Mean arterial pressure modification by Pericardium 6 acupoint (Neiguan) in healthy subjects versus smokers and diabetic patients

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ABSTRACT:*Blood pressure and heart rate values are commonly used in medical practice to assess cardiovascular risk in smoker subjects or with type 2 diabetes mellitus (DM2). Nonetheless, mean arterial pressure (MAP) and differential pressure of pulse (PP) provide essential information on cardiovascular risk and are not commonly assessed. Acupuncture has been shown to modify various parameters of cardiovascular function. The acupuncture point Pericardium 6 (PC6) is used in several autonomic disorders, particularly in arterial pressure and pulse rate disorders. This research aimed to study the effect of acupuncture at PC6 on MAP healthy subjects, smokers and patients with DM2. A cross-sectional study was carried out. Thirty-eight volunteers, aged between 35 - 55 years, were recruited. Three experimental groups were categorized as healthy subjects (n=12), smokers (n=15), and type 2 diabetics (n=11). The ad-hoc institutional ethic committee approved the study, and all participants gave written consent. Systolic and diastolic blood pressure and pulse rate were measured using the Omron HEM-7120 instrument (Kyoto, Japan). Manual acupuncture was applied at point PC6. The mean arterial pressure and pulse pressure were analyzed. Mean arterial pressure (MAP) was estimated with the equation MAP= 1/3[SBP - DBP]+ DBP, and the pulse pressure was obtained by the difference between the systolic and diastolic pressures. Values pre- versus post-acupuncture were compared for both groups. Pearson's correlation coefficients between baseline and post-acupuncture values were calculated to analyze the correlations between variables. Similarly, Correlations of Pearson were calculated comparing the changes produced in the variables elicited by acupuncture. The variable values were described as mean ± SD. The t-student test was employed to compare paired data for the values corresponding to the same subject, and the Welch test for samples with different n and variances. A P< 0.05 figure was considered significant. A two-tailed analysis was considered for all tests. MAP decreased steadily in all groups studied but only significantly in the total sample and in subjects with DM2. The correlation analysis of Pearson between the decrease in MAP elicited by acupuncture and the baseline MAP showed a moderate and not significant negative value for smokers. The linear correlation analysis between final and baseline MAP showed high positive correlations in the total population, healthy individuals, and subjects with type 2 diabetes mellitus; and weak positive correlation in the group of smokers. The linear correlation analysis between acupuncture-induced change in MAP and baseline MAP showed weak negative correlations in the total population and healthy subjects, moderate negative in smokers and strongly negative in subjects with DM2.*
KEYWORDS:*Mean arterial pressure, acupuncture, Pericardium 6, smoking, diabetes.*

I. INTRODUCTION

Mean arterial pressure and health. It has been shown that elevated night-time MAP may play a critical role in developing left ventricular hypertension in people with white-coat hypertension (1). Besides, It has been reported that MAP is a good predictor of the intensity and frequency of complications in critically ill patients; for instance, the occurrence of renal failure has also been correlated with MAP in patients with septic shock (2). Furthermore, Li et al. (2019) described that nocturnal mean arterial pressure rising increase short- and long-term mortality in critically ill adult patients (3). Besides, the mean arterial pressure appears to be a valuable, bedside, and non-invasive prognostic tool capable of promptly identifying intermediate-high risk acute pulmonary embolism patients at higher risk of 48 h clinical deterioration (4). Also, it has been reported that low MAP may decrease the risk of postoperative cognitive deficit after coronary artery bypass grafting surgery if cardiopulmonary bypass time is stratified rigorously between low MAP and high MAP patients (5).

Smoking increases the risk of hypertension by some 2 to 3 times (6). The combined action of smoking and hypertension usually increases cardiovascular complications and leads to a progression of

atherosclerosis(7).Otherwise, hypertension and type 2 diabetes are common comorbidities; hypertension is twice as frequent in patients with diabetes compared with those who do not have diabetes.[8] More than half of patients with type 2 diabetes mellitus (T2DM) have arterial hypertension (9).

Pericardium 6 acupoint is considered effective in managing cardiovascular disorders by modulating the activity of this system (10). Besides, its benefit at the cardiovascular level has been proven even in laboratory animals (11). Its therapeutic effect occurs through different mechanisms (12).The study aimsto assess the effects of manual acupuncture at PC6 on mean arterial pressure in normotensive subjects, comparing healthy subjects with smokers and type 2 diabetic patients.

II. MATERIALS AND METHODS

1. Population. An experimental cross-sectional study was carried out. Twelve healthy subjects, 12 smokers, and 11 patients with type 2 diabetes mellitus with oral glycemic control were included in the study. None had total serum cholesterol values >200 mg/dl or electrocardiogram abnormalities. Subjects were studied fasting and abstaining from caffeine or alcohol 12 hours before the study.

2. Ethical aspects. The Ethics Committee of the Division of Biological and Health Sciences of the Iztapalapa Unit of the Autonomous Metropolitan University approved the study, which conforms to the revised version of the Declaration of Helsinki (World Medical Association 2013) for medical research with human beings (13). The subjects gave their written informed consent to participate.

3. Instrumentation and recordings. Blood pressure measurement was performed using an oscillometric device that recorded the pressure of the right brachial artery (OMRON Hem 907XL, Kioto, Japón).

4. Interventions. Acupuncture was applied to the PC6 or Neiguan point according to its Chinese name (Figure 1), and it was stimulated manually unilaterally in the right arm and contralaterally to the side of the recording of the PVD 5 minutes (minutes 1 to 5). The needle was inserted at an average depth of 1.2 cm. A stainless-steel needle 0.30 X 40 mm (Hwato, Suzhou, Jiangsu, China) was used.
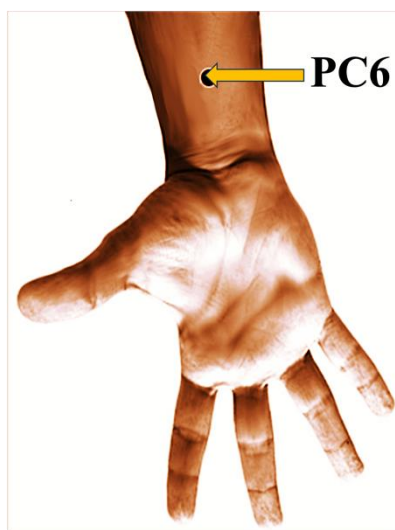

Figure 1. Pericardium 6 (Neiguan) acupoint.

5. Study protocol. The recordings were made in a clinical setting with a temperature of 23 °C ± 2 °C. All subjects were allowed to rest and acclimatize for at least 20 minutes before the start of the recordings. In addition, the subjects were instructed to abstain from alcohol for ≥ 24 h before the experiment, coffee, tea, and exercise on the day of experiments, and have a light meal two h before each experiment. After registering its clinical information, the subjects remained supine for a period ≥ 15 min before starting the records. The measurements were taken between 9:00 a.m. to 12:00 p.m. to standardize the conditions regarding the circadian rhythms in blood pressure and heart rate. After the rest period, the variables were recorded in the baseline state, then acupuncture was applied for 5 min, and after 15 minutes, the variables were recorded again.

6. Outcomes. Records of systolic pressure (SP), diastolic pressure (DP), and heart rate (HR) were obtained. Pulse pressure (PP) was calculated as the difference between systolic pressure and diastolic pressure. In addition, the correlation of age with the magnitude of the changes elicited by acupuncture in the variables studied was analyzed.

7. Statistical analysis. The two-tailed t-student test was employed to compare paired data for the values corresponding to the same subject, and the Welch test for samples with different n and variances. A two-tailed analysis was considered for all tests. Data are reported as means ± standard deviation (SD) and analyzed using the statistical package for social sciences (SPSS, version 22.0) (Chicago, USA).The chosen level of statistical significance was $p < 0.05$.

III. RESULTS AND DISCUSSION

Population

Table 1 shows the demographic data of the groups studied. No significant differences were observed in the variables studied between the experimental groups. None of the study subjects were hypertensive at the time of the study.

Table 1. Demographic and clinical data for study groups.

Demographic and clinical parameter	Healthy subjects	Smokers	Subjects with DM2
n (female)	7 (5)	15 (0)	6 (5)
Age (yr)	43.3 ± 5.5	45.3 ± 5.6	45.4 ± 8.4
Brachial systolic BP (mm Hg)	125.3 ± 9.0	123.7 ± 9.7	127.9 ± 7.7
Brachial diastolic BP (mm Hg)	82.3 ± 11.7	82.5 ± 5.6	82.0 ± 7.9
Heart rate (bmp)	75.6 ± 12.0	72.5 ± 14.9	76.6 ± 6.0

Data are mean ± SD.

DM2: diabetes mellitus type 2.

Effect of acupuncture on the mean arterial pressure

Table 1 depicts the effect of the application of acupuncture on the right PC6 point. Acupuncture elicited a decrease of MAP in all groups as follows: MAP decreased steadily in all groups studied but only significantly in the total sample ($p < 0.001$) and in subjects with type 2 diabetes mellitus ($p= 0.001$).

Correlations of Pearson

The results of thePearson correlation analysis between the decrease in MAP related to the application of acupuncture and the baseline MAP are shown in Table 3. The correlation values showed negative r-values in all groups, especially smokers (r= -0.409), but were not statistically significant relationships.

Table 2. Effect of acupuncture in PC6 on mean arterial pressure (MAP).

Population	MAP (mmHg)		
	Basal	Posacupuncture	P value
All subjects	96.7 ± 7.5	92.0 ± 9.2	< 0.001*
Healthy	97.0 ± 10.1	91.6 ± 11.7	0.051
Smokers	96.2 ± 5.1	92.4 ± 6.9	0.063
Diabetic	97.3 ± 7.5	90.3 ± 9.5	0.001*

Mean ± SD.

* $p< 0.05$

Table 3. Comparison of Pearson correlation between mean arterial pressure change elicited through acupuncture in PC6 and basal mean arterial pressure.

Population	MAP (mmHg)	
	r	P-value
All subjects	-0.204	0.221
Healthy	-0.181	0.576
Smokers	-0.409	0.146
Diabetic	-0.005	0.991

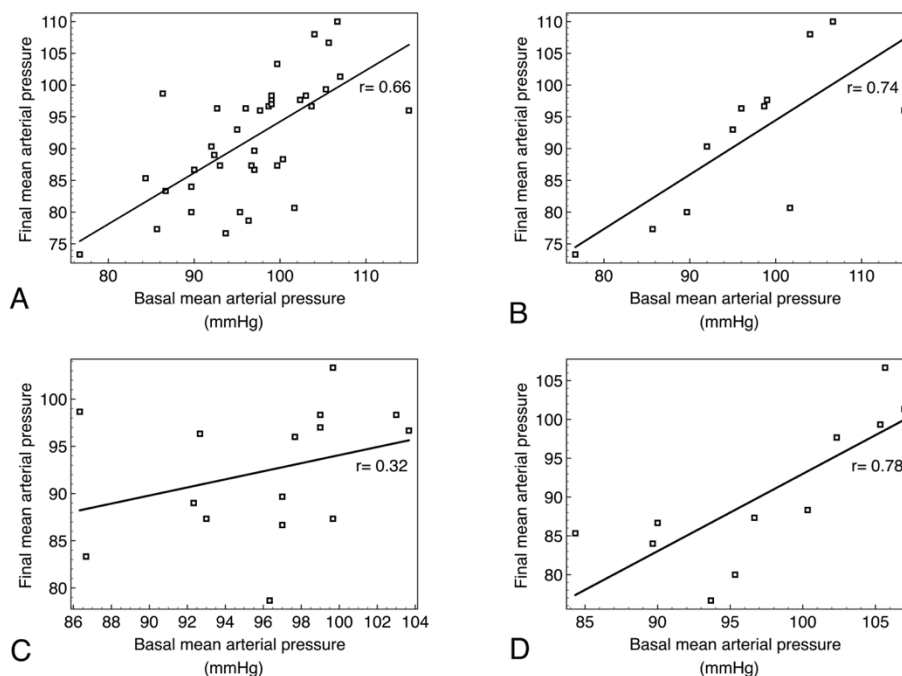r = Pearson correlation coefficient.

* $p< 0.05$

Figure 2. Correlation coefficient between the resulting mean arterial pressure and the basal mean arterial pressure in the experimental groups. A. all subjects; B. healthy subjects; C. smokers; D. subjects with diabetes mellitus type 2. r= correlation coefficient.

The correlation coefficients between the endMAP and the basal MAP in the experimental groups are shown in Figure 2. The linear correlation analysis between end MAP and baseline MAP showed high positive correlations in the total population (r= 0.66), healthy individuals (r= 0.74), and subjects with type 2 diabetes mellitus (r= 0.78); and a weak positive correlation in the group of smokers (r= 0.32).

The correlation coefficients between the change in MAP elicited by manual acupuncture in PC6 and the basal MAP in the experimental groups are shown in Figure 3.The linear correlation analysis showed weak negative correlations in the total population (r= -0.20)andhealthy subjects (r= -0.18), moderate negative in the group of smokers (r= -0.41), and very weak negative in the group of subjects with DM2 (r= -0.001).
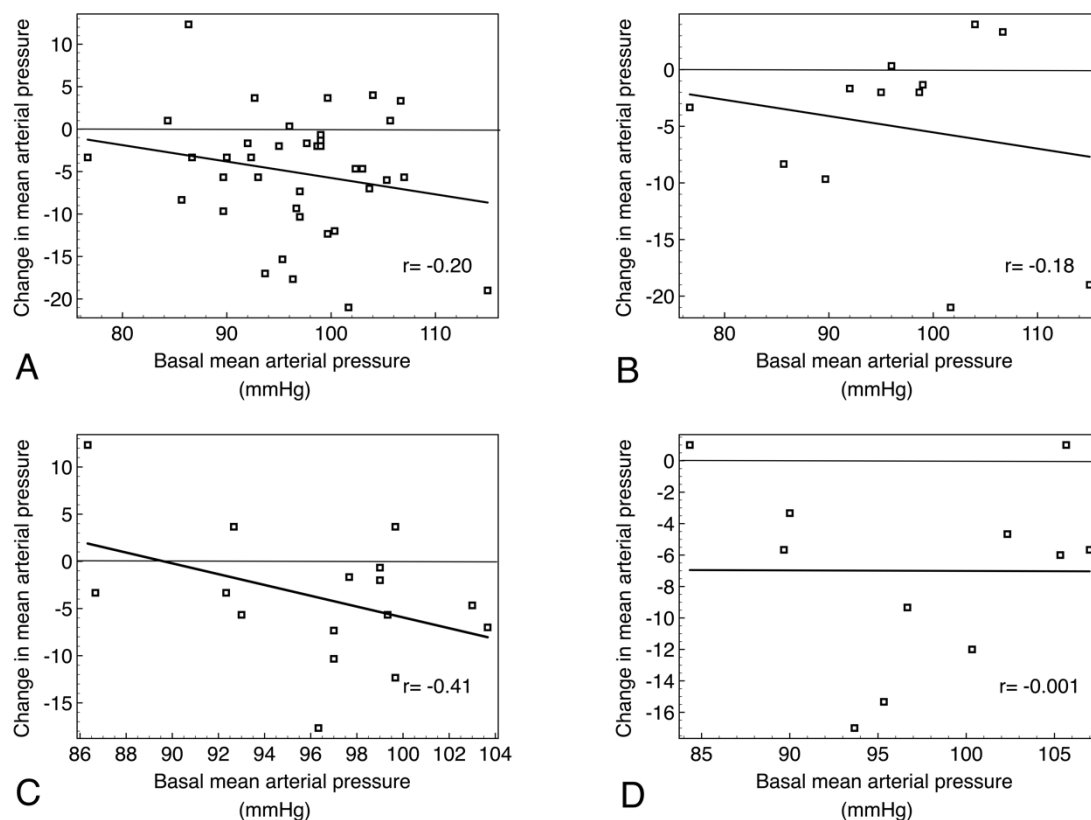
Figure 3. The correlation coefficient between the change in mean arterial pressure elicited by manual acupuncture in PC6 and the basal mean arterial pressure in the experimental groups. A. all subjects; B. healthy subjects; C. smokers; D. subjects with diabetes mellitus type 2. r= correlation coefficient.

Main findings. The main findings of this study related to the application of acupuncture on the right PC6 point were as follows:MAP decreased steadily in all groups studied but only significantly in the total sample and subjects with type 2 diabetes mellitus. The correlation analysis of Pearson between the decrease in MAP caused by the application of acupuncture and the baseline MAP showed a moderatenegative valuein smokers but was not statistically significant. The linear correlation analysis between end MAP and baseline MAP showed high positive correlations in the total population, healthy individuals, and subjects with type 2 diabetes mellitus; and weak positive correlation in the group of smokers. The linear correlation analysis between acupuncture-induced change in MAP and baseline MAP showed weak negative correlations in the total population and in healthy subjects, moderate negative in the group of smokers, and strong negative in the group of subjects with type 2 diabetes mellitus.

Acupuncture in smokers. Previous experiments in our laboratory showed that the response to acupuncture in smokers decreased with age compared to healthy subjects, especially in systolic and pulse pressure (14). This finding was consistent with the cardiovascular alterations produced by tobacco smoking and that increases with age (15). Besides, smoking that modifies arterial stiffness and wave reflection might significantly affect central blood pressure, which is more closely related to target organ damage (16).Hypertensive smokers are more likely to develop severe forms of hypertension, including malignant and renovascular hypertension, an effect likely due to an increased atherosclerosis (17).

Acupuncture in diabetic patients. In diabetic patients, the effect of acupuncture on the systolic pressure, heart rate, and remarkably, pulse pressure age-related decrease. This finding coincides with the possible presence of diabetic neuropathic heart disease (18,19). Besides, patients with diabetes mellitus experience increased peripheral artery resistance caused by vascular remodeling and increased body fluid volume; both mechanisms elevate systemic blood pressure (20).It has been shown that MAP is as strong as systolic and diastolic BP in predicting progression to diabetes (21). Besides, the MAP is an independent predictor for the 5-year risk of incident diabetes among adults, and this relationship between MAP and diabetes is non-linear; when MAP is below 100.3 mm Hg, MAP is closely positively related to diabetes (22).

PC6 and hypertension. Previous preliminary studies suggested that the stimulation of acupoints can elicit different effects on arterial blood pressure (10). Besides, manual acupuncture of PC6 evoked a complex cardiovascular response, probably related to a vagal response and a negative inotropic effect (23). Our results are consistent with previous findings that showed acupuncture in PC6 modifies SDDVP indices related to the stiffness of the great arteries in normal and hypertensive subjects (24).It has been shown that MAP is a valuable subrogate of the brachial-ankle pulse wave velocity (25);therefore, the reduction of MAP produced by acupuncture in PC6 may be a useful therapeutic measure.

IV. CONCLUSION

Our findings suggest a differentiated response in mean arterial pressure to manual acupuncture in PC6 between healthy subjects, smokers, and patients with type diabetes mellitus. These data show that the PC6 point exerts differentiated effects on the variables studied according to the pathophysiological substrate of smokers or patients with type 2 diabetes mellitus smoking; this differentiation in effects is probably related to a different ANS response of the diabetic group.

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