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Research paper

Acute effects of physical exercise with microcurrent in the adipose tissue of the abdominal region: A randomized controlled trial

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ABSTRACT

Introduction: Increased abdominal fat and sedentary lifestyles contribute to cardiovascular disease risk. Low-intensity electrical current (microcurrent) on the abdominal region, associated with physical exercise, appears to be an innovative method to increase the lipolytic rate of abdominal adipocytes, in order to reduce abdominal fat. This study aimed to analyze the acute effects of microcurrent associated with an aerobic exercise program in healthy subjects in lipolysis.

Method: A double-blinded, randomized controlled trial was developed and conducted in a higher education school. Eighty-three healthy subjects, aged between 18 and 30 years old and with a 18.5 to 29.9 kg/m^2 body mass index were randomly assigned either to an experimental or to a placebo group. Subjects received a trans-abdominal microcurrent stimulation for 40 min with (experimental group) or without (placebo group) electrical current, followed by a single aerobic exercise session (60 min at 45–55% VO2max intensity). Lipolytic activity (serum glycerol), abdominal fat (waist circumference, abdominal skinfold, ultrasonography), and serum lipid profile (serum triglyceride, total cholesterol, low-density lipoprotein cholesterol and high-density lipoprotein cholesterol) were evaluated in all subjects. Physical activity (International Physical Activity Questionnaire) and dietary intake (food-frequency questionnaire) questionnaires were applied.

Results: After the intervention, lipolytic rate was significantly higher ($p = 0.003$) in the experimental group (mean = 0.15) than in the placebo group (mean = 0.09). Glycerol results showed a statistically significant increase between baseline and after the intervention for both experimental group ($p = 0.001$) and the placebo group ($p = 0.001$).

Conclusion: Combined use of microcurrent and physical aerobic exercise had an acute effect enhancing lipolytic rate comparing to exercise alone, in young healthy subjects.

1. Introduction

Abdominal obesity, namely visceral and deep subcutaneous adipose tissue, are associated with a greater risk for the development of metabolic and cardiovascular complications than in other regions of the body [1–3]. These tissues show higher metabolic (pro-inflammatory, lipogenic, and lipolytic) activity and subsequently higher proportion of saturated fatty acids [4,5]. This enables an increasing in blood triglycerides, which may culminate in dyslipidemia, diabetes, hypertension and, thus, increased cardiovascular disease risk [3,6]. However it has been widely discussed in the literature, that not only individuals with a body mass index (BMI) considered high or excessive can present a dysfunction in adipocyte behavior, but also it can be found in adipocytes in individuals with normal BMI [7].

Among others, age, gender, genetics, hormones and ethnicity are broad etiological factors that contribute to a variation in adipose tissue accumulation and plasma lipids [8,9]. A hypercaloric and fat-rich diet, together with sedentary lifestyle, also play a

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major role in the development of abdominal obesity, thus lifestyle modification programmes regarding nutrition, physical activity and weight control/loss are a major public health concern nowadays, showing promising results [10,11].

Moderate aerobic exercise increases blood flow and enables fatty acid delivery from the adipose tissue to skeletal muscles during muscular activity [12,13]. Catecholamines (adrenaline and noradrenaline) regulate lipolysis during exercise, stimulating and inhibiting lipolysis through beta-adrenergic and alpha-adrenergic pathways respectively, and thus increasing fatty acids and glycerol secretion from the adipose tissue [12,14]. In addition, exercise promotes muscular cytokines secretion, which may induce systemic effects in the adipose tissue through IL-6 mediated lipolysis and fatty acids oxidation, and irisin-induced white adipose tissue to brown adipose tissue turnover [15]. Also, the use of transcutaneous microcurrent together with aerobic exercise appears to have a cumulative effect in the mobilization of the abdominal adipose tissue, providing means to local abdominal fat treatment [16].

A microcurrent is characterized by the application of a low frequency and low intensity current, which stimulates triglycerides hydrolysis, hence releasing free fatty acids and glycerol into the blood circulation [17]. Fatty acids become then available for oxidation and energy expenditure during physical exercise [18–21]. On the other hand, venous glycerol can indicate lipolytic activity in adipose tissue, because is not reutilized for the resynthesis of new triglycerides due to unavailability of glycerol kinase in adipose tissue [7,14].

The present study aims to assess the effect of a single application of abdominal microcurrent, in addition to a single session of aerobic exercise, in acute lipolytic activity, as evaluated by the serum glycerol levels variation in clinically healthy individuals. It was aimed, also, to evaluate if the gender and the amount of adipose tissue are related to the effects of microcurrent on the lipolytic activity.

2. Methods

2.1. Study design, randomization, and implementation

This study was a double-blinded, randomized controlled trial (RCT) and performed between January 2013 and March 2014.

The study was approved by the Ethics Board (nr. 0325/2013 and nr. 04131/2013) and Direction (n° 000276) at the central coordinating and participating institution. The trial was registered at the US National Institutes of Health (ClinicalTrials.gov) #NCT02110927. All participants provided informed consent in compliance with the principles of the Declaration of Helsinki.

Following eligibility screening by the research coordinator, eligible subjects were randomly allocated by sex into the placebo and experimental groups. The randomization schedule was stratified in mutable blocks of 4, through a unique random number designation (Microsoft Office Excel). Apart from the researcher responsible for the electrolipolysis protocol, all other researchers and participants were blinded to the intervention allocation.

Participants

The study was developed and conducted in a higher education school. All students (n = 1966) were invited to participate by electronic email and answer a sample characterization and selection questionnaire. We assessed 196 participants who volunteered responding to an email, aged between 18 and 30 years old and with a 18.5 to 29.9 kg/m^2 BMI. Students were excluded according to the following exclusion criteria: pregnant, pregnant in the previous year or planning to get pregnant soon; clinical history of cancer; metabolic, renal or digestive dysfunctions; abdominal surgery; contraindications to microcurrent application, such as abdominal, dermatologic or tactile sensibility dysfunctions; pacemakers; intrauterine contraceptive device; osteosynthesis material in the abdominal region; conditions limiting aerobic exercise such as cardiovascular, respiratory or orthopaedic diseases; involvement in other fat reduction procedures/programmes; and hypocaloric diets. A total of 101 volunteers were excluded and the 95 subjects eligible to participate in the study were randomly assigned to the experimental group (EG) (n = 47) or to the placebo group (PG) (n = 48) (Figure I). Excel softwear was used to randomize participants into the groups. Five subjects in the EG and seven subjects were lost in the PG (Fig. 1). Thus, at the end of the study, the EG data was available for 42 subjects (16 males; 26 females) and for PG, 41 subjects (15 males; 26 females)

2.2. Measurements

2.2.1. Anthropometrics

Height was assessed by a standard, wall mounted stadiometer, before intervention. Body mass and fat mass percentage were measured by bio-impedance using a Tanita Inner Scan BC-522 (Tanita, Tokyo, Japan), with the subjects wearing light clothing without shoes [22]. For the bio-impedance evaluation, the volunteers were instructed not to drink alcohol nor to perform vigorous physical exercise before 24 h, as well as to avoid heavy meals and to empty the bladder before the measurement.

The BMI was calculated according to the World Health Organization guidelines [23].

2.3. Abdominal fat

Waist circumference was measured at the midpoint between the lowest rib and the iliac crest.

Abdominal skinfold and suprailiac skinfold were measured using an analogic Caliper Harpenden (Baty International, West Sussex, United Kingdom) [24].

Ultrasonography was performed using a ViamoTM[7] ultrasound system (Toshiba Medical Systems, Tustin, California) to measure subcutaneous and visceral abdominal fat below the xiphoid apophysis, and navel fat below the navel [16].

All the measurements were evaluated before intervention.

2.4. Physical activity

Subjects' physical activity levels were assessed, on the day of the intervention protocol, through the abridged form of the International Physical Activity Questionnaire (IPAQ) application, previously validated, which records the duration of physical activity reported as metabolic equivalent task (MET) minutes/week, and categorizes the physical activity undertaken in the previous 7 days on three levels (low, moderate, and high) [25,26].

2.5. Dietary intake

Semi-quantitative Food Frequency Questionnaire, referring to 12 months prior to the study, was used to monitor dietary intake. All subjects answered to the questionnaire on the day of the intervention protocol. The Food Processor Plus ® (ESHA Research, Salem, Oregon) was used to convert food into nutrient (consumption of caffeine, sugar, calcium, magnesium, alcohol, protein, carbohydrates, total fiber, sodium, total fat, saturated fat, monounsaturated fat, cholesterol, *n*-3 and *n*-6 fatty acids, and total energy intake) [27].

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