

ORIGINAL ARTICLE

Effect of acupuncture in Pericardium 6 (Neiguan) acupoint in the acute cardiovascular response to active standing in healthy subjects



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KEYWORDS

Pericardium 6
acupoint;
Orthostatic stress;
Mean arterial pressure;
Heart rate;
Left ventricular
ejection time

Abstract

Objective: To demonstrate the effect of acupuncture in Pericardium 6 (Neiguan) acupoint in the acute homeostatic response to orthostatic challenge in healthy subjects.

Design: A cross-sectional experimental study was conducted at Acupuncture Facility at Universidad Autónoma Metropolitana, Ciudad de México, México. Participants: Fifteen healthy university students (seven women) aged 22.5 ± 1.36 (mean \pm SD) participated in the present study to investigate the changes in cardiovascular function after standing active standing and their modification with manual acupuncture in Pericardium 6 (Neiguan) acupoint in healthy volunteers.

Interventions: The treatment consisted of one session of manual acupuncture in the Pericardium 6 (Neiguan) in the right arm. The following data for continuous beat-to-beat registration: mean arterial pressure (MAP), heart rate (HR), stroke volume (SV), total peripheral resistance (TPR), and left ventricular ejection time were computed in healthy volunteers after standing. The obtained signals were plotted and averaged, and a linear correlation of each average was calculated. Besides, the Pearson correlation coefficient was calculated for the recording periods of 1–10 after the standing position in basal and treated conditions.

Results: Acupuncture was showed to increase the speed of change in MAP, HR, and TPR and decreased the speed of changes in SV and LVET when comparing the slopes of the initial cardiovascular changes related to active standing. Besides, Pearson analysis showed that acupuncture treatment modifies to higher correlation the cardiovascular responses to orthostatic stress.

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Conclusions: We found that manual acupuncture in the right PC6 boosted the initial adaptive mechanisms to orthostatic stress in healthy subjects. It is valuable to initiate clinical trials to see if this treatment improves symptoms in patients with orthostatic hypotension.
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PALABRAS CLAVE

Acupunto pericardio 6;
 Estrés ortostático;
 Presión arterial media;
 Frecuencia cardiaca;
 Tiempo de eyección
 ventricular izquierda

Efecto de la acupuntura en el acupunto Pericardio 6 (Neiguan) en la respuesta cardiovascular aguda a la posición erguida activa en sujetos sanos

Resumen

Objetivo: Demostrar el efecto de la acupuntura en el acupunto Pericardio 6 (Neiguan) en la respuesta homeostática aguda al desafío ortostático en sujetos sanos.

Diseño: Se realizó un estudio experimental transversal en el Centro de Acupuntura de la Universidad Autónoma Metropolitana, Ciudad de Méjico, Méjico. Participantes: cincuenta estudiantes universitarios sanos (siete mujeres) de edad $22,5 \pm 1,36$ (media \pm DE) participaron en el presente estudio para investigar los cambios de la función cardiovascular tras la posición erguida activa y su modificación con acupuntura manual en el acupunto Pericardio 6 (Neiguan) en voluntarios sanos.

Intervenciones: El tratamiento consistió en una sesión de acupuntura manual en el Pericardio 6 (Neiguan) del brazo derecho. Se registraron los datos siguientes para grabación latido a latido continuo: presión arterial media (PAM), frecuencia cardiaca (FR), volumen sistólico (VS), resistencia periférica total (RPT), y tiempo de eyección ventricular izquierda en voluntarios sanos tras permanecer de pie. Se trazaron y promediaron las señales obtenidas, calculándose la correlación lineal de cada media. Además, se calculó el coeficiente de correlación de Pearson para los periodos de registro 1–10 tras la posición erguida en condiciones basales y post-tratamiento.

Resultados: Se observó que la acupuntura incrementaba la velocidad del cambio en términos de PAM, FR y RPT, y reducía la velocidad de los cambios en términos de VS y LVET al comparar las pendientes de los cambios cardiovasculares iniciales relacionados con la posición erguida activa. Además, el análisis de Pearson reveló que el tratamiento de acupuntura modifica al alza la correlación de las respuestas cardiovasculares al estrés ortostático.

Conclusiones: Encontramos que la acupuntura manual en el PC6 derecho potenciaba los mecanismos adaptativos iniciales al estrés ortostático en sujetos sanos. Sería valioso iniciar ensayos clínicos para observar si este tratamiento mejora los síntomas en pacientes con hipotensión ortostática.

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Introduction

Orthostasis

Active standing is valuable to assess responses during the initial phase of the orthostatic challenge and is one of the primary tests to diagnose idiopathic orthostatic hypotension and related disorders of the autonomic nervous system.¹ An abnormal sympathetic response upon assuming an upright posture, as observed in orthostasis, can present frequently or occasionally with dizziness or lightheadedness.² Therefore, the rapid and complex homeostatic responses of the cardiovascular and autonomic nervous systems that maintain blood pressure and ensure adequate perfusion of major organs are unlikely to be achieved through drug therapy plus other measures.³

Clinical and experimental observations have suggested that acupuncture may have therapeutic effects on various types of hypertension, coronary heart disease, dysrhythmias, and myocardial infarction.^{4,5} Besides, the PC6 acupoint (PC6) is one of the most commonly used acupoints, is indicated for treating cardiovascular-related disorders (Fig. 1), and is one of the primary acupoints used to treat cardiovascular diseases.^{6,7} PC6 is also an acupoint commonly used to study the effects and

mechanisms of acupuncture in several different animal models of cardiovascular disease.⁸ Although several studies report the cardiovascular effects of PC6,^{9–11} its mechanisms are not fully understood. Furthermore, to our knowledge, the kinetics of the cardiovascular effect point PC6 has not been described.

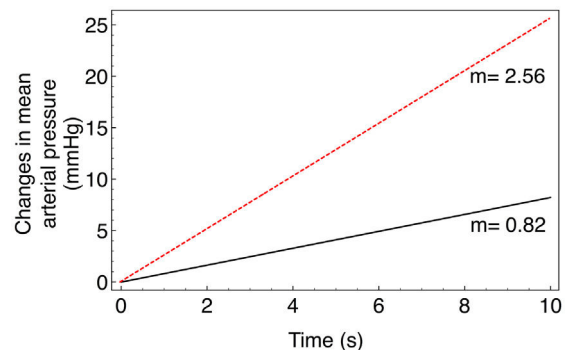


Fig. 1 Comparison of the effect of active standing on mean arterial pressure through linear regression in untreated subjects (solid line) versus subjects treated with acupuncture in Pericardium 6 (dotted line).

Therefore, the primary objective of this study is to evaluate the effect of manual acupuncture in Pericardium 6 (Neiguan) in the acute homeostatic response to active standing in healthy subjects.

Materials and methods

A cross-sectional experimental without control study was conducted. The study was performed at the Acupuncture Facility at Universidad Autónoma Metropolitana.

Population

All of the subjects included in this study were healthy volunteers of Universidad Autónoma Metropolitana, Ciudad de México, México. There were 15 healthy subjects (seven women) aged 22.5 ± 1.36 (mean \pm SD) without clinical data of cardiovascular diseases, with body mass index <25.0 , and without medication or treatment with acupuncture in the last two weeks before the study.

Ethical aspects

The study was approved by the Biological and Health Division Ethics Committee and conformed to the Declaration of Helsinki (World Medical Association 2013). Furthermore, the subjects were provided with a full explanation about the study and signed written informed consent.

Signal registration

In this study, continuous beat-to-beat blood pressure (BP) data was obtained from the sample of 15 subjects. The finometer instrument (Finometer; Finapres Medical Systems, Amsterdam, The Netherlands) was used. A cuff was placed on the middle phalanx of the left middle finger, and blood pressure and heart pulse were recorded continuously. The variables were mean blood pressure (MBP), heart rate (HR), stroke volume (SV), total peripheral resistance (TPR), and left ventricular ejection time (LVET). The Finapres system provides continuous and simultaneous estimates of these variables. A continuous recording of 10 min was completed for each participant: in supine rest 5 min and after taking the standing position 5 min. With the recorded data, the hemodynamic parameters were estimated using the Modelflow method based on a three-element Windkessel model.¹² The MAP, HR, SV, and LVET values were calculated using the BeatScope-v02.10 software (Finapres Medical Systems, Enschede, The Netherlands). This software allows the registration, control, and storage of the complete data obtained by the finometer and subsequent offline review. The TPR was determined as the quotient of the MAP divided by the cardiac output by using the ModelFlow algorithm, and the unit of measurement for the TPR was medical units $\text{mmHg} \cdot \text{min} / \text{l}$.¹³

Comparisons and statistics

The 11-min records of each subject were plotted in the Plot2 software (Michael Wesemann, Berlin, Germany, 2019). Interpolated data for the fifteen subjects were averaged,

and linear regression of the untreated and acupuncture effect was obtained for every parameter. Subsequently, the graphs corresponding to each variable were gathered in a single graph. Moreover, the linear regression of the groups untreated and with acupuncture treatment for each variable was compared. Data were analyzed using the social science statistical package (SPSS, version 22.0) (Chicago, USA). The statistical significance level chosen was $p < 0.05$.

Acupuncture treatment

Pericardium 6 (Neiguan) acupoint on the right arm was selected for manual acupuncture stimulation. The Pericardium 6 acupoint is located two cun above the dorsal wrist crease between the tendons of flexor carpi radialis and palmaris longus, see Fig. 2. Manual acupuncture was performed by inserting a stainless steel acupuncture needle 40 mm in length and 0.25 mm in diameter (HBW Supply Inc., San Jacinto Hemet, CA, USA). The needle was inserted perpendicular to the skin surface to a depth of approximately 15 mm, no additional stimulation was performed, and the needle remained inserted for one minute.

Practitioner's background

An acupuncturist practitioner with one year of experience performed all the acupuncture treatments.

Protocol

Measurements were made after a fasting period of ≥ 8 h. After recording clinical information, all subjects rested for ≥ 15 min before initiating the recordings. Measurements were carried out between 9:00 a.m. and 12:00 p.m. to

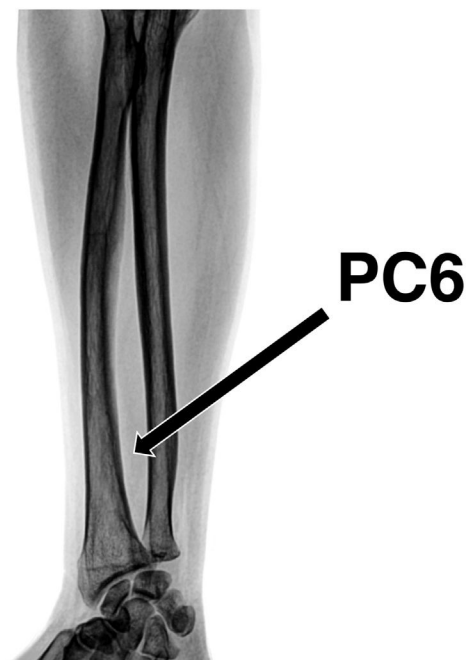


Fig. 2 Pericardium 6 (Neiguan) acupoint.

standardize conditions related to circadian cardiovascular variations. After the rest period, a continuous recording of 10 min was completed for each participant. After five minutes of registration, subjects were gently asked to reach a standing position without aid, and then the period of registration was completed (Fig. 3). After one week of a washout period, the same experimental protocol was performed with the acupuncture treatment before the continuous data recording. Medical staff and a nearby open bed were available to assist those with syncope.

Comparisons

The comparison was made among the linear regression values of pooled registers of the untreated versus treated subjects.

Statistical analysis

For the analysis, the linear regression values of the cardiovascular variables of the untreated group and the group treated with acupuncture were compared. In addition, the adjustment level between the variables studied in subjects not treated or treated with acupuncture was examined using Pearson's correlation coefficient. The analysis was performed with the software SPSS 16.0 (SPSS IBM, USA). The statistical significance level (α) was set at 0.05.

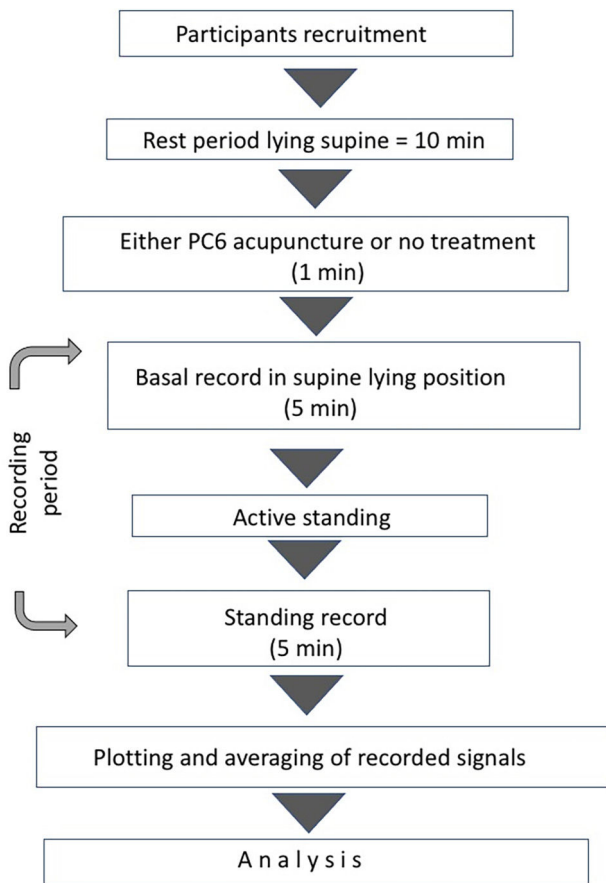


Fig. 3 Flowchart of the study.

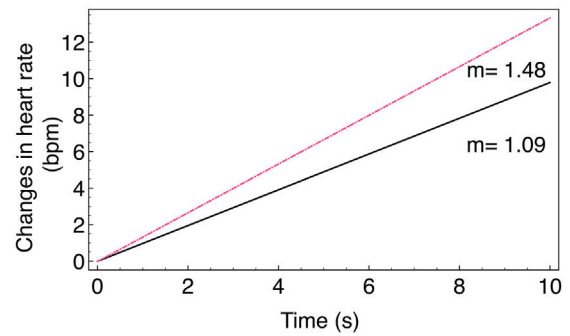


Fig. 4 Comparison of the effect of active standing on heart rate through linear regression in untreated subjects (solid line) versus subjects treated with acupuncture in Pericardium 6 (dotted line).

Results

The study population consisted of 15 (7 female) healthy subjects having a global age of 22.5 ± 1.36 (mean \pm SD).

Linear regression analysis

Comparison of changes in MAP, HR, SV, TPR, and LVET by linear regression of changes in mean arterial pressure during orthostatic stress in untreated subjects (solid line) versus those treated with acupuncture in Pericardium 6 (marked line) is shown in Figs. 1, 3–7 respectively.

Comparison of the slopes of the initial cardiovascular changes caused by orthostatic stress showed that acupuncture increased the speed of the changes in MAP, HR, and TPR (see Figs. 1, 4 and 6, respectively; while SV and LVET changes slowed down (see Figs. 5 and 7, respectively).

Pearson correlation coefficients

Table 1 shows the Pearson correlation values between the variables in the untreated and treated groups.

After acupuncture treatment, MAP increased the level of adjustment with the other variables, positive with

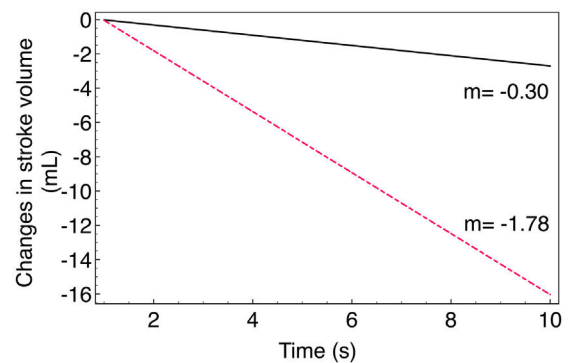


Fig. 5 Comparison of the effect of active standing on stroke volume through linear regression in untreated subjects (solid line) versus subjects treated with acupuncture in Pericardium 6 (dotted line).

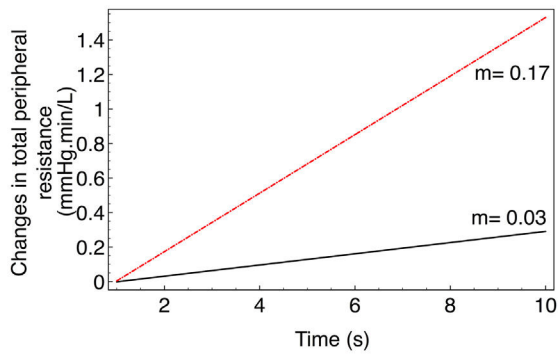


Fig. 6 Comparison of the effect of active standing on total peripheral resistance through linear regression in untreated subjects (solid line) versus subjects treated with acupuncture in Pericardium 6 (dotted line).

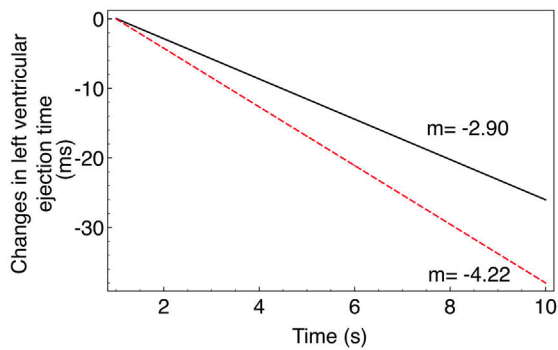


Fig. 7 Comparison of the effect of active standing on left ventricular ejection time through linear regression in untreated subjects (solid line) versus subjects treated with acupuncture in Pericardium 6 (dotted line).

HR ($r = 0.6767$ $p < 0.001$) and TPR ($r = 0.9050$ $p < 0.001$) and negative with SV ($r = -0.7998$ $p < 0.001$) and the LVET ($r = -0.6772$ $p < 0.001$). Besides, HR increased the level of adjustment positive with TPR ($r = -0.6549$ $p < 0.001$);

negative with SV ($r = -0.6549$ $p < 0.001$) and TPR ($r = -0.5096$ $p = 0.0156$). In addition, SV increased the level of adjustment negatively with TPR ($r = -0.8179$ $p < 0.001$). Finally, TPR increased its negative adjustment with LVET ($r = -0.6105$ $p = 0.0024$).

Discussion

This study is the first to our understanding that systematically examines the effect of acupuncture on PC6 on immediate cardiovascular responses to standing. The Finapres system provides continuous and concurrent calculations of MAP, HR, SV, TPR, and LVET and allows the continuous study of the changes in these variables after active standing.¹⁴ The characteristic findings were that treatment with manual acupuncture in PC6 acupoint increases the MAP, HR, and TPR slopes. Besides, acupuncture increased the degree of correlation of MAP with HR, SV, and TPR. These data are consistent with findings from a previous study that showed that manual acupuncture in PC6 significantly decreases the b/a index value of the acceleration photoplethysmogram that is related to the impedance of the arterial system.¹⁵

Orthostatic hypotension, defined as a reduction in systolic or diastolic blood pressure upon standing,¹⁶ is generally due to ANS dysfunction, medication use, hypovolemia, or non-neurological cardiovascular disorders that cause heart failure.¹⁷ Orthostatic hypotension is a disorder that causes significant disability, and treatment includes pharmacological measures and other interventions with generally unsatisfactory results.¹⁸

Acupuncture is effective in alleviating some autonomic symptoms.¹⁹ Besides, acupuncture has been proposed to treat orthostatic hypotension in patients with spinal cord injury.²⁰ Previous preliminary studies suggested that manual acupuncture of PC6 evoked a complex cardiovascular response, probably related to a modification of autonomic nervous system activity and a negative inotropic effect.²¹ In our study, comparing the slopes of the initial cardiovascular changes due to standing, acupuncture increased the speed of change in MAP, HR, and TPR and decreased the speed of SV and LVET changes. Besides, Pearson analysis showed that cardiovascular responses to orthostatic stress. In addition, the shortening of LVET with acupuncture in PC6 is probably initially related to increased

Table 1 Comparison of Pearson correlation coefficients between the cardiovascular variables in the immediate period of active standing with or without acupuncture treatment.

	HR		SV		TPR		LVET	
	A r (p)	B r (p)	A r (p)	B r (p)	A r (p)	B r (p)	A r (p)	B r (p)
MAP	-0.2640 (0.2352)	0.6767 ($< 0.001^*$)	-0.0106 (0.9648)	-0.7998 ($< 0.001^*$)	-0.0205 (0.9296)	0.9050 ($< 0.001^*$)	0.0067 (0.9764)	-0.6772 ($< 0.001^*$)
HR	-	-	-0.2814	-0.6549 ($< 0.001^*$)	0.3322 (0.1310)	0.7369 ($< 0.001^*$)	-0.1384 (0.5402)	-0.5096 (0.0156*)
SV	-	-	-	-	-0.3874 (0.0752)	-0.8179 ($< 0.001^*$)	0.3570 (0.1030)	-0.2459 (0.2718)
TPR	-	-	-	-	-	-	-0.6143 (0.0024*)	-0.6105 (0.0024*)

r = Pearson correlation coefficient; * $p < 0.05$.
A, untreated; B, treated.

MAP, mean arterial pressure; HR, heart rate; SV, stroke volume; TPR, total peripheral resistance; LVE, left ventricular ejection time.

sympathetic nervous tonus and myocardial contractility and an increase in TPR.

Conclusion

We found that manual acupuncture in the right PC6 could boost the initial adaptive circulatory response to orthostatic stress in healthy subjects. Therefore, conducting clinical trials is valuable to see if this acupuncture treatment improves symptoms in patients with orthostatic hypotension.

Declaration of competing interest

The authors have no conflict of interest to declare.

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