

Cardiovascular immediate response to PC6 manual acupuncture

José Federico Rivas-Vilchis^{1*}, Eduardo Gámez-Valdés², Moisés Salvador Castañeda-Ramírez¹

¹ Especialización en Acupuntura y Fitoterapia, Unidad Iztapalapa, Universidad Autónoma Metropolitana, México

•Correspondence: jfrv@xanum.uam.mx

² Departamento de Atención a la Salud, Unidad Xochimilco, Universidad Autónoma Metropolitana, México

Abstract—The maximal rate of left ventricular pressure rising or LVdP/dt(max) is related to loading conditions on the ventricle and myocardial contractility; thus, it is a predictor of the inotropic effects. The Pericardium 6 (PC6) or Neiguan acupoint modifies the cardiovascular system, reduces systolic blood pressure in subjects with hypertension, and modifies myocardial activity in experimental and clinical studies.

Purpose. This study was to examine the effect of manual acupuncture in Pericardium (PC6) acupoint on cardiovascular function in healthy subjects.

Participants and methods. A cross-sectional experimental study was conducted at Clínica de Acupuntura, Unidad Iztapalapa, Universidad Autónoma Metropolitana, Ciudad de México, México. Fifteen healthy university students (eight women) aged 25.2 ± 3.24 (mean \pm SD) participated in the present study to investigate the kinetics of the acute effect of acupuncture stimulation at PC6. The protocol included one session of manual acupuncture in the PC6 acupoint in the left arm. These parameters for every heartbeat: Cardiac output (CO), heart rate (HR), stroke volume (SV), peripheral resistance (TPR), and LVdP/dt(max) were calculated.

Results. This treatment showed a significant inhibitory effect on CO, HR, SV, LVdP/dt(max); and a stimulatory effect on TPR. The decrease in LVdP/dt(max) showed a significant correlation with SV and CO, but not with HR.

Conclusion. Data suggest the possibility of manual acupuncture of PC6 evoked a complex cardiovascular response, probably related to a vagal response and a negative inotropic effect. Further intervention studies are needed to assess if acupuncture at PC6 could elicit changes in myocardial function.

Keywords—Pericardium 5, Neiguan, acupuncture, LVdp/dt(max), cardiac output, total peripheral resistance.

I. INTRODUCTION

The first derivative of a left ventricular pressure signal (LVdP/dt(max)) is a convenient index for LV contractile state [1]. Left ventricular (LV) contractility is one of the main determinants of cardiac function and an important element of the hemodynamic evaluation in inward patients [2].

Previous preliminary studies suggested that the stimulation of acupoints can elicit different effects on arterial blood pressure [3]. Stimulation of PC6 and PC4 reduced heart rate and improved HRV index in postoperative spinal surgery patients [4]. A previous study showed that acupuncture at PC6 acupoint produced changes in the second derivative of digital volume pulse waveform in normal and hypertensive subjects [5]. The purpose of this study was to evaluate the effects of manual acupuncture at PC6 on (LVdP/dt(max)) and cardiovascular parameters in healthy subjects.

II. SUBJECTS AND METHODS

Study Design and setting. A kinetics study without control was conducted. The study was performed at Acupuncture Clinic, Unidad Iztapalapa, Universidad Autónoma Metropolitana.

Population. All of the subjects in this study were healthy student volunteers of the Institution Universidad Autónoma Metropolitana, campus Iztapalapa, Ciudad de México, México. These subjects were recruited by advertising. The study population consisted of 15 (8 female) healthy subjects having a global age of 25.2 ± 3.24 (mean \pm SD), without clinical data of cardiovascular diseases, obesity, athletic training; non-smoking, and without having received medication or treatment with acupuncture in the month before the study.

Ethical aspects. The institutional Biological and Health Division Ethics Committee approved this study (Approval Number 10.05.17). The study conforms to the principles of the Declaration of Helsinki (World Medical Association 2013). The subjects gave written, informed consent to participate.

A. Instrumentation and recordings

A continuous beat-to-beat blood pressure (BP) data from our sample of 16 healthy subjects was used in the present study. A finger cuff was placed in the middle phalanx of the left middle finger, with the hand positioned at heart level (Finometer; Finapres Medical Systems, Amsterdam, The Netherlands), and arterial pressure was recorded continuously [6]. The Finapres system provides continuous and concurrent calculations of cardiac output (CO), heart rate (HR), stroke volume (SV), total peripheral resistance (TPR), and the first derivative of a left ventricular pressure

signal (LVdP/dt(max)); and it is commonly used in research settings [7]. Participants completed a supine resting recording period of 10 min. Data recorded estimate hemodynamic parameters using the Modelflow method based on a three-element Windkessel model [8]. The CO, HR, SV, and MAP were calculated by BeatScope - v02.10 software (Finapres Medical Systems, Enschede, The Netherlands). This software allows online monitoring, control, storage, and offline revise of the complete Finometer data, including cardiac parameters [9]. LVdP/dt(max) represents the maximal rate of pressure increase in the left ventricle during systole, always computed on the finger pressure waveform. TPR was determined as the quotient of ModelFlow-derived MAP divided by CO. The unit of measurement for ModelFlow TPR is CGS units, i.e., dys.s.cm^{-5} [10].

B. Signal processing and analysis

All recorded signals from each experimental run were plotted and then averaged with the software Plot2 for Mac (Michael Wesemann, Berlin, Germany, 2019).

C. Acupuncture treatment

Manual acupuncture without additional electrical or laser stimulation was applied on the PC6 acupoint, Fig. 1. The left-arm point was traditionally located wherein the needle was inserted vertically to a depth of 15 mm for 5 minutes [11]. Sterile disposable acupuncture needles with 50-mm-long, 0.22-mm-wide, with a plastic handle (Seirin Corporation, Shizuoka, Japan) were used.

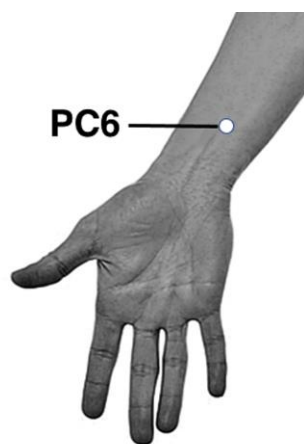


Fig. 1. Pericardium 6 (PC6) acupoint.

Practitioner's Background. One acupuncturist, with more than ten years of experience, performed all the acupuncture stimuli.

D. Study protocol

The subjects were instructed to abstain from alcohol for ≥ 24 h before the experiment, coffee, tea, and exercise on the day of the experiments, and to have a light meal two h before each experiment. During the study, the subjects remained supine. After registration of its clinical information, each subject was

at rest for ≥ 15 min before starting the records. The measurements were taken between 9:00 a.m. to 12:00 p.m. to standardize the circadian variations in blood pressure. After the rest period, the Finapres finger cuff was affixed to the middle finger of each subject. Data recording commenced, and after one-minute registration, manual acupuncture at the PC6 acupoint for an additional record of 5 min. After the needle was removed, an additional 5 min period was recorded. This study was fifteen records with the same experimental protocol, performed in the same laboratory. The outcome variables were: CO, HR, SV, TPR, and LVdP/dt(max).

E. Comparison and statistics

The records of each subject in the initial transacupuncture period of 30 seconds were plotted in the Plot2 software (Michael Wesemann, Berlin, Germany, 2019). Interpolated data for the fifteen subjects for that period were averaged, and an average curve of the acupuncture effect was obtained for every parameter. Subsequently, the curves corresponding to each variable were gathered in a single graph. A correlation of Pearson was used to examine a linear relationship between two variables using a statistical package (SPSS, version 22.0) (Chicago, USA). The level of statistical significance was $p < 0.05$.

III. RESULTS AND DISCUSSION

A. Parameters of mean arterial pressure

Fig. 2 shows the mean arterial pressure parameters: Cardiac output (CO) and total peripheral resistance (TPR) during the initial 30 seconds of manual acupuncture at PC6.

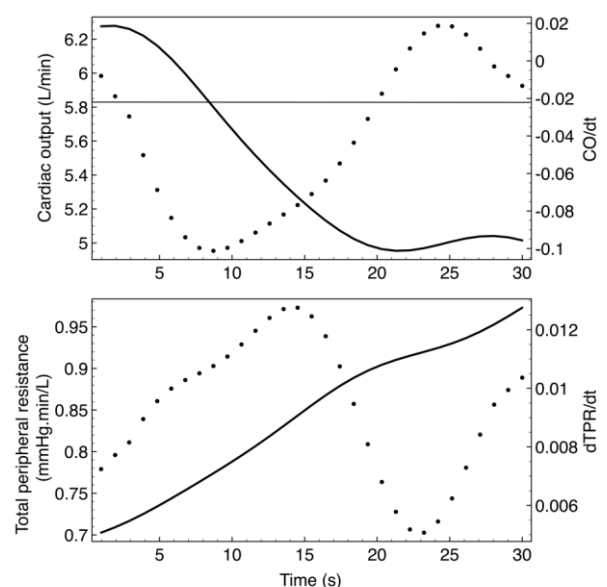


Figure 2. Parameters of mean arterial pressure: Cardiac output (CO) and total peripheral resistance (TPR) during the initial 30 seconds of manual acupuncture at the Pericardium 6 acupoint of left-side.

B. Parameters of cardiac output

Fig. 3 shows the cardiac output parameters: Heart rate (HR) and stroke volume (SV) during the initial 30 seconds of manual acupuncture at the left-side.

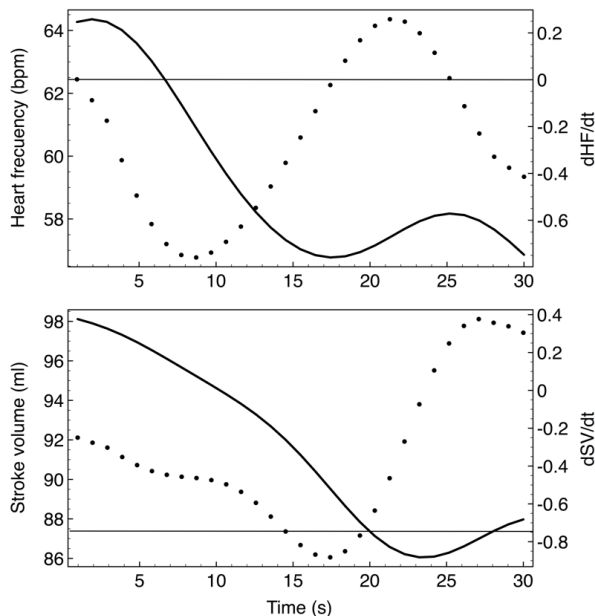


Figure 3. Parameters of cardiac output: Heart frequency (HF) and stroke volume (SV) during the initial 30 seconds of manual acupuncture at the left-side Pericardium 6 acupoint.

C. LVdP/dt(max)

Fig. 4 shows the LVdP/dt(max) changes during the initial 30 seconds of manual acupuncture at the left-side Pericardium 6 acupoint.

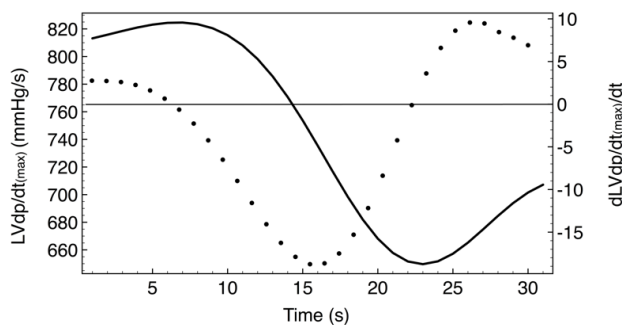


Figure 4. Changes of LVdP/dt(max) during the initial 30 seconds of manual acupuncture at left-side Pericardium 6 acupoint.

Fig. 5 shows the changes in heart rate (HR), stroke volume (SV), and LVdP/dt(max) during the initial 30 seconds of manual acupuncture at Pericardium 6 acupoint.

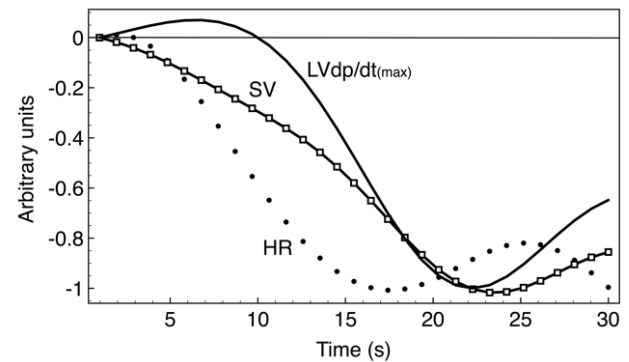


Figure 5. Changes in heart rate (HR), stroke volume (SV), and LVdP/dt(max) during the initial 30 seconds of manual acupuncture at Pericardium 6 acupoint.

Pearson correlation coefficient analysis showed positive and significant associations between SV and LVdP/dt(max) in the analyzed periods, both $p < 0.001$, a positive and significant with TPR in the second period $p = 0.0043$, and negative and non-significant association with the HR in the analyzed periods, $p = 0.4299$ and $p = 0.7061$ respectively, see Table 1.

Table 1. Pearson correlation coefficients (r^2) for the relation of the LVdP/dt(max) with heart rate, stroke volume, and total peripheral resistance after manual acupuncture in Pericardium 6 (PC6) acupoint.

	Periods			
	LVdP/dt(max) 0 – 15 s		LVdP/dt(max) 16 – 30 s	
	r^2	P	r^2	P
HR	-0.2204	0.4299	-0.1063	0.7061
SV	0.8239	< 0.001*	0.8800	< 0.001*
TPR	0.1067	0.7050	0.6720	0.0043*

HR= Heart rate; SV= Stroke volume; TPR= Total peripheral resistance.

r^2 = Pearson coefficient correlation. P= p-value.

* $p < 0.05$.

IV. DISCUSSION

This study provided evidence that manual acupuncture in PC6 immediately decreased CO, HR, SV, and LVdP/dt(max). Otherwise, TPR increased in a manner probably related to a compensatory response. The correlation analysis showed that the LVdP/dt(max) decrease was related to the SV diminution. The LVdP/dt(max) is a common, robust, and sensitive indicator of cardiac contractility changes if the experimental parameters such as preload, afterload, and heart rate are well-controlled [12]. LVdP/dt(max) has been proposed to evaluate inotropic effects of drugs [13]. To our best knowledge, this is the first report about the effect of acupuncture on LVdP/dt(max). The PC6 point is used successfully to treat pain related to myocardial infarction. Moreover, its analgesic effect is likely related to a decreased oxygen demand produced by a negative inotropic effect elicited by PC6, as reported in this research [14].

V. CONCLUSION

In conclusion, manual acupuncture of PC6 evoked a complex cardiovascular response, probably related to a vagal response and a negative inotropic effect. Further intervention studies are needed to assess if acupuncture at PC6 could elicit changes in myocardial function.

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