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RESEARCH ARTICLE

KAATSU METHOD ASSOCIATED WITH INSPIRATIONAL MUSCLE TRAINING WITH MINIMUM LOAD VERSUS TRADITIONAL INSPIRATIONAL MUSCLE TRAINING IN HEALTHY NON-TRAINED INDIVIDUALS

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ABSTRACT

The method of training with partial blood flow occlusion has been one of the great research targets of health professionals in recent years for having significant results in high performance athletes. At the same time, Inspiratory Muscle Training (IMT) provides an improvement in the functionality of inspiratory muscles, including the diaphragm, generating morphological changes. The objective of the present study was to evaluate the influence of the KAATSU (KT) method on Inspiratory Muscle Training. This is a randomized clinical trial consisting of 22 untrained, healthy patients divided into two groups (IMTG + KT: 13, IMTG: 9). Both groups performed spirometry before and after the protocol. The groups were submitted to a protocol of 8 sessions, in which the Inspiratory Muscle Training + KAATSU Group (IMTG + KT) was performed with an initial load of 40% of the Maximum Inspiratory Pressure (MIP) associated to the vascular occlusion training in the proximal third of the humerus, inflating to 220mmHg. The IMT Group (IMTG) training was carried out with 70% of Maximum Inspiratory Pressure (MIP). It was observed that both protocols obtained significant results in the spirometric variables of Forced Expiratory volume (FEV 1) and Forced Vital Capacity (FVC) pre and post intervention. However, IMTG + KT was significantly higher when compared to IMTG at all evaluated points.

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INTRODUCTION

Modernization simplifies daily life, however, it minimizes the imposition of body movement. This decrease in physical activity brings with it the presence of stress and sedentarism, notable opponents of a good quality of life. The practice of physical activity can influence the increase in the perception of quality of life independent of age, as well as a way of preventing numerous diseases (FERREIRA; DIETTRICH; PEDRO, 2015). The KAATSU vascular occlusion training

method was created in the 1960s by the Japanese scientist Yoshiaki Sato and since then has been used as a training strategy to gain muscle strength and hypertrophy through vascular occlusion that generates muscle hypoxemia, resulting in positive hemodynamic, hormonal and muscular responses (TANIMOTO *ET AL*., 2005). This training was developed to help athletes and non-athletes using the tourniquet reducing blood flow and increasing intramuscular hypoxia, which leads to an increase in the plasma concentration of the GH hormone and consequently in the increase of respiratory muscle strength and hypertrophy, potentiating the training of these individuals. It is generally believed that increased muscle strength and hypertrophy are directly linked to high intensity exercises composed of an average load of 70% of 1 Maximum Repetition (MR) (SATO, 2005). Strength training is one of the most popular forms of exercise and aims to improve an individual's physical fitness as well as the conditioning of athletes by requiring that the body's muscles promote movement or try to move against the opposition of a force usually exerted by some kind of equipment. This type of training has a wide coverage from plyometric exercises to races on slopes, among other approaches against resistance (MOREIRA 2017). Inspiratory muscle training provides improved inspiratory muscle functionality, including in the diaphragm generating morphological changes. It is a way to perform the maintenance of this muscular group, reducing the signs of dyspnea during the efforts, the muscular fatigue, generating an increase of the ventilatory capacity of the patient (VENTRUSCULO; DONADIO, 2015). Thus, the purpose of this study is to evaluate the influence of the KAATSU method on minimal-load inspiratory muscle training and compare it with traditional inspiratory muscle training in healthy untrained individuals.

MATERIALS AND METHODS

This is a randomized clinical trial consisting of 22 untrained, healthy patients divided into two groups (IMTG + KT: 13, IMTG: 9). The research was carried out in the pneumology laboratory of the Faculdade de Tecnologia e Ciencias-FTC (College of Technology and Sciences), located in the city of Vitória da Conquista, state of Bahia, Brazil. Men and women aged between 18 and 30 years were used as inclusion criteria, since there is a better physical and metabolic resistance compared to individuals younger than 18 years and older than 30 years, since they are healthier individuals. As an exclusion criteria, participants who missed initial and final evaluations of the protocol, as well as individuals with chronic respiratory diseases, pulmonary neoplasia, those who had regular physical activity for more than 3 months, smokers and users of anabolic steroids. After knowing the objectives and the relevance of the research, as well as the knowledge about the data collection and analysis procedures regarding the authorization of the participants that were part of the research, the CONSENT TERM was signed in two ways. This study obeyed the ethical norms required by Resolution No. 466/2012 of the National Health Council, which deals with researchs involving human beings. In the IMT + KAATSU Group (IMTG + KT), the spirometry was performed using the Sibelmed - Datapip Micro-C Spirometer and performed the inspiratory power test with the PowerBREATHE-K5 before the first session and after the last session. The protocol was then started using the WCS Cardiomed Scientific occlusion apparatus, with dimensions of 7x80 cm, which were used in the upper limbs, using 220 mm / Hg, and there could be no loss of the radial pulse. In case of loss, occlusion values would be attributed primarily lower than initially predicted with the return of the pulse. In case of loss, occlusion values would be attributed primarily lower than initially predicted with the return of the pulse.The middle third of the arm was occluded, right and left, then the participant initiated Inspiratory Muscle Training (IMT), using PowerBREATHE-K5 with 40% predicted maximum inspiratory pressure (MIP) foretold, with 3 repetitions of 30 forced inspirations in an interval of 3 minutes between sets.
In the IMT Group (IMTG), spirometry was performed using the Sibelmed-Datapip Micro-C Spirometer and performed the inspiratory power test with the PowerBREATHE-K5 before the first session and after the last session. After that, only the Inspiratory Muscle Training (IMT) was applied without occlusion of the lower and upper limbs, with 70% loading of the predicted Maximum Inspiratory Pressure (MIP), with 3 repetitions of 30 forced inspirations, within a 3 minute interval between the series.

The application of the protocol was done by the researchers and counselors of the research, for a period of 4 weeks, being 2 days a week, totaling 8 service sessions in both groups. The Statistical Package for the Social Sciences SPSS (version 15.0) was used for the statistical analysis. In the descriptive analysis, the mean and standard deviation was performed with numerical variables and categorical variables and there were percentage and absolute values. The Pearson correlation coefficient was used to evaluate the relation between two numerical variables and the Chi-Square method for two categorical dichotomous variables. In the relation between a numerical variable and a dichotomous categorical one, Student's t test was employed in a dependent and independent way.

RESULTS

The sample consisted of 22 individuals, considered healthy, of both sexes, randomly assigned to two groups, IMTG + KT with 13 participants submitted to KAATSU associated with IMT, and IMTG with 9 participants who underwent IMT only. The groups' characterization of the sociodemographic clinical profile and their their homogeneity are described in Table 1.

Table 1. Clinical profile and demographic partner of the sample. Vitoria da Conquista - BA, 2019

Variables	Groups		*p-value*
	IMTG+KT (n = 13)	IMTG (n = 9)	
*Age, *years*	25,1 ± 3,1	23,6 ± 3,0	0,27*
Weight	69,6 ± 13	70,2 ± 15,5	0,92*
Sex, *n (%)*			
Male	5 (45,5%)	6 (54,5%)	0,38**
Female	8 (72,7%)	3 (27,3%)	
Height	172,4 ± 8,5	167,4 ± 9,2	0,21*
Systolic blood pressure	117,7 ± 6,6	116,1 ± 8,6	0,64*
Diastolic blood pressure	72,2 ± 9,7	74,6 ± 6,6	0,49*
Heart rate	75,6 ± 12,0	71,7 ± 5,2	0,31*

*T-Student test. Independent, **Pearson's chi-square test
Source: Research data.

Considering important values for lung function evaluation, oxygen saturation, FEV1 and FVC were evaluated before and after training. The results obtained after the intervention in IMTG + KT are superior to the results of IMTG in the same period, indicating that the application of IMT + KAATSU can make pulmonary function and gas exchange more efficient.

Table 2. Pre-Post Positive Intervention in Pulmonary Function and Gas Exchange

Variable		Average Pre-interv.	Average Post-Interv.	*p**
Oxygen Sat.*(%)*				
	IMTG+KT	95,8 ± 1,4	96,0 ± 1,3	0,36*
	IMTG	90,6 ± 1,9	96,3 ± 1,0	0,38*
FEV¹ *(L)*				
	IMTG+KT	4,0 ± 0,4	4,5 ± 0,4	0,03*
	IMTG	3,6 ± 0,8	3,8 ± 0,8	<0,001*
FVC*(L)*				
	IMTG+KT	4,5 ± 0,5	4,8 ± 0,4	<0,001*
	IMTG	4,2 ± 0,9	4,4 ± 0,9	<0,001*

* Paired Student´s t-teste;
Source: Research data.

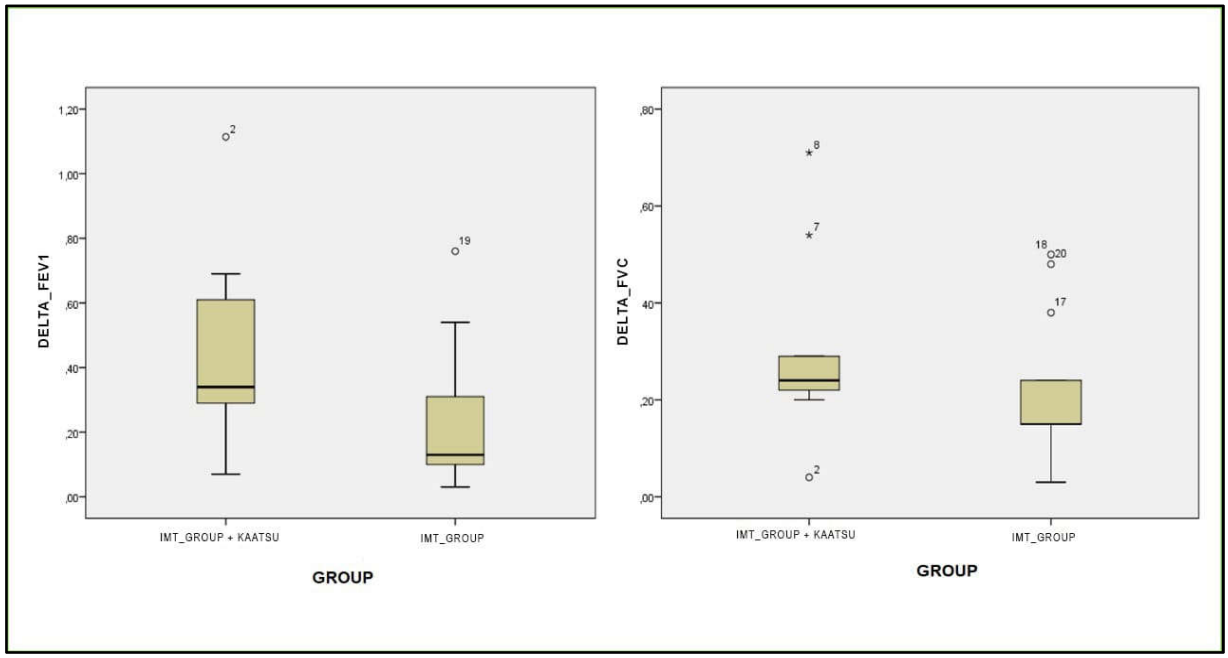

Figure 1. Box plot plot of the relation between pulmonary function gains between protocols.
Source: Research Data

Figure 1 shows the relation between pulmonary function gain measurements between the protocols, elucidating the association between these two techniques, KAATSU and IMT, evaluated in this study, obtained superior results, in comparison to the use of IMT alone, being that the IMTG + KT obtained a 450-ml Forced Expiratory Volume (FEV1) compared to the IMTG which had a FEV1 of 234 ml, and in the Forced Vital Capacity (FVC) the IMTG + KT had a gain of 306 ml, while the IMTG had a gain of 210 ml.

DISCUSSION

Pascotini *et al* (2013) states that inspiratory muscle training is an intervention that has been adopted to improve the strength and resistance to inspiratory muscle fatigue. The acute effects of KAATSU have been the study interest of several professionals, Costa *et al* (2012) points out that increased resistance and gain of muscle mass has a direct link with muscle fatigue and the accumulation of metabolites within it. Similar responses are found when performing vascular occlusion with partial restriction of muscle blood flow during training with low resistance. A combined therapy, combining more than one resource or technique, in which one potentiates the effect of the other, is widely used by physiotherapists in their clinical practice. The association of these two techniques, KAATSU and IMT, evaluated in this study, obtained superior results, in comparison to the use of IMT alone.

Analyzing the subacute effects of the partial vascular occlusion technique, and knowing that the hemodynamic parameters can be altered as a result of the exercise (SILVA *et al*, 2016)it is possible to conclude that by partially blocking local blood flow, systemic responses are triggered causing changes in both the cardiovascular and respiratory systems, improving the individual's pulmonary functional capacity and inspiratory muscle strength, favoring gas exchange and good tissue oxygenation. No studies were found in the literature comparing the two methods in a randomized manner. The current study demonstrates the effectiveness of the association of KAATSU with IMT and it is still possible to suggest that the results may be even more positive in unhealthy individuals with inspiratory muscle weakness since IMT causes even more remarkable effect in patients with greater inspiratory muscle weakness (XU *et al*, 2018) and also in elderly individuals. Costa *et al*. (2012) points out that the reduction of muscular blood flow causes gains similar to high intensity activities, but without overload, which is valid for this population considering that the senescence process causes important physiological losses.

Conclusion

It can be concluded that when applying partial vascular occlusion (KAATSU) in the upper limbs, associated with low-intensity IMT, triggers subacute systemic responses that cause cardiac and respiratory changes capable of improving

pulmonary functional capacity and efficiency in gas exchange, potentiating the action of the IMT, generating results superior to the high-intensity IMT, applied alone, in untrained individuals, considered healthy. We suggest further research on the subject, with a larger number of individuals, experiments that analyze the effects when occlusion is performed in the lower limbs associated with IMT and also studies with other populations, such as patients with respiratory diseases, elderly and athletes who doesn´t present contraindications of the application of the technique, this way it will be possible to explore and extend the applicability of the technique, benefiting as many individuals as possible.

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