

Short Communication

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The effect of electro-acupuncture on pro-oxidant antioxidant balance values in overweight and obese subjects: a randomized controlled trial study

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Abstract:

Objective: To undertake a randomized controlled trial in 196 obese subjects to examine the effect of electro-acupuncture on serum pro-oxidant antioxidant balance (PAB) values.

Methods: Subjects received authentic acupuncture (cases) or sham acupuncture (controls) for 6 weeks in combination with a low-calorie diet. In the following 6 weeks, they received the low-calorie diet alone. Serum PAB was measured at baseline, and 6 and 12 weeks later.

Results: We found that serum PAB values decreased significantly in the group receiving the authentic acupuncture compared to the sham treatment ($p < 0.001$) at week 6, and whilst serum PAB increased significantly ($p < 0.05$) in the second phase of the study, a significant difference between two groups remained at 12 weeks ($p < 0.05$).

Conclusions: Electro-acupuncture in combination with a low-calorie diet was more effective at reducing serum PAB values in obese subjects compared to diet alone. Further work is required to determine the mechanism by which electro-acupuncture has this effect.

Keywords: electro-acupuncture, obesity, pro-oxidant antioxidant balance

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Introduction

Obesity is an increasingly prevalent public health problem globally [1], and in Iran it has been reported that the rate of overweight and obesity in men and women aged 15–65 years is 7.8 and 19.7%, respectively [2]. There are several treatment options for obesity including a reduced-calorie diet, increased activity, behaviour modification, pharmacotherapy, surgery and complementary medicine, such as acupuncture [3, 4]. Suppressing appetite is the main consideration for obese patients who desire to maintain a low-calorie diet, and this may be possible using acupuncture treatment [5].

The serum pro-oxidant antioxidant balance (PAB) assay gives an integrated value for pro- and antioxidant capacity. As reported previously, it has been shown that one measure of oxidative stress, serum PAB, is increased in patients with cardiovascular disease (CVD) [6]. Furthermore, it has been shown that serum PAB is

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increased in obese patients and is positively correlated to body weight [7–9]. It would be desirable to be able to control obesity by a safe and effective treatment modality; acupuncture is one of the most popular complementary treatments. Acupuncture is performed by stimulating particular points on the skin called acupoints. Among several methods used for acupoint stimulation [5], needling is one of the most common methods, and stimulation can either be manually or electrically (electro-acupuncture). Acupuncture has been used in the treatment of several conditions including obesity [5] and immune-related diseases, such as allergic disorders, autoimmune diseases, and immunodeficiency syndromes [5].

The pro-oxidant–antioxidant balance may be important in determining CVD risk and may be affected by weight reduction. Therefore, we wished to investigate the effects of a low-calorie diet in combination with acupuncture on serum PAB concentrations.

Materials and methods

Two hundred and twenty overweight and obese subjects were recruited from the Nutrition clinic, Qaem hospital, Mashhad, Iran. These subjects were randomly assigned (using random number tables) into one of the two treatment groups: a case group receiving authentic acupuncture and a control group receiving sham acupuncture. In this study, overweight was defined as a BMI of 25 to <30, and a BMI of ≥ 30 was defined as obesity. They neither had received any other weight control measures nor had any medical and/or drug history within the last 3 months before their participation in the study. Participants were informed about the study both verbally and using written information sheets. Volunteers were given time to discuss the study and were encouraged to ask questions. Those who had diabetes, hypertension, heart disease, endocrine abnormalities, and pregnancy were excluded from the study. Finally, 196 subjects were enrolled into the study after checking for the inclusion and exclusion criteria. Each patient gave informed written consent to participate in the study, which was approved by the Mashhad University of Medical Science Ethics Committee. Blood collection was performed as previously described [10].

Electro-acupuncture treatment in cases

Eight acupuncture points on the abdomen, including Tianshu (ST-25) bilateral, Weidao (GB-28) bilateral, Zhongwan (REN-12), Shuifen (REN-9), Guanyuan (REN-4), Sanyinjiao (SP-6), and additional points including Quchi (LI-11) and Fenlong (ST-40) for excess mood (patients with higher energy) and Qihai (REN-6) and Yinlingqiao (SP-9) for deficiency mood (patients with lower energy) on both lower legs were selected. In the authentic body–acupuncture group, acupuncture needling with manipulation and use the normal electric lines of the electric acupuncture machine (Ying Lee, KWD 808) to 4 needles on the abdomen, two needles (ST-25) and (GB-28) on each side, was applied for 20 min. In this group, the stainless steel acupuncture needles (3.8 cm long) were inserted to a depth of approximately 2.5 cm after skin sterilization. The needles in the lower legs were manipulated by rotating them back and forth until the subjects had the sensation of De-Xi, a term used in acupuncture to describe a feeling of heaviness in the area surrounding the locus of insertion. The needles in the abdomen were applied with electricity. The needles were connected to an electrical stimulator. Electricity was generated as an output of programmed pulse voltage, 30–40 Hz, dense-disperse wave, 390 μ s square pulse, and at a maximal tolerable intensity, 500 μ A (12–23 V) (a strong but not painful sensation to the patient). Each acupuncture treatment lasted for 20 min. All subjects were asked to receive two treatment sessions per week for a total of 6 weeks. After that, all patients in both groups received no acupuncture treatment for the next 6 weeks, but were still given advice to keep going on their diet control. All needling was done by a specialized acupuncturist [11].

PAB assay

A modified serum PAB assay was applied based on a previously described method [12]. The values of serum PAB are expressed in arbitrary Hamidi–Koliakos (HK) units, which represent the percentage of hydrogen peroxide in the standard solution.

Statistical analysis

SPSS software (version 16, Chicago, IL, USA) was used to perform the statistical analysis. Values were expressed as mean \pm SEM or, in the case of non-normally distributed, as median and interquartile range. Data were analysed using Student's *t* test or Mann–Whitney test. For comparison between two related samples, paired *t* test and the Wilcoxon signed ranks test were used. For multiple comparisons of parameters, Bonferroni corrections were used. A two-sided *p* value < 0.05 was considered as statistically significant.

Results

By the end of the study, 35 subjects withdrew for personal reasons and 161 participants completed the study (Figure 1). A comparison between clinical, biochemical characteristics, and PAB values of participants showed that there were no significant differences between the two groups at baseline (Table 1) [10].

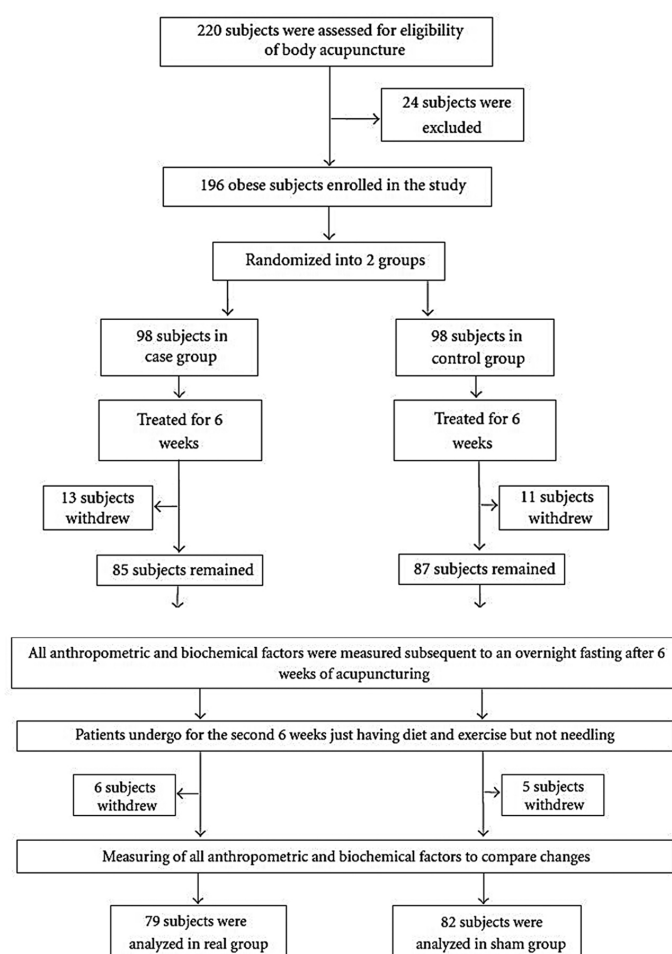


Figure 1: Trial profile and design.

Table 1: Baseline characteristics of participants.

Factors	Case, n=79	Control, n=82
Age, years	38.68 \pm 0.98	37.41 \pm 1.01
Weight, kg	84.10 \pm 1.67	85.02 \pm 1.75
Height, cm	161.08 \pm 0.83	160.79 \pm 0.92
Body fat, %	37.00 \pm 0.69	37.08 \pm 0.79
BMI, kg/m ²	32.30 \pm 0.52	32.74 \pm 0.59
WC, cm	102.39 \pm 1.28	100.74 \pm 1.46
HC, cm	113.76 \pm 1.03	114.98 \pm 1.18
FBG, mg/dl	84.48 \pm 1.46	87.76 \pm 2.58

TC, mg/dl	173.54±4.13	171.96±4.11
TG, mg/dl	112.48±6.24	123.58±5.8
HDL-c, mg/dl	42.60±0.99	41.65±1.06
LDL-c, mg/dl	108.19±3.44	107.46±3.05
SBP, mmHg	107.91±1.92	107.38±1.77
DBP, mmHg	73.33±1.71	75.95±1.67
PAB, HK	90±10.9	88±9.5

BMI: body mass index; WC: waist circumference; HC: hip circumference; FBG: fasting blood glucose; TC: total cholesterol; TG: triglycerides; HDLC: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol, DBP: diastolic blood pressure, SBP: systolic blood pressure. HK, Hamidi-Koliakos.

As can be seen from Figure 2, in the first period, there was a significant reduction in serum PAB ($p < 0.001$) for the case group. However, in the second period of the study, using low-calorie diet alone, we found a significant rise in serum PAB values in the case group ($p < 0.05$), but no significant difference in serum PAB in the control group ($p = 0.12$) in the second period. After 12 weeks of study, we found a significant ($p < 0.001$) reduction of serum PAB values in the case group, and 12-week diet therapy alone showed no significant effect on serum PAB values in the control group ($p = 0.31$).

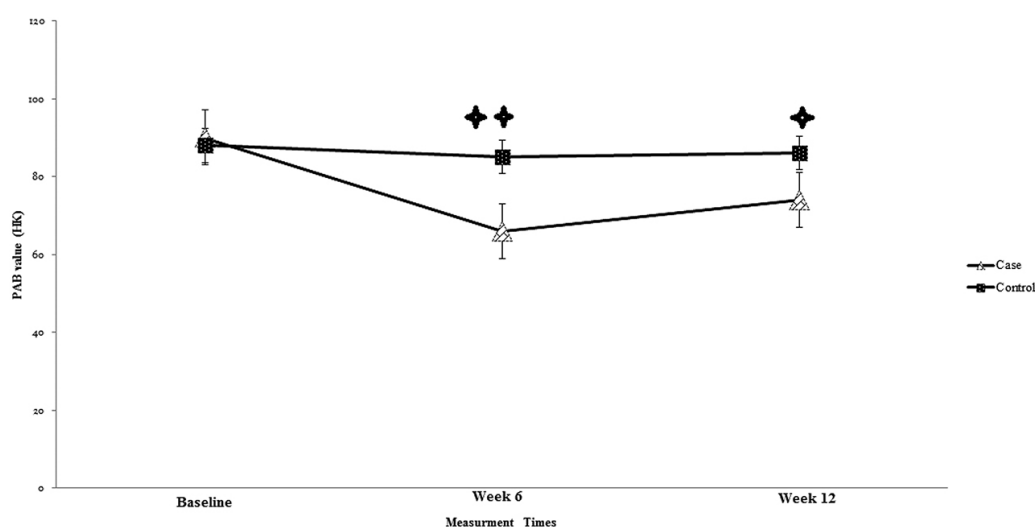


Figure 2: Serum PAB values in different periods of study in the two study groups. Values are presented as mean±SD. **= $p < 0.001$ and * $p < 0.05$.

Discussion

The principal finding of the present study was the significant reduction in serum PAB values in obese subjects following authentic acupuncture plus diet, but not diet alone. These findings are consistent with studies that reported that acupuncture may reduce oxidative stress in animal models [13]. In the study by Phunchago et al., the authors induced oxidative stress in male rats by treatment with alcohol. The results showed that acupuncture at HT7 significantly decreased serum acetylcholinesterase activity and malondialdehyde (MDA) concentrations, but increased the activities of catalase, superoxide dismutase, and glutathione peroxidase in the hippocampus [14]. Moreover, Yu et al. evaluated oxidative stress, as well as the antioxidant enzyme response, and the role of acupuncture stimulation in regulating oxidative stress in the nigrostriatal system in rat. They found that oxidative stress-related parameters apart from catalase, and rotational asymmetry, were reversed by acupuncture stimulation [13]. The authors proposed that the acupuncture signal could travel to the central nervous system via afferent nerve pathways and caused various neurological and physiological changes there [13]. The antioxidant defence system alteration may be one of those changes. They also suggested that acupuncture acted as a neuromodulating input into the central nervous system, yielding the ultimate antioxidant therapeutic effect [13].

Zhang et al. have reported that acupuncture raises the activities of total superoxide dismutase (SOD), CuZn-SOD, and MnSOD; reduced the level of serum MDA and superoxide anion; and regulated the ratio of reduced glutathione (GSH) and oxidized glutathione (GSSG) in the mitochondria of rats [15]. Acupuncture treatment could reduce mitochondrial oxidative stress by increasing SOD activity and regulating the GSH pool, indicating that acupuncture may be effective in maintaining mitochondrial homeostasis and improving endogenous

antioxidant defence. The authors hypothesized that this increase might be due to an improved cerebral blood flow, which could offer adequate substrates (oxygen and glucose). Under hypoxic conditions or ischemia, a reduced complex IV activity augments the production of ROS.

Further studies should include a larger sample size and also a control group with no treatment, no diet, or exercise to determine the effects of acupuncture on overweight and obesity. Furthermore, in order to prove the possible delayed impact of acupuncture, following up participants in such studies after some weeks without any treatment subsequent a period of needling can be helpful. On the other hand, as strength point of our study, we applied a modified PAB assay in this study which is simple, rapid, and cost-effective and can measure the pro-oxidant level and the antioxidant capacity in one assay [12].

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