

## Original article

# Kinetics of cardiovascular function changes elicited by auricular acupuncture in Heart point



José Federico Rivas-Vilchis<sup>a,\*</sup>, Fernando Hernández-Sánchez<sup>b</sup>,  
 Moisés Salvador Castañeda-Ramírez<sup>a</sup>

<sup>a</sup> Especialización en Acupuntura y Fitoterapia, División de Ciencias Biológicas y de la Salud, Unidad Iztapalapa, Universidad Autónoma Metropolitana, México

<sup>b</sup> Unidad de Materiales, Centro de Investigación Científica de Yucatán, AC. Mérida, Yucatán, México

## ARTICLE INFO

## Article history:

Received 1 February 2020

Accepted 23 March 2020

Available online 27 June 2020

## Keywords:

Auricular acupuncture

Cardiac output

Heart auricular acupoint

Mean arterial pressure

Heart rate

Stroke volume

## ABSTRACT

**Objective:** This study aimed to analyze the effect of acupuncture in Heart auricular point on cardiovascular function in healthy subjects.

**Design:** A kinetics cross-sectional experimental study was conducted at Clínica de Acupuntura, Unidad Iztapalapa, Universidad Autónoma Metropolitana, Ciudad de México, México. **Participants:** Eight healthy university students (four women) aged  $21.12 \pm 1.81$  (mean  $\pm$  SD) participated in the present study to investigate the kinetics of the acute effect of acupuncture stimulation at auricular point Heart.

**Interventions:** The study consisted of one session of manual auricular acupuncture in the Heart point in the right ear. The following data for every heartbeat: Cardiac output (CO), heart rate (HR), stroke volume (SV), mean arterial pressure (MAP), and systemic vascular resistance (SVR) were computed. Manual acupuncture was applied at the auricular point Heart.

**Results:** This treatment showed an inhibitory effect on CO, HR, SV, and MAP; and stimulatory effect on SVR. Our results showed that acupuncture at the auricular point Heart initially produced a decrease in both HR and SV, therefore in CO; and secondly, a rise of SVR as a compensatory response.

**Conclusions:** Data suggest the possibility of vagal stimulation immediately after auricular acupuncture in Heart point with a secondary sympathetic response.

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## Cinética de los cambios en la función cardiovascular provocados por auriculopuntura en el punto Corazón

## RESUMEN

**Objetivo:** El objetivo de este estudio fue analizar el efecto en la función cardiovascular provocado por la auriculopuntura en el punto Corazón en sujetos sanos.

## Palabras clave:

Auriculopuntura

Gasto cardiaco

\* Corresponding author. Mailing address: San Rafael Atlixco 186, Ciudad de México, México 09340. Tel.: +5558044920. FAX. +5558044728  
 E-mail address: [jfrv@xanum.uam.mx](mailto:jfrv@xanum.uam.mx) (J.F. Rivas-Vilchis).

<https://doi.org/10.1016/j.acu.2020.03.003>

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Acupunto auricular Corazón  
 Presión arterial media  
 Frecuencia cardiaca  
 Volumen sistólico

**Diseño:** Este estudio experimental cinético y transversal fue realizado en la Clínica de Acupuntura, Unidad Iztapalapa, Universidad Autónoma Metropolitana, Ciudad de Méjico, Méjico.

**Participantes:** En el presente estudio participaron ocho estudiantes universitarios sanos (cuatro mujeres), con edades de  $21,12 \pm 1,81$  (media  $\pm$  DE), para investigar la cinética del efecto agudo de la auriculopuntura en el punto Corazón.

**Intervenciones:** El estudio consistió en una sesión de auriculopuntura manual en el punto Corazón del oído derecho. Se computaron los siguientes datos para cada latido del corazón: gasto cardiaco (GC), frecuencia cardiaca (FC), volumen sistólico (VS), presión arterial media (PAM), y resistencia vascular sistémica (RVS). Se aplicó auriculopuntura manual en el punto Corazón.

**Resultados:** Este tratamiento reflejó un efecto inhibitorio en GC, FC, VS y PAM, y un efecto estimulador en RVS. Nuestros resultados reflejaron que la auriculopuntura en el punto Corazón produjo inicialmente un descenso de FC y VS y, por tanto de GC, y en segundo lugar un incremento de RVS como respuesta compensatoria.

**Conclusiones:** Los datos sugieren la posibilidad de estimulación vagal tras la auriculopuntura en el punto Corazón, con respuesta simpática secundaria.

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## Introduction

Although traditional theories explain acupuncture effects based on the principle of energy flow in paths called channels, using modern technology, one can demonstrate experimental or clinically some of the effects and mechanisms of acupuncture stimulation in different organic systems.<sup>1-3</sup> The Finapres finger cuff recording system allows in experimental subjects to immediately, continuously, and noninvasively visualize changes in mean arterial pressure (MAP), heart rate (HR), stroke volume (SV), cardiac output (CO) and systemic vascular resistance (SVR) through continuous calculations of beat-to-beat variations. This system allows us to examine changes in these variables at rest or during movement<sup>4-6</sup>; therefore, this system could continuously assess the effect of acupuncture interventions.

Auriculotherapy is frequently used to treat cardiovascular disorders.<sup>7</sup> It has been reported that auricular acupuncture improves prehypertension and hypertension.<sup>8</sup> Many researchers have used the auricular stimulus as a noninvasive assessment of the autonomic nervous system, and to study the heart rate variability among other cardiovascular variables.<sup>9</sup> The auricular Heart point has been used to improve vascular hypertension,<sup>10</sup> and to modify second-derivative indices of photoplethysmogram.<sup>11</sup> The Heart point locates in the center of the concha cavum of the ear,<sup>12</sup> see [Figure 1](#). Our study aimed to analyze the kinetics of cardiovascular effects of auricular acupuncture in the Heart point of healthy subjects.

## Materials 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.

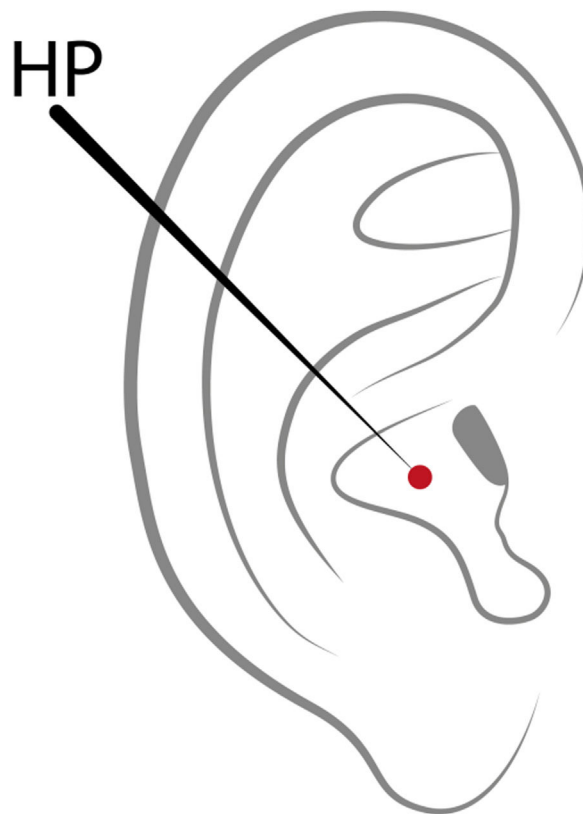


Figure 1 – Auricular Heart point.

**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 8 (4 female) healthy subjects having a global age of  $21.12 \pm 1.81$  (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 ten days before the study.

### Ethical aspects

The institutional Biological and Health Division Ethics Committee approved this study (Approval Number 15.04.16). The study conforms to the principles of the revised version of the Declaration of Helsinki (World Medical Association 2013). The subjects gave written, informed consent to participate.

### Instrumentation and recordings

A continuous beat-to-beat blood pressure (BP) data from our sample of 8 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. The Finapres system provides continuous and concurrent calculations of CO, BP, SV, SVR, and HR; and it is commonly used in research settings. Participants completed a supine resting recording period of 2 min. Data recorded estimate hemodynamic parameters using the Modelflow method based on a three-element Windkessel model.<sup>13</sup> 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.<sup>14</sup> SVR was determined as the quotient of ModelFlow-derived MAP divided by CO. The unit of measurement for ModelFlow SVR is CGS units, i.e.,  $\text{dys.s.cm}^{-5}$ .

### 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).

### Auricular acupuncture treatment

Manual acupuncture without additional electrical or laser stimulation was applied on the auricular point Heart, [Figure 1](#). The point in the ear was traditionally located wherein the needle was inserted vertically to a depth of 2 mm for 60 seconds. Sterile acupuncture needles that were 13 mm, 0.22 mm, with a silver handle (Seirin Corporation, Shizuoka, Japan) were used.

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

### Study Protocol

The subjects were instructed to abstain from alcohol for  $\geq 24$  h before the experiment; and coffee, tea, and exercise on the day of 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 a period  $\geq 15$  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 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 of registration, acupuncture in the right auricular Heart point was applied for and additional record of 60 seconds. After the needle was removed, the recording was stopped. This study was eight records with the same experimental protocol, performed in the same laboratory. The outcome variables were: CO, HR, SV, MAP, and SVR.

### Comparisons and statistics

The records of each subject in the transacupuncture period of 60 seconds were plotted in the Plot2 software (Michael Wesemann, Berlin, Germany, 2019). Interpolated data for the eight subjects for that period were averaged, and a kinetic curve of the acupuncture effect was obtained for every parameter. Subsequently, the curves corresponding to each variable were gathered in a single graph. The data initial and final during the acupuncture period for each variable were compared with the t-student of the two-tail test. The data were statistically analyzed, using statistical package for the social sciences (SPSS, version 22.0) (Chicago, USA). Data are indicated as means  $\pm$  SD. The level of statistical significance was  $p < 0.05$ .

## Results

### Kinetics study

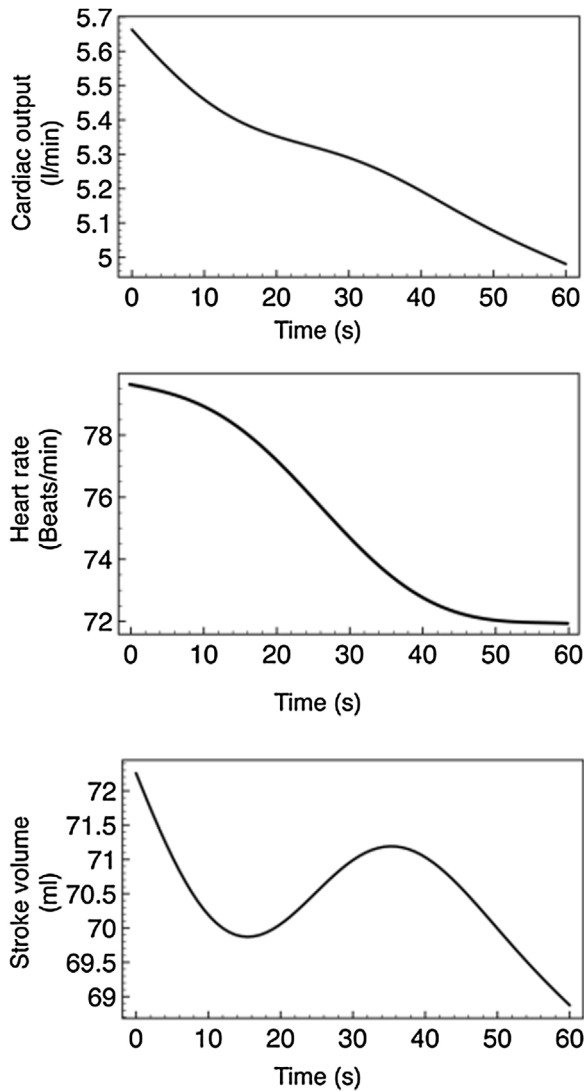
**CO and SV.** Continuous and noninvasive measurement of cardiovascular parameters is essential for a better understanding of the mechanisms of acupuncture. The time courses of the beat-to-beat changes of CO, HR, and SV are shown in [Figure 2](#). CO is the volume of blood the heart pumps per minute and calculated by multiplying the stroke volume by the heart rate. As soon as the auriculopuncture treatment was started, HR and SV steadily decreased, and therefore CO diminished.

**Mean arterial pressure and systemic vascular resistance.** The time courses of the beat-to-beat changes of MAP and SVR are shown in [Figure 3](#). Despite a significant decrease in CO ( $p=0.027$ ), acupuncture in Heart point produced only a marginal decrease in MAP because of a compensatory and significant increase in SVR ( $p=0.036$ ), see [Figure 3](#).

The changes in cardiovascular parameters elicited by auricular puncture are shown in [Table 1](#). Although HR and SV had a non-significant decrease, CO showed a significant reduction ( $p=0.027$ ) by auriculopuncture.

### Correlations

The Pearson correlation coefficient analysis ([Table 2](#)) showed significant and positive associations between the decrease in the CO and HR ( $p=0.0062$ ), and a strong positive association with the SV ( $p<0.00001$ ). Respect the MAP, a significant and positive association was seen between the decrease in the MAP either the CO ( $p=0.0017$ ), or HR ( $p=0.0132$ ); whereas a non-significant and negative with the SVR ( $p=0.6549$ ).



**Figure 2 – Data shown are average of 1 min records of a continuous register of cardiac output, heart rate, and stroke volume of each subject.**

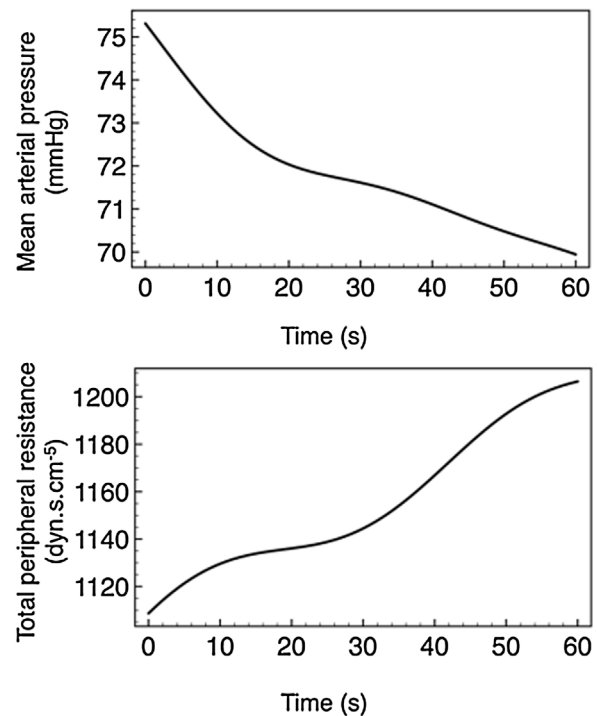
**Table 1 – The changes of cardiovascular parameters before and after manual acupuncture in Heart auricular point.**

Parameters	Basal	Pos-treatment	p-value
CO (L/min)	5.81 ± 1.22	4.97 ± 0.93	0.027*
HR (beat/min)	79.23 ± 11.61	73.12 ± 6.35	NS
SV (ml)	74.33 ± 16.42	68.51 ± 14.22	NS
MAP (mmHg)	76.11 ± 9.02	70.32 ± 10.11	NS
SVR (dyn.s/cm <sup>5</sup> )	1079.20 ± 236.54	1190.85 ± 294.05	0.036*

Mean ± standard deviation.  
 CO=Cardiac output; HR=Heart rate; SV=Stroke volume; MAP=Mean arterial pressure; SVR=Systemic vascular resistance.  
 \*p< 0.05

**Discussion**

Our results regarding the decrease in HR are in agreement with those of previous reports. In humans, acupressure in



**Figure 3 – Data shown are average of 1 min of a continuous register of mean arterial pressure, and systemic vascular resistance of each subject.**

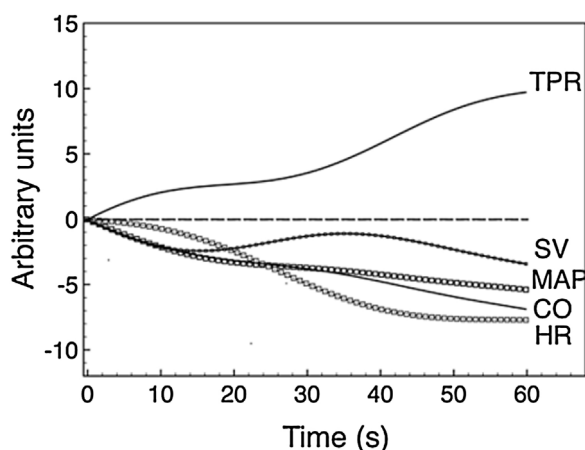
**Table 2 – Pearson correlation coefficients (r<sup>2</sup>) for the relation of the factors determinating cardiac output and mean arterial pressure after manual acupuncture in Heart auricular point.**

	r <sup>2</sup>	p
CO=HR x SV		
CO and HR	0.3173	0.0062*
CO and SV	0.5158	0.00001*
MAP=CO x SVR		
MAP and CO	0.3608	0.0017*
MAP and SVR	-0.0532	0.6549

CO=Cardiac output; HR=Heart rate; SV=Stroke volume; MAP=Mean arterial pressure; SVR=Systemic vascular resistance.  
 \*p< 0.05.

Heart point produced a significant reduction of HR in healthy volunteers<sup>9</sup>; and auriculopuncture also reduced heart rate in athletes.<sup>15</sup> Besides, in experimental models with animals, auricular point Heart showed an inhibitory effect on arterial pressure and heart rate, and the authors proposed that this treatment regulates cardiovascular function by activating baroreceptor sensitive neurons in the nucleus tractus solitarius.<sup>16</sup>

Consequently, the decrease observed in heart rate and stroke volume could be explained for a decrease in sympathetic system activity or an increase in vagal tone as it has been reported in experiments with auricular points stimulation.<sup>15,17,18</sup> Our results showed that acupuncture in Heart point produced a remarkable increase in SVR. We hypothesized that the increase in the SVR was a secondary



**Figure 4 – Summary of the effects of acupuncture in Heart auricular point. SVR= systemic vascular resistance, SV= stroke volume, MAP= mean auricular pressure, CO= cardiac output, HR= heart rate.**

response to the reduction in MAP related to the reduction of CO, as shown in Figure 4.

Conclusions. The following conclusions can be drawn from the results of this study: HR steadily decreased, and SVR sharply increased during acupuncture in Heart auricular point. Otherwise, CO decreased accordingly to HR, whereas the SVR increased in a manner probably related to a compensatory response.

### Conflict Of Interest

The authors have no conflict of interest to declare.

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