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Abdominal and auricular acupuncture reduces blood pressure in hypertensive patients

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ABSTRACT

Introduction: Hypertension is an important risk factor of cardiovascular disease (CVD), which is associated with premature death, myocardial infarction, stroke, peripheral vascular disease, and renal disease. The goal of the present study was to use a randomized controlled clinical trial to explore and compare the effectiveness of abdominal and auricular acupuncture on blood pressure in 440 subjects with and without obesity.
Methods: Four hundred participants were recruited and randomized to one of four groups: cases and controls receiving auricular acupuncture (204 subjects) and cases and controls receiving abdominal electroacupuncture (196 subjects). Blood pressure and anthropometric parameters were measured before and after the intervention period. In order to match the initial diet of the groups, participants were required to follow an isocaloric diet for two weeks before the trial, and a low-calorie diet for 6 weeks during the intervention period.
Results: We observed a significant time dependent improvement in the systolic blood pressure measurements in the abdominal intervention group, although this improvement was more pronounce in the first period of study. Of note, in the auricular intervention group, a significant increasing in the level of SBP was detected. Importantly no statistically significant changes were found in the corresponding sham groups.
Conclusions: Our findings demonstrated that abdominal electro-acupuncture for 6 weeks reduced both systolic and diastolic blood pressure and auricular acupuncture had a short-term adverse effect on both SBP and DBP.

1. Introduction

Hypertension is the most prevalent cardiovascular disorder risk factor.[1–3] Hypertension is known to increase susceptibility to several other conditions, including premature death, myocardial infarction, stroke, peripheral vascular disease, and renal disease.[2,3] There is growing body of evidence showing an association between obesity and increased blood pressure.[4] We have previously reported that weight and BMI were significantly higher in patients with increased blood pressure compared to healthy subjects.[5] Hypertension can be managed in several ways such as, lifestyle changes; restricting the intake of salt, meat and poultry, weight loss and exercise, and treatments offered by complementary medicine.[4,5]

Several other interventions have been developed to manage hypertensive patients that include treatment with antihypertensive drugs and acupuncture. Acupuncture is a method for restoring balance of Qi, the life force that circulates throughout the body in energy pathways that are called meridians, by stimulating specific points over the surface of body known as acupuncture points or acupoints.[6] Drug therapies may be associated with unwanted multi organ side effects,[5] and maintaining lifestyle changes is often dif-

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ficult to sustain.[2] Hence complementary medicine interventions, particularly acupuncture, have increased in popularity, in recent years.[5] The effect of acupuncture on blood pressure has been evaluated previously, and has been shown to be effective when used alongside the patients' routine medications, or when used alone.[5] Although there have been several studies conducted to assess the effectiveness of acupuncture on lowering blood pressure, there have been no studies comparing the efficacy of auricular acupuncture and abdominal electroacupuncture interventions on blood pressure in relation to adiposity.[6,7] In the present study we aimed to compare the effectiveness of auricular acupuncture and abdominal electroacupuncture and have assessed the possible relationship between anthropometric parameters and the effectiveness of these interventions.

2. Methods and subjects

2.1. Study design and subjects

Four hundred and forty overweight and obese subjects were recruited from the nutrition clinic of Ghaem hospital, Mashhad, Iran. In this investigation; overweight was defined as a body mass index (BMI) of 25 to <30, and a BMI of ≥30 was defined as obesity. None of the subjects had received any other weight control measures, nor did they have any medical and/or drug history within the last three months prior to participating in the study. Volunteers were informed about the investigation verbally and using written information. Subjects were given time to decide whether to take part in the study, and discuss any questions they had about the investigation. Each participant gave informed written consent to be enrolled in the investigation, which received the approval of Mashhad University of Medical Sciences Ethics Committee. The exclusion criteria were: diabetes, pre-existing heart disease, endocrine disorders and pregnancy. Individuals who did not wish to continue at any point in the study were withdrawn from the study. Four hundred subjects were initially enrolled into the study and were randomized into one of four groups, consisting of 2 groups of cases and controls for auricular acupuncture (each group consisted of 102 subjects) and 2 groups of cases and controls for abdominal electroacupuncture (each group consisted of 98 subjects). Each patient was given a number between 1 and 4, and each number was assigned to one of our study groups. As the setting of authentic and sham interventions were almost the same with only minute differences which would not seem important to the participant, neither participants nor the researchers knew which group received authentic intervention and which group underwent sham intervention. Only the acupuncturist was informed of group allocations to use the appropriate intervention for each participant. The subjects were between 18 and 55 years old and had a BMI between 25 and 45 kg/m2. Blood pressure, anthropometric and biochemical parameters were measured before and after the intervention. In order to match the initial diet of the groups, participants were required to follow an isocaloric diet (wash-out diet) for two weeks before starting the trial. They were then instructed to follow a low-calorie diet for 6 weeks. The low-calorie diet consisted of 1000 kcal deficit per day less than the individual's daily energy expenditure. The resting energy expenditure was calculated using the equation of Harris Benedict.[8] and was used to determine the amount of food to be consumed per day for the participants. The wash-out diet and the 6-week dietary program for each participant was designed by a nutritionist according to the participant's energy expenditure. The diet was assigned and the participants' compliance was monitored on a weekly basis.

Diabetes was defined by a fasting blood glucose of ≥ 126 mg/dL on ≥ 2 occasions or treatment with hypoglycemic medications, and hypertension by blood pressure ≥140/90 mmHg on ≥2 occasions or if patient was being treated with anti-hypertensive drugs.[9]

2.2. Interventions

2.2.1. Abdominal electroacupuncture treatment

Traditional Chinese style electro-acupuncture was used in accordance with the Advanced Textbook of traditional Chinese Medicine and Pharmacology, and the textbook of Acupuncture and Moxibustion Administration Methods.[10,11] In each session, four needles were inserted for each subjects. The acupoints chosen were.[1] tianshu (ST25) on both sides,[2] weidao (GB28) on both sides,[3] zhongwan (RN12),[4] shuifen (RN9),[5] guanyuan (RN4), and[6] sanyinjiao (SP6). Additional acupoints for patients with excess pattern were[1] quchi (LI11) and[2] fenglong (ST40); and for patients with deficiency pattern were[1] qihai (RN6) and[2] yinlingquan (SP9). Phlegm-dampness or phlegm-heat were considered as excess pattern; and spleen/stomach qi deficiency or primary qi deficiency were considered as deficiency pattern. These patterns were determined by their different signs, symptoms, age, diet, digestion, family medical history, emotion, lifestyle, and gastric or splenic or renal hypofunction. As in gastric and splenic hypofunction dampness cannot be transformed, it results in internal phlegm-turbidity. Normal 3.8 cm Chinese-made Huan-Qui needles were inserted 1 cun deep into the tissue, seeking a pain response. During each session, two needles were inserted into tianshu (ST25) and two needles into weidao (GB28) bilaterally. The needles were connected to the acupuncture machine [Ying Lee, KWD 808, China] with one electric wire. The machine was set to generate dense-disperse-wave impulse at a frequency of 30–40 Hz at the maximum tolerable intensity (390 μS square pulse, 500 Ω, 12–23 V), which made painless yet strong sensation for the patient. In case of a diminished sensation during a treatment session, output current would be slightly increased.

In the sham abdominal acupuncture group, needles for the acupoints which were on the RN meridian were inserted 0.3 cun lateral to the authentic acupoints. Other needles were inserted 0.5 cun upwards and 0.5 cun lateral to the authentic acupoints. All needles of the sham group were inserted as superficially as was possible. Electric wires for the sham group were connected to the same machine, however no electricity was being generated by the acupuncture machine in the sham group.

All of the needles for both study groups were kept in their place for about twenty minutes. The procedure was carried out throughout the study by one of the authors, HA; who has a 10-year experience in acupuncturing. Abdominal acupuncture details are demonstrated in Table 1.

2.2.2. Auricular acupuncture treatment

Standardized acupoints were identified based on the theory of Chinese medicine, and treatment procedure was developed according to "Advanced Textbook of traditional Chinese Medicine and Pharmacology" and "The Textbook of Acupuncture and Moxibustion". Six acupoints on the ear were chosen which were Shen Men (TF4), Mouth (CO1), Stomach (CO4), Hunger point, Sanjiao (CO17), Center of Ear (HX1) in the case group ear-pressing plaster with seed 22 was applied routinely on them (Fig. 1). The acupoints were sterilized with 75% alcohol preparation pads, then, the ear-pressing plaster were inserted with seed into the acupoints. The acupuncturist applied the ear-pressing plasters to acupoints on one ear in each visit and they were kept on the ear for three days. We requested all participants to put pressure on the auricular points for about 20 s 30 min before eating. They had 2 sessions weekly for 6 weeks in total, and seed plasters were changed once every 3–4 days. Acupuncture was carried out on the ear points on one ear in

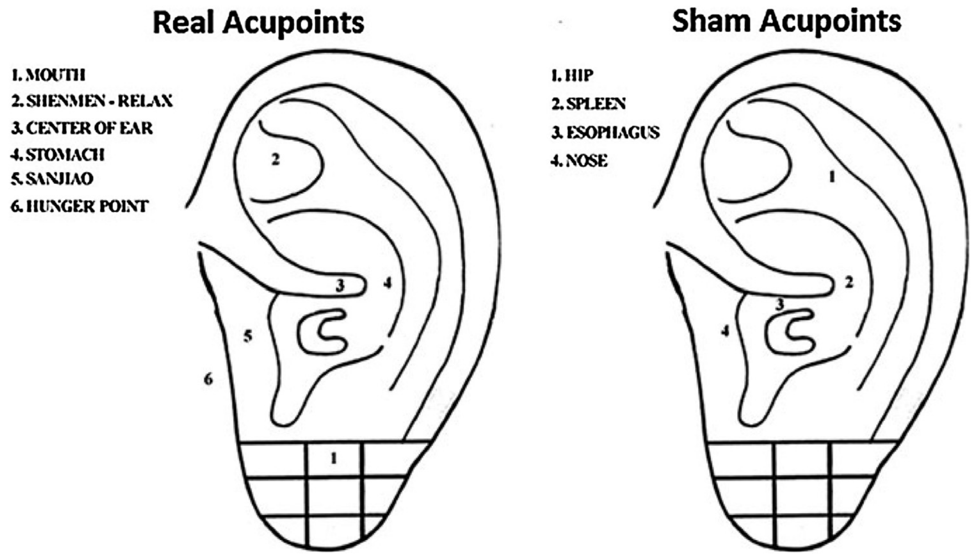

Fig. 1. Real and sham acupoints which were used in the auricular intervention group.

Table 1
Details of abdominal electroacupuncture intervention.

Abdominal acupuncture details	
Style of acupuncture	Traditional Chinese
Number of needle insertions per subject per session	6
Acupoints	*Tianshu* (ST25) on both sides, *Weidao* (GB28) on both sides, *Zhongwan* (RN12), *Shuifen* (RN9), *Guanyuan* (RN4), and *Sanyinjiao* (SP6)
Depth of insertion	1 cun for authentic acupuncture
Response sought	pain
Needle stimulation	Electroacupuncture
Needle retention time	20 min
Needle type	Needle 0.25*25 mm(1.5 cun) Huan –Qiu (Chinese Made)
Number of treatment sessions	12
Frequency and duration of treatment sessions	6 weeks twice weekly
Other components of the treatment	Low calorie diet
Sham intervention details	The same acupoints were selected and needles were inserted: – as superficial as possible – 0.3 cun lateral for acupoints on RN meridian – 0.5 cun lateral and 0.5 cun upwards other acupoints

one visit and the opposite ear in the following visit. This trend was used until the end of the study.

In the control (sham) group of auricular acupuncture, participants received their treatment using placebo needles, the ear-pressing plasters without seed. We used spleen (CO13), hip (AH5), nose and esophagus (CO2) in sham group (Fig. 1). The procedure of treatment was the same as the one applied for the case group. The sham points that were used were not related to hypertension, and the plasters on the ears were without seed and did not have any electrical stimulation.

2.3. Statistical analysis

The SPSS software version 16 (Statistical Package for Social Sciences, IBM, Chicago, Illinois, USA) was used for statistical analysis with descriptive statistics (mean, median, interquartile range, and standard deviation) being determined for each variable. The data were checked for normality with the Kolmogorov-Smirnov test and applied paired t tests in order to compare pairs of associated samples and independent t tests in order to compare pairs of independent samples. A Bonferroni's correction was used to adjust for multiple comparisons. In all cases, $P \leq 0.05$ was considered to be significant. The sample size was calculated based on a former study conducted in this field. The required sample size was estimated to be 55 patients in each study group at a power of 80% and a confidence interval of 95%. Approximately 100 patients were initially recruited to each group to allow for drop out and possibly do analysis in subgroups (male, female) which in this analysis no significant results have been obtained. As acupuncture is still not very popular and common among Mashhad citizens, we believed that a larger safety margin was needed to allow for possible drop outs in the course of this rather long-term study.

2.4. Outcome measures

2.4.1. Blood pressure measurements

We used blood pressure measurements of the right arm in our analysis. Normally, the difference between blood pressure measurements of left and right arm could be up to 10 mmHg.[12] Thus we used blood pressure readings of the right arm in our analysis in order to compare and analyze a consistent set of data throughout the study. At each visit, blood pressure was measured twice, about five minutes after the patients arrived, and about 15–20 min after the first reading. Mean blood pressure of each visit is reported in this article. Blood pressure was measured using a standard mercury sphygmomanometer, and was measured by the same person across the study.

2.4.2. Anthropometric measurements

The anthropometric parameters which were measured for all subjects were height and waist circumference, body weight (BW) and BMI; according to a standard protocol. The research team used a Tanita BC-418 body composition analyzer (Tanita, Tokyo, Japan) to measure the body weight (BW), and BMI. The variables were recorded at the beginning of the investigation, as well as at the end of the treatment. The measurements were done between 7:00 to 9:00 A.M. after an overnight fasting since evening of the last day.

Table 2
Comparison of demographic factors and blood pressure values among patients of the study groups.

Abdominal	Case group			Control group		
Variable	1 st measurements	2nd measurements	3rd measurements	1 st measurements	2nd measurements	3rd measurements
BW (kg)	83.38 ± 18.19	81.23 ± 16.21α	81.27 ± 17.27α,β	85.02 ± 16.93	82.81 ± 17.01α	84.94 ± 17.03α
BMI (kg/m$^{2)}$	32.30 ± 5.12	31.17 ± 5.15α	30.98 ± 5.32α,β	32.74 ± 5.67	31.87 ± 5.72α	31.74 ± 5.93α
WC (cm)	102.39 ± 12.62	95.12 ± 11.82α	92.91 ± 12.53α,β	100.74 ± 12.98	96.66 ± 12.15α	97.16 ± 10.49α
HC (cm)	113.76 ± 10.15	106.59 ± 9.16α	105.84 ± 10.39α,β	114.99 ± 11.28	111.11 ± 11.04α	110.41 ± 11.91α
WC/HC ratio	0.90 ± 0.10	0.89 ± 0.09α	0.88 ± 0.09α	0.87 ± 0.08	0.87 ± 0.07	0.88 ± 0.07
SBP (mmHg)	122.9 ± 25.8	113.1 ± 21.1α	112.9 ± 20.2α,β	116.8 ± 23.1	113.3 ± 20.0	116.8 ± 21.3
DBP (mmHg)	68.1 ± 11.2	68.1 ± 11.3α	64.7 ± 10.7α,β	71.3 ± 12.0	72.0 ± 10.6	72.9 ± 23.5
LDL (mg/dl)	108.19 ± 33.18	91.34 ± 34.01	74.51 ± 29.06α,β	107.46 ± 28.63	99.93 ± 26.99	93.27 ± 24.81α,β
HDL (mg/dl)	42.60 ± 9.60	38.51 ± 8.62α	54.33 ± 23.93α,β	41.65 ± 10.06	38.16 ± 8.82α	53.05 ± 23.93α,β
FBG (mg/dl)	84.48 ± 14.14	87.46 ± 12.98	87.28 ± 25.48	87.76 ± 24.41	89.64 ± 31.76	90.03 ± 26.77
TG (mg/dl)	98.00 (74.25–130.25)	85.50 (60.00–112.00)	82.00 (55.00–111.00)	112.00 (75.50–160.50)	110.00 (81.00–156.50)	95.50 (72.25–144.00)
Auricular						
BW (kg)	84.33 ± 16.97	81.35 ± 16.79α	81.25 ± 17.50α	81.53 ± 17.95	77.98 ± 12.11α	77.87 ± 12.94α
BMI (kg/m^2)	32.15 ± 4.89	30.85 ± 4.52α	30.90 ± 5.15α	31.40 ± 4.09	31.04 ± 4.47α	30.70 ± 4.66α,β
WC (cm)	102.75 ± 13.46	98.04 ± 11.86α	99.96 ± 13.83α,β	101.27 ± 10.94	98.17 ± 11.69α	103.51 ± 10.59β
HC (cm)	115.13 ± 9.31	110.87 ± 9.89α	111.56 ± 11.08α,β	112.65 ± 8.79	112.14 ± 9.39α	113.70 ± 9.33β
WC/HC ratio	0.89 ± 0.07	0.88 ± 0.09α	0.89 ± 0.08α,β	0.89 ± 0.07	0.87 ± 0.08α	0.91 ± 0.06
SBP (mmHg)	109.6 ± 21.9	115.2 ± 19.7α	111.3 ± 22.8	112.5 ± 19.4	115.7 ± 21.6	115.7 ± 21.9
DBP (mmHg)	74.4 ± 12.2	81.7 ± 9.0α	78.2 ± 11.7α	74.7 ± 10.7	75.5 ± 11.2	74.4 ± 10.5
LDL (mg/dl)	92.31 ± 26.47	97.14 ± 29.44	89.53 ± 54.75	97.58 ± 28.57	97.13 ± 24.95	105.42 ± 40.08
HDL (mg/dl)	37.61 ± 8.51	39.34 ± 13.02	58.11 ± 46.85α,β	38.55 ± 8.03	40.92 ± 9.80α	52.78 ± 23.94α,β
FBG (mg/dl)	83.63 ± 17.66	80.70 ± 11.76	87.11 ± 16.69α,β	90.08 ± 26.53	80.00 ± 11.38α	87.52 ± 11.72β
TG (mg/dl)	106.00 (78.50–136.50)	86.00 (68.00–120.00)	92.00 (64.50–132.50)	109.00 (72.25–143.75)	83.00 (64.50–129.50)	94.50 (68.75–122.25)

BW: Body weight; BMI: Body mass index; WC: waist circumference; HC: Hip circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; LDL: low-density lipoprotein cholesterol; HDL: high density lipoprotein cholesterol; FBG: Fasting blood glucose; TG: tryglyceride. Values are expressed as mean ± SD, or median and interquartile range. α means significant changes in comparison with first measurements and β means significant changes in comparison with second measurements.

3. Results

3.1. Demographic data

Of the 400 subjects who were originally recruited, 330 completed the study. For the 70 subjects who withdrew from the study, the most common reasons for withdrawal were the long period of the study, and an unwillingness to undertake all the required laboratory tests. The majority of patients were normotensive, and a few of them had a blood pressure a little above 140 mmHg and were unaware of their hypertension. None of the patients were using any anti-hypertensive drugs. Patients were recruited regardless of their occupation. Participants were divided into two study groups for studying the effects of auricular acupuncture and abdominal electroacupuncture, each study group had two subgroups: authentic intervention and sham intervention. All of the groupings were randomized using random number tables.[11] The auricular acupuncture group initially consisted of 204 subjects; 102 each receiving authentic acupuncture or control treatment. At the end of the study, a total of 35 subjects withdrew from the auricular acupuncture groups (16 from the authentic acupuncture group and 19 from the control group). The abdominal electroacupuncture group initially consisted of 196 subjects, who were divided to two groups of 98 subjects for cases and control groups. At the end of the study, a total of 35 subjects withdrew from the abdominal group (19 from the authentic acupuncture group and 16 from the control group). The subjects in the authentic acupuncture and control groups for both the auricular or abdominal methods were had a similar gender ratio, age, anthropometric measures, and lipid profile levels ($P > 0.05$). However, the baseline blood pressure measurements were significantly lower in the auricular acupuncture group compared to abdominal electroacupuncture groups ($P < 0.05$). Baseline characteristics of our abdominal intervention and auricular intervention populations are described in Table 2.

3.2. Systolic blood pressure

3.2.1. Abdominal groups

In our abdominal intervention group, we observed a significant time dependent improvement in the systolic blood pressure measurements over the period of our study. However, the improvement during the first period of the study was almost twice as great as the improvement in the second period of study (5.89 ± 8.15 mmHg compared with 3.01 ± 6.74 mmHg) (Table 3). No statistically significant changes were observed in the corresponding sham group ($P = 0.65$). Blood pressure significantly improved in case group compared with sham group ($P < 0.001$).

We found that changes in SBP was positively correlated only with fasting blood glucose in our sham intervention group ($P = 0.05$, $r = 0.35$). No other significant correlations were found between changes of SBP and anthropometric and biochemical factors in our abdominal electro-acupuncture group.

3.2.2. Auricular groups

In the auricular intervention group, we observed a significant increase in SBP over the first period of the study (−4.04 ± 17.23 mmHg, $P = 0.049$). However, in the second period of the study, there was a significant reduction in SBP (3.86 ± 13.86 mmHg, $P = 0.027$), resulting in a non-significant overall improvement during the whole study (0.57 ± 17.07 mmHg, $P = 0.779$). No statistically significant changes were observed in the corresponding sham group ($P = 0.87$). When comparing changes in SBP between case group and sham group, no statistically notable difference was observed ($P = 0.75$).

Based on our analysis, changes in systolic blood pressure (SBP) were positively correlated with BMI, hip circumference (HC), and TG in our authentic intervention group, and negatively correlated with waist circumference in our sham intervention group ($P \leq 0.05$) (Table 3).

Table 3
Comparison of blood pressure at different time points.

	Abdominal intervention		Auricular intervention	
Authentic	Mean Difference ± SD	p-value	Mean Difference ± SD	p-value
SBP1- SBP2	5.89 ± 8.15	<0.001	5.89 ± 8.15	<0.001
SBP2- SBP3	3.01 ± 6.74	0.001	3.01 ± 6.74	0.001
SBP1- SBP3	9.52 ± 10.8	<0.001	9.52 ± 10.8	<0.001
DBP1- DBP2	1.69 ± 5.97	0.038	1.69 ± 5.97	0.038
DBP2- DBP3	1.63 ± 5.80	0.036	1.63 ± 5.80	0.036
DBP1- DBP3	3.58 ± 7.16	0.001	3.58 ± 7.16	0.001
Sham				
SBP1- SBP2	1.66 ± 6.31	0.108	1.66 ± 6.31	0.108
SBP2- SBP3	−1.38 ± 8.07	0.309	−1.38 ± 8.07	0.309
SBP1- SBP3	−0.73 ± 9.30	0.648	−0.73 ± 9.30	0.648
DBP1- DBP2	−0.26 ± 4.78	0.737	−0.26 ± 4.78	0.737
DBP2- DBP3	1.57 ± 9.29	0.324	1.57 ± 9.29	0.324
DBP1- DBP3	0.14 ± 7.01	0.903	0.14 ± 7.01	0.903

SBP: Systolic blood pressure; DBP: diastolic blood pressure; 1: at the beginning of the study; 2: after six weeks; 3: after 12 week.

3.2.3. Comparison between abdominal and auricular groups

Overall, we found that abdominal intervention was significantly more effective in lowering SBP compared to the auricular intervention group (9.5 ± 10.8 mmHg versus 0.6 ± 17.1 mmHg, respectively, P = 0.005).

3.3. Diastolic blood pressure

3.3.1. Abdominal groups

In the abdominal intervention group, we observed an overall time dependent reduction of blood pressure by 3.58 ± 7.16 mmHg during the whole study (P = 0.01). The improvements in DBP the first and second period were almost equal (Table 3). No statistically significant changes were observed in the corresponding sham group (P = 0.90). Blood pressure significantly improved in authentic acupuncture group compared with sham intervention (P = 0.03).

The changes in DBP had a significant positive correlation with baseline values of LDL and HDL among participants of sham intervention (P = 0.03, r = 0.39; P = 0.01, r = 0.44, respectively). No other statistically significant correlation was found between anthropometric and biochemical factors in the authentic or sham groups.

3.3.2. Auricular groups

In the auricular intervention group, there was a significant time dependent increase in diastolic blood pressure of our patients between the first and second periods, however, blood pressure decreased significantly between the second and third periods, the overall change in DBP between the first and third period showed a significant increase. (−7.73 ± 12.19 mmHg, P < 0.001; 3.78 ± 10.95 mmHg, P = 0.007; −3.98 ± 12.41 mmHg, P = 0.010 respectively) (Table 3). No statistically significant changes were observed in the corresponding sham group (P = 0.93). A significant increase was observed in case group compared with control group (P = 0.04).

We found that there was a significant positive correlation between changes in DBP with BMI and TG in our authentic intervention group (P = 0.006, r = 0.33; P = 0.01, r = 0.33, respectively). No other statistically significant correlation was found between anthropometric and biochemical factors in the authentic or sham groups.

3.4. Comparison between abdominal and auricular groups

Overall, we found that abdominal intervention was significantly more effective in lowering DBP compared to the auricular intervention (P = 0.001)

4. Discussion

We found that abdominal electroacupuncture is the superior intervention compared to auricular acupuncture for reducing SBP and DBP in our groups of subjects with overweight and obesity. In the first 6 weeks of study, participants were instructed to adhere to a low-calorie diet. It is possible that participants were better able to adhere to the diet because acupuncture increases release of dopamine and serotonin, which helps to regulate appetite.[13] It is notable that the participants were determined to lose weight, which is another factor helping them to stick to the administrated diet.

In the authentic abdominal electroacupuncture group, both systolic and diastolic blood pressure levels were reduced significantly at the end of the study compared with the sham group. We used electroacupuncture because electric current increases the effective radius of the inserted needle, compensating for possible minor misplacements of the needle, thus increasing the efficacy of the treatment. Regarding the effects of the treatment on both SBP and DBP, we saw a rapid effect of the treatment; SBP was reduced significantly at the end of the first period of the study. SBP continued to decrease in the second period of study, which shows that the effect of the intervention does not come to a halt when the intervention is stopped, and the intervention's effect is sustained after the patients stopped receiving the treatment. However, SBP continued to fall at a reduced rate compared to the first period, whereas for DBP, the decrease was almost the same as the first period of the study. In auricular acupuncture groups, we used normal seeds instead of electroacupuncture needles. We wanted to compare abdominal electroacupuncture with a method that does not contain needling, so that if it was as effective as abdominal electroacupuncture, it could be used to effectively treat patients who are afraid of needles. We observed that in the first period, both SBP and DBP increased significantly. In the second period in both groups we observed an improvement that may have compensated for the adverse effect on SBP, but could not bring DBP levels back to normal.

Previous studies have shown the effectiveness of acupuncture in the management of hypertension.[1,2,14,15,16,17,18,191, 2, 14–19] Regarding abdominal electroacupuncture, our findings were consistent with their results, as we found abdominal electroacupuncture effective in lowering blood pressure in our authentic treatment group. But regarding auricular acupuncture, our data suggest that it has a potentially negative impact on blood pressure that should be kept in check if the intervention is being used for its other therapeutic effects. This is in contrast with the review of Wei He et al. which concluded that by regulating the activity of the auricular branch of the vagus nerve, auricular acupuncture can reduce blood pressure values.[20] However, it should be pointed out that in their review, the data related to blood pressure had been gathered only from the studies on animal models including rats and rabbits. In a recent systematic review on acupuncture effects in patients with hypertension, Wang et al. reported that acupuncture lowers SBP by 7.5 mmHg and DBP by 4.2 mmHg, suggesting that it can have potential benefit for patients suffering from hypertension.[19] Similar results have been found among patients suffering from mild hypertension or prehypertension, and also regarding ambulatory blood pressure among hypertensive patients, except for DBP during nights, which was not high in their baseline population.[1,2] Although in our study, we found that the effect of the treatment was sustained in the abdominal group, in another acupuncture study, it was found out that the effects were diminished after a 12-week period.[2]

To our knowledge, all studies were done on subjects who were suffering a form of hypertension, not on patients with borderline and slightly more than border line blood pressures. Also reports about the effects of using acupuncture treatment without accompanying medications was inconsistent. There are studies, and a meta-analysis which concludes that acupuncture could be significantly effective only when used as an adjunct treatment, not by its own.[17,21] However, those findings are in contrast with the findings of our study, which was done on patients who were not receiving any anti-hypertensive drugs. There have been other studies that have reported results similar to ours.[15] We should also take the limitations of this study into consideration. In this study, the baseline blood pressure values were significantly different between the abdominal and auricular intervention groups. In our study, all patients were instructed to follow a low calorie diet, which can also lower blood pressure; since a low calorie diet can reduce blood pressure, it is a potentially confounding factor. Furthermore, the follow up period of our study was short, and we did not include a regular record of blood pressure values in the first and second periods of the study to determine how long it took for the intervention to make significant difference on blood pressure. However, the effects of abdominal electroacupuncture on SBP and DBP did not diminish until the end of the study.

Acupuncture could exert its effect on blood pressure by several different mechanisms. In animal studies, it has been shown that long term treatment with acupuncture could delay development of hypertension by increasing NO release to normal levels in spontaneously hypertensive rats.[22] Also it has been shown that acupuncture could significantly increase eNOS expression, and attenuate nNOS expression in both stress induced rat models and spontaneously hypertensive rat models.[23] In man, acupuncture has been shown to regulate blood pressure by changes in aldosterone, renin, angiotensin II and endothelin- 1, and by regulating neurotransmitters including GABA, serotonin, and endocannabinoids. The long lasting effects of the acupuncture can be attributed to GABA and opioids in rVLM, neural circuitry between the ventrolateral and arcuate periaqueductal grey matter, and by prolonging the increase in preproenkephalin mRNA levels and encephalin levels in the rVLM and arcuate. The role of renin, norepinephrine and aldosterone have been shown to have a role in long-lasting inhibitory effects of acupuncture on sympathetic activity in hypertensive patients who have undergone electroacupuncture treatment.[5,15] Previous studies have reported that each 10 mmHg reduction of SBP or 5 mmHg reduction of DBP can reduce the risk of coronary heart disease and stroke by 22% and 41%, respectively, which means that the findings of our study is clinically important. Considering the significant difference in the outcome of the acupuncture treatment when performed on different acupoints on body, future studies could put much more stress on the exact acupoints on which the treatment is being done. This effect is not limited to hypertension; as there is evidence that different acupoints which are all very effective on obesity have significantly different outcomes on abdominal fat mass due to different factors.[24] Also because of the different levels of efficacy of the treatment on different acupuncture sites, there is an increasing need for a review of all the studies available to exactly determine the best available acupoints involved in treating different medical conditions.

As using different acupoints in acupuncture treatment could have different outcomes for patients, future studies are suggested to focus on comparing the effectiveness of different acupoints on the related medical conditions. This can help us identify the best acupoints which can be used to treat a specific medical condition and as a result improve the efficiency and effectiveness of acupuncture treatment as an alternative or complementary method of intervention.

5. Conclusion

To the best of our knowledge this is the first study that compares the effects of abdominal and auricular acupuncture, among subjects with normal hypertension who are not receiving any anti-hypertensive drugs. Our findings suggest that of the two methods used in this study for management of blood pressure, only the abdominal method was capable of reducing both systolic and diastolic measurements. Surprisingly, our data suggests that auricular acupuncture could have short-lived adverse effects on both SBP and DBP. Which indicates that not only auricular acupuncture on the acupoints we used are not capable of treating hypertension, but also therapists who rely on this intervention for other therapeutic effects should keep its adverse effects in check. Lack of severe and systemic adverse effect, and the attractiveness of acupuncture intervention for patients have led to the high compliance of the treatment compared with the conventional drug regimens for controlling hypertension. These combined with the promising outcomes that are increasingly being available through different studies being performed all around the world is making acupuncture treatment a complementary and/or an alternative treatment of choice among many patients and physicians. And this study shows that abdominal electroacupuncture is a highly effective treatment for the ones who are at risk of developing hypertension.

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Conflict of interest

The authors confirm no conflict of interest.

References

1. Liu Y, Park JE, Shin KM, et al. Acupuncture lowers blood pressure in mild hypertension patients: a randomized, controlled, assessor-blinded pilot trial. *Complement Ther Med*. 2015;23(5):658–665.
2. Flachskampf FA, Gallasch J, Gefeller O, et al. Randomized trial of acupuncture to lower blood pressure. *Circulation*. 2007;115(24):3121–3129.
3. Li J, Zheng H, Zhao L, et al. Acupuncture for patients with mild hypertension: study protocol of an open-label multicenter randomized controlled trial. *Trials*. 2013;14:380.
4. Borgi L, Curhan GC, Willett WC, Hu FB, Satija A, Forman JP. Long-term intake of animal flesh and risk of developing hypertension in three prospective cohort studies. *J Hypertens*. 2015;33(11):2231–2238.
5. Cheng L, Li P, Tjen ALSC, Longhurst JC. What do we understand from clinical and mechanistic studies on acupuncture treatment for hypertension? *Chin Med*. 2015;10:36.
6. Abdi H, Abbasi-Parizad P, Zhao B, et al. Effects of auricular acupuncture on anthropometric, lipid profile, inflammatory, and immunologic markers: a

randomized controlled trial study. *J Altern Complement Med (New York, NY)*. 2012;18(7):668–677.
7. Abdi H, Zhao B, Darbandi M, et al. The effects of body acupuncture on obesity: anthropometric parameters, lipid profile, and inflammatory and immunologic markers. *Sci World J*. 2012;2012:603539.
8. Siervo M, Boschi V, Falconi C. Which REE prediction equation should we use in normal-weight, overweight and obese women? *Clin Nutr (Edinb, Scotl)*. 2003;22(2):193–204.
9. Crea F, Gaspardone A, Tomai F, et al. Risk factors in schoolchildren associated with a family history of unheralded myocardial infarction or uncomplicated stable angina in male relatives. *J Am Coll Cardiol*. 1994;23(6):1472–1478.
10. Lu S. *Acupuncture and Moxibustion Administration Methods (Ci Fa Jiu Fa Xue)*. Beijing: China: Traditional Chinese Medicine Publishing; 2003:55.
11. Cai J, Chao G, Chen D, Chen K, Chen X, Cheng X. *Advanced Textbook on Traditional Chinese Medicine and Pharmacology*. vol. 1. Beijing: New World Press; 1995.
12. Mann DL, Zipes DP, Libby P, Bonow RO. *Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine*. Elsevier Health Sciences; 2014.
13. Meguid MM, Fetissov SO, Varma M, et al. Hypothalamic dopamine and serotonin in the regulation of food intake. *Nutrition*. 2000;16(10):843–857.
14. Yin C, Seo B, Park HJ, et al. Acupuncture, a promising adjunctive therapy for essential hypertension: a double-blind, randomized, controlled trial. *Neurol Res*. 2007;29(Suppl. 1):S98–103.
15. Li P, Tjen ALSC, Cheng L, et al. Long-lasting reduction of blood pressure by electroacupuncture in patients with hypertension: randomized controlled trial. *Med Acupunct*. 2015;27(4):253–266.
16. Zhang J, Ng D, Sau A. Effects of electrical stimulation of acupuncture points on blood pressure. *J Chiropr Med*. 2009;8(1):9–14.
17. Li DZ, Zhou Y, Yang YN, et al. Acupuncture for essential hypertension: a meta-analysis of randomized sham-controlled clinical trials. *Evid Based Complement Altern Med: eCA*. 2014;2014:279478.
18. Kim LW, Zhu J. Acupuncture for essential hypertension. *Altern Ther Health Med*. 2010;16(2):18–29.
19. Wang J, Xiong X, Liu W. Acupuncture for essential hypertension. *Int J Cardiol*. 2013;169(5):317–326.
20. He W, Wang X, Shi H, et al. Auricular acupuncture and vagal regulation. *Evid Based Complement Altern Med: eCAM*. 2012;2012:786839.
21. Turnbull F, Patel A. Acupuncture for blood pressure lowering: needling the truth. *Circulation*. 2007;115(24):3048–3049.
22. Hwang HS, Kim YS, Ryu YH, et al. Electroacupuncture delays hypertension development through enhancing NO/NOS activity in spontaneously hypertensive rats. *Evid Based Complement Altern Med: eCAM*. 2011;2011:130529.
23. Huang YL, Fan MX, Wang J, et al. Effects of acupuncture on nNOS and iNOS expression in the rostral ventrolateral medulla of stress-induced hypertensive rats. *Acupunct Electro-Ther Res*. 2005;30(3–4):263–273.
24. Darbandi M, Darbandi S, Owji AA, et al. Auricular or body acupuncture: which one is more effective in reducing abdominal fat mass in Iranian men with obesity: a randomized clinical trial. *J Diab Metab Disord*. 2014;13(1):92.