3 attempts, and the distance from this point to the ground was measured with an inelastic tape (MARQUES; GONZALEZ-BADILLO, 2005). Participants from each group were evaluated before the firstand the seventh intervention, and after the twelfth intervention (executed after 24h of the last intervention). The Aussie current was applied with the 10-channel Neurodyn Ibramed®device by the protocol based on the goal of gaining muscle power (AGNE, 2013), using the following parameters: Frequency carrier: 1 KHz; Frequency modulated: 110 Hz; Burst duration: 2 ms; Time on: 3; time off: 9 s; Rise Time: 2 s; Drop Time: 2 s; Stimulation Mode: Synchronous; Treatment Time: 50 minutes. The patient failure limit was respected, interrupting the current according to his request. Three device channels/exits (6 electrodes) were longitudinally displayed by the technique of application on motor points in each of the quadriceps muscles (vastus medialis, vastus lateralis and quadriceps, bilaterally). It is important to note that before the electrodes were employed, the patient's cutaneous sensitivity was evaluated through the Sieve-Weinsten®monofilaments instrument.

In the first contact with the volunteers who accepted to take part in the research and who fit the inclusion and exclusion criteria, the informed consent form (ICF) was presented, being this the first instrument to be presented. After explanation and signing of the ICF, they were submitted to the sociodemographic and health conditions questionnaire. The sociodemographic questionnaire was developed by the researcher with questions related to the participants' identification, requesting name, age, gender, educational level, profession, marital status, physical activity practice, medicines use, pain report, among others. After this initial phase, the groups to which the volunteers were blindly allocated were drawn. From this moment, the members of each group were evaluated in the vertical jumping test with countermovement before the first and the seventh intervention, and after the last intervention (12th). Interventions in all groups occurred 3 times a week for 4 weeks. The CG members performed only the muscular strengthening with squat exercise from 0º of knee flexion to the limit of 90º of flexion and returning to degree 0. The load was offered in barbell with dumbbells in shoulders, according to the 1RM test of each individual (70% of 1 RM was used for the exercise), and the number of repetitions was set conforming to the concentric failure of the individual's muscle. SAG participants performed the squat exercise with the same CG protocol together with the use of the Aussie current according to the aforementioned protocol. It must be noted that in this case, the squatting time in each repetition was set conforming to the established contraction and relaxationtimes in the electrical stimulation device. The data analysis was performed through descriptive statistics with absolute frequency distribution, means, and standard deviation. The normal distribution of the data was tested by the Komogorov-Smirnov test. The inferential statistics used were paired Student t-test to verify the difference between the means before and after treatments in each group. To verify the differences in relation to the techniques used in different groups, the independent Student t-test was performed. The level of significance was 5% (α=0.05). The data were tabulated in the Excel 2013 program and the Statistical Package for Social Sciences for Windows program (SPSS 21.0, 2013, SPSS, Inc, Chicago, IL) was used for statistical analysis. This research obeyed the ethical norms required by Resolution 466/2012 from National Health Council. The central study protocol was submitted to the Human Beings Ethics Committee in Research of the Northeast Independent Faculty, and the data collection was only initiated after approval and authorization by the committee under the report number of 2.418.72. Since the volunteer has agreed in taking part of the research, it was requested to sign the ICF, so that they could make their decision fairly and without embarrassment.

RESULTS

The 9 participants ages ranged from 19 to 29 years, with a mean of 21.77 ± 3.23 years old. The average height was of 1.59 ± 4.97 m, corresponding to a number close to the one obtained by IBGE (2017), in which women Brazilian average height was between 1.60 - 1.61m. The average weight was 57.6 ± 9.69 kg, and was verified that a large proportion of individuals do not practice regular physical activity (77.8%). Concerned to the parameters of muscular strength gain assessment, in the control group an augment of 3.0 cm from the initial vertical jump to the final vertical jump was detected (p=0.000). Related to the70% of 1MR, it was identified that the increase was only of 0.75 kg between the initial and the final (p=0.001). For the Aussie group, there was a boost in both parameters, where the vertical jump showed a difference of 4.8 cm between the initial and final (p=0.000), and concerned to the70% of 1MR there was anaugment of 12 kg (p=0.001). When producing the comparative analysis between the CG and SAG, it was found out that there was a statistically significant difference between the maximal load supported in 1MR (p=0.004), numerically equivalent to 11.25kg of more gain for SAG. Regarding the vertical jump distance, although there was anincrement of 1.8 cm greater in SAG, this difference was not statistically significant (p=0.408).

Table 1. Evaluation of thevertical jump distanceand 70% of 1MR mean differences in the CG. Vitória da Conquista, Bahia, 2018

Variables	N	Mean	Standard Deviation	P
Initial Vertical Jump	4	232.25	6.65	0.000
Intermediate Vertical Jump	4	233.50	6.45	0.000
Final Vertical Jump	4	235.25	7.80	0.000
Initial 1MR	4	26.50	1.91	0.000
Intermediate 1MR	4	25.75	4.34	0.001
Final 1MR	4	27.25	3.59	0.001

Source: Research data.

Table 2. Evaluation of thevertical jump distance and 70% of 1MR mean differences in the SAG. Vitória da Conquista, Bahia, 2018

Variable	N	Mean	Standard Deviation	P
Initial Vertical Jump	5	237.60	13.01	0.000
Intermediate Vertical Jump	5	238.60	9.76	0.000
Final Vertical Jump	5	242.40	10.71	0.000
Initial 1MR	5	31.20	10.05	0.002
Intermediate 1MR	5	35.20	9.85	0.001
Final 1MR	5	43.20	10.61	0.001

Source: Research data

Table 3. Muscle strength evaluation according to the vertical jump distance and 70% of 1MR groups means difference before and after intervention. Vitória da Conquista, Bahia, 2018

Variable	Before-after difference CG	Before-after difference SAG	*p**
70%of 1MR, mean (± SD[2])	0.75kg (3.4)	12kg (1.58)	0.004
Vertical Jump Distance, mean (± SD[2])	3.0 cm (1.82)	4.8cm (4.02)	0.408

[2]Sample Standard Deviation * Paired Student t-test.
Source: Research data

DISCUSSION

These study findings allow to consider that both protocols are effective in terms of the muscle strength gain assessed by vertical jump and the load capacity in 1RM, being of great relevance, in view of this work main objective, the recording of a superior increment in muscle strength gain in SAG (70% of the load in 1MR) compared to the CG. It was also verified that the study population was predominantly composed of university students with low adherence to regular physical activity. When investigating the specific aspects of the muscular strength gain, it was possible to notice that in both groups there was gain in the vertical jump, with an increase of 3.0 cm in the CG and 4.8 cm for the SAG. Despite a higher SAG number, the difference was not statistically significant between the groups. No studies were found in literature that evaluated power gain in vertical jump with Aussie current stimulation in quadriceps for possible comparisons. It must be remarked, however, that in the present study it was possible to observe a gain of 0.75 kg in the maximal load supported in 1RM in the CG and of 12 kg in SAG. This difference numerically represents11.25 kg more gain for the SAG (p=0.004). This finding can be explained by the Agripino and Santana (2017) studies, which state that the Aussie current is able to produce greater extensor torque, higher recruitment of motor units, and lower level of discomfort in healthy subjects. These feature is further substantiated by studies such as of Camargo (2011) where he affirms that, by associating physical activity with neuromuscular electrical stimulation, it is possible to activate from 30% to 40% more motorunits than in the common exercises and conventional treatments, and as well to affect muscular structures. It is also observed in the stimulated muscles, an increase of around 20% for the blood circulation and this event occurs after one minute of the beginning of the electric current application, lasting in average 5 minutes after its end, which provides an even more suitable environment during the metabolic stress caused by the exercise, favoring hypertrophy.

In addition, it must be highlighted that the low level of Aussie current discomfort- which occurs due to the electrical stimulus composed of short duration bursts, offering a small risk for skin irritation- makes the electric current density is reduced, thus allowing the use of higher intensities and, consequently, leading to a greater number of motor units recruited, resulting and greater hypertrophy (CAMARGO, 2011). Montagnana and Gonçalves (2015) also point out that neuromuscular electrical stimulation provides muscle strengthening by a mechanism other than voluntary contraction, since in a voluntary muscular contraction, the smaller motoneurons that innervate the tonic fibers are activated first, being those with larger size the ones responsible for innervating the phasic fibers recruited later. Electric current, on the other hand, stimulates the type IIb large diameter motor nerves to contract before the type I fibers. Then, it is possible to assume that the contraction vigor increases, considering that type IIb fibers are capable of producing more strength. It is possible to emphasize that the Aussie current is indicated by the authors Montagna and Gonçalves (2015) asthe neuromuscular electrical stimulation current that produces the greatest torque during its use, reverberating in a superior capacity to generate muscle strength. Then, itis suggested that a higher metabolic stress is present and, consequently, substantiated hypertrophy. Concerned to the other outcomes, it has to be pointed out that regarding the high percentage of sedentary participants (77.8%), studies such as Barcelos *et al.* (2016) states that the magnitude of hypertrophic response in sedentary individuals is lower than in active individuals, since the sedentary ones have lower protein synthesis at rest and higher muscle catabolism. In addition, Leite and Nonaka (2009) affirm that the sedentary people have smaller capacity of fast recruitment of muscular fibers, what takes to the smaller production of muscular force. With this in mind, it is worth remark, then, that the participants could have had an even greater muscle strength gain if they were individuals with regular physical activity habits. Among the limitations of this research, the size of the sample, which was small due to the withdrawal of participants during treatment, is remarked, which may have exerted a negative influence on the statistical accuracy of the results.

Conclusion

After data statistical analysis, it was verified more effectiveness of the strength training associated with the electrical stimulation for purposes of lower limbs strengthening when compared to the work out without neuromuscular electrical stimulation. Then, it is assumed that the application of the Aussie current proves to be an efficient method in aiding muscle strengthening. Therefore, it is recommended that physiotherapy professionals employ this protocol as a resource for providing optimization of resistance muscle strengthening, and consequent, strength gain. Thus, the athletes and non-athletes' recovery and return to the activities is accelerated through this rehabilitation procedure. In addition, it can be used with the aim of potentiating muscular strength in high-performance athletes.

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