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Effect of sympathetic auricular acupoint in orthostatic response

José Federico Rivas-Vilchis [1,*], Fernando Hernández-Sánchez [2] and Moisés Salvador Castañeda-Ramírez [1]

[1] *Specialization in Acupuncture and Phytotherapy, Division of Biological and Health Sciences, Iztapalapa Unit, Metropolitan Autonomous University, Mexico.*
[2] *Materials Unit, Yucatan Scientific Research Center, AC. Merida, Yucatan, Mexico.*

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Abstract

Objective: To elucidate the effect of auriculopuncture in Sympathetic points on autonomic function, we investigated the heart rate (HR) response to orthostatic challenge in healthy subjects.

Design and setting: An experimental and cross-sectional study was conducted at Acupuncture Clinic, Universidad Autónoma Metropolitana, and México.

Participants. Twenty healthy university students (twelve women) aged 22.7 ± 1.5 (mean ± SD) participated in the study.

Interventions and outcomes: The study consisted of two sessions of auricular acupuncture in the Sympathetic point in the right or left ear. The data for continuous normal beat-to-beat recording to derive the statistical parameters of the normal R-R intervals of the electrocardiogram was obtained using the SphygmoCor equipment (AtCor Medical Pty Ltd, Sidney, Australia). The registration periods were computed in a supine position and then after standing. The primary outcomes were the changes in the velocities of the primary HR increase, bradycardia secondary response, and interval between the times of maximum increase in HR and minimum in secondary response.

Results: Acupuncture at the Sympathetic point in the right ear raises the velocity of the initial HR increase and decreases the velocity of bradycardia secondary response and elicits a shortening of the period between the maximum increase and minimum in the secondary response in HR, in all cases significant. Otherwise, auriculopuncture in the Sympathetic point of the left ear did not produce significant changes in the outcomes studied.

Conclusion: Data suggest that auriculopuncture in the Sympathetic right point elicits a vagal suppression in the initial orthostatic response to active standing.

Keywords: Auricular acupuncture; Orthostatism; Sympathetic auricular acupoint; Heart rate; Standing

1. Introduction

Auriculomedicine treats several conditions, principally pain,[1,2] insomnia,[3] and gastrointestinal disorders. [4] Some studies have suggested that auriculotherapy would modulate the reticular formation and the autonomic nervous system.[5]

* Corresponding author: José Federico Rivas-Vilchis
Health Sciences Department, Universidad Autónoma Metropolitana, México City, México.

Active standing is helpful in assessing responses during the initial phase of the orthostatic challenge, and it is the best test to diagnose some disorders of the autonomic nervous system, including idiopathic orthostatic hypotension.[6] Sympathetic insufficiency or sympathetic withdrawal upon assuming an upright posture (standing), as observed in orthostasis, is abnormal and can present as occasional or frequent dizziness or lightheadedness upon standing.[7] Orthostatic hypotension is an independent risk factor for all-cause mortality and cardiovascular morbidity.[8] Therefore, the complexity of the homeostatic responses that maintain blood pressure and ensure adequate perfusion of major organs makes it challenging to manage orthostatic disorders with medications and other therapeutic measures.[9]

Clinical and experimental observations have suggested that acupuncture may have therapeutic and preventive effects on various types of hypertension, coronary heart disease, dysrhythmias, and myocardial infarction.[10,11] Recent studies have supported the efficacy of auricular point stimulation to change activity in the sympathetic and parasympathetic nervous systems.[12,13] In addition, stimulation of the sympathetic point has been observed to significantly decrease electrodermal response compared to placebo auricular stimulation at a non-specific point on the helix.[14] Auriculoacupuncture on the right-side or left-side Sympathetic points has different effects on mean arterial pressure and cardiac output.[15]

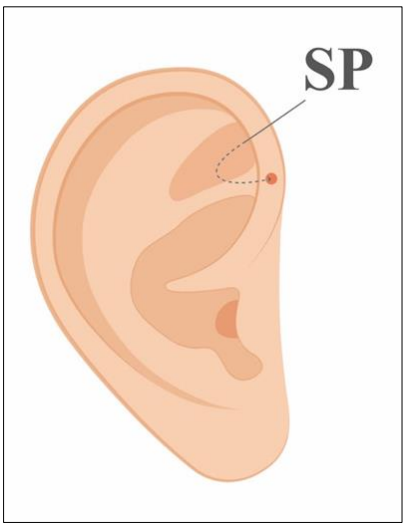


Figure 1 Auricular Sympathetic point

Aim

Therefore, the essential objective of this study was to assess whether stimulation of the auricular Sympathetic acupuncture point modifies the acute homeostatic response to active standing in healthy subjects; and to analyze whether auriculopuncture in the right or left Sympathetic auricular point has different effects.

2. Material and methods

2.1. Study design

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

2.2. Population

All the subjects included in this study were healthy volunteers of Universidad Autónoma Metropolitana, Ciudad de México, México. There were 20 healthy subjects (twelve women) aged 22.7 ± 1.5 (mean ± SD). Subjects were free of all cardiorespiratory, autonomic, and systemic illnesses, took no medications, and were non-smokers, with body mass index < 25.0 kg/m2, and without medication or treatment with acupuncture in the last two weeks before the study, see Table 1. In addition, all subjects refrained from caffeine, alcohol, and intense exercise for at least 24 h prior to testing.

2.3. Ethical aspects

The Biological and Health Division Ethics Committee approved the protocol that conformed to the Declaration of Helsinki.[16] Furthermore, the subjects were given a full explanation of the study and signed written informed consent.

2.4. Instrumentation and recordings

This study obtained continuous normal beat-to-beat recording was obtained using the CVMS-CPH model SphygmoCor equipment, manufacturer AtCor Medical Pty Ltd, Sydney, Australia. The device considers the normal heartbeats to derive the statistical parameters of the normal R-R intervals of the electrocardiogram. In addition, filtration methods removed ectopic beats. A typical five-minute recording of the HR curve after standing is shown in Figure 2.

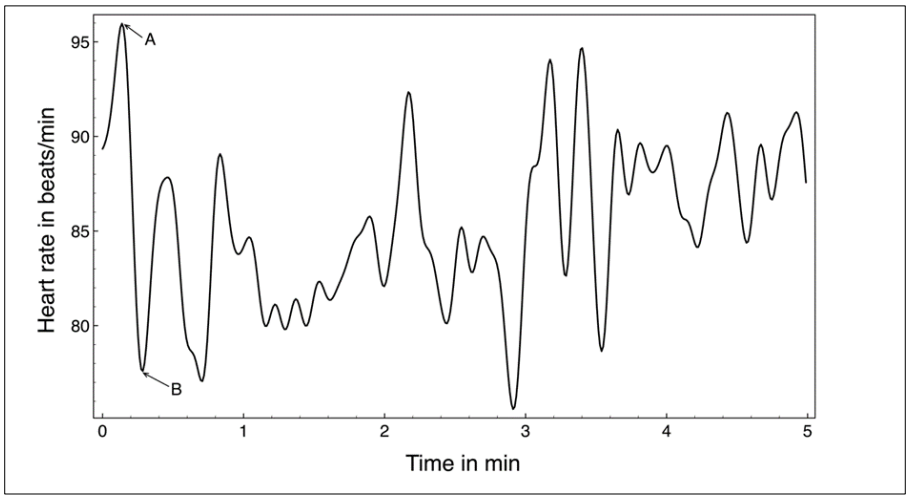


Figure 2 A typical smoothed representation of the heart rate curve during the orthostatic response. After standing, the initial heart rate changes were: A= initial increase in heart rate; B= secondary decreased heart rate

The RR intervals were analyzed in the recorded data with the Plot 2 software (Version 2.6.15, © micw.org, 2019, Wesemann M, USA). This software allows us to convert the RR intervals to heart rate, normalize the curve to seconds or minutes, smooth the signal, obtain derivatives, and conduct subsequent offline reviews, see Figure 3.

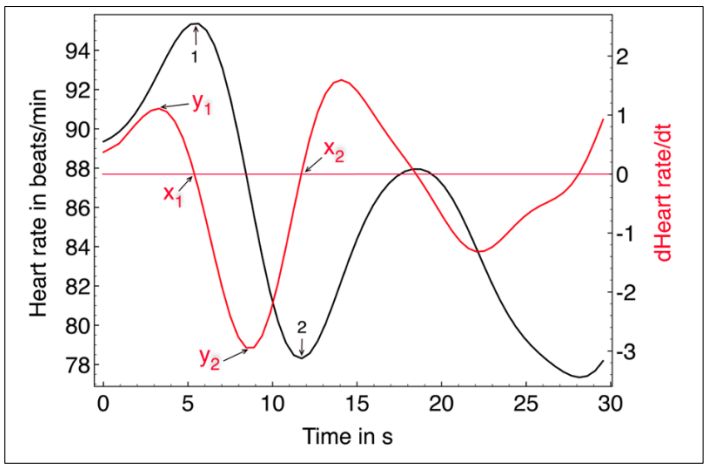


Figure 3 Smoothed representation of heart rate response during the first minute after standing (black line) and its corresponding first derivative curve (red line). The left y-axis represents heart rate in beats/min; the y-axis represents the first derivative of heart rate in dheart rate/dt. The X-axis represents the time in minutes

2.5. Auriculopuncture treatment

The Sympathetic auricular point on either right or left ear was selected for manual auriculopuncture stimulation. The point was located conventionally, and manual auriculopuncture 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 ear skin surface to an average depth of 2.0 mm, no additional stimulation was performed, and the needle remained inserted for one minute.

2.6. Practitioner's Background

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

2.7. Study protocol

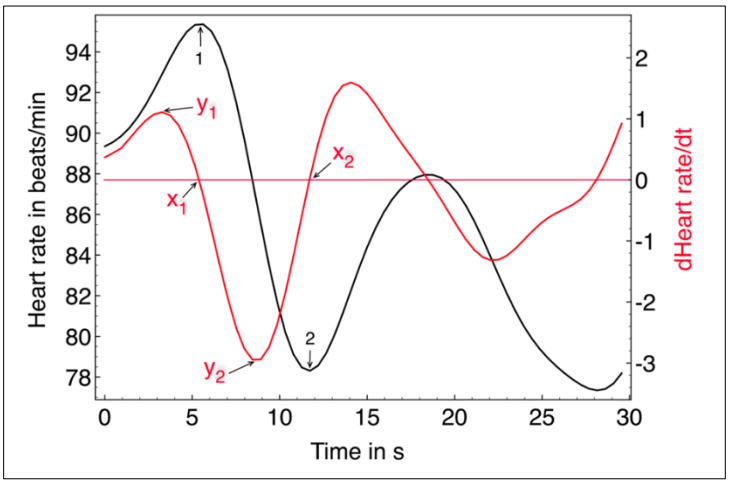
The experimental procedures were performed between 9:00 and 13:00 AM inside a quiet room maintained at 22 to 24 °C. Following a 15 min acclimatization period, a continuous normal heartbeat recording was taken. Each record of heartbeats was as follows: after an initial period of five-minute in the supine position, the subjects were gently helped to reach the standing position, followed by a five-minute recording in the standing position. After 20 minutes of rest in the supine position, the Sympathetic point of auriculotherapy was applied for 1 min, and the continuous recording was repeated in the supine and the standing positions, as mentioned.

All subjects could tolerate the 5 min stand-up, and none reported pre-syncope symptoms. Medical personnel and an open bed were available should a subject become syncopal. The two records with the same procedure were repeated in the right or left ear after a one-week washout.

2.8. Experimental sequence

- An initial period of five minutes in the supine position
- Change to stand position
- Five minutes in the standing position
- Twenty minutes of rest in the supine position
- One minute of auriculopuncture
- Initial period of five-minute in the supine position
- Change to stand position
- Five minutes in the standing position

2.9. Outcomes measures



1= the maximum initial increase in heart rate; 2= secondary decrease in heart rate. y_1= point of the maximum speed of the initial increase in heart rate; y_2= point of the maximum decrease speed in heart rate after standing; x_1= time of the point of the maximum initial increase in heart rate, according to the first derivative; x_2= time of the point of maximum secondary decrease in heart rate according to the first derivative.

Figure 4 Analysis points for the heart rate recording across the active standing of the subject and its first derivative. Heart rate in beat/min (black line) and its derivative dheart rate/dt (red line) during the first 30 seconds after active standing

Figure 4 shows the analysis points in the heart rate recording after the active standing of the subject and its first derivative of the normal wave without notching or slurring; whenever the HR velocity reached a maximum or a minimum acceleration, it corresponds with a zenith o nadir point in the derivative curve (red line), respectively. The following parameters were calculated:

- The máximum speed value of the initial increase in heart rate (y_1);
- The máximum speed value in the secondary decrease of heart rate (y_2);
- The delta of $x_2 - x_1$.

2.10. Statistical analysis

Because there were no significant differences between the experimental values from men and women, both data were combined for analysis. Results were reported as means ± standard deviation. The *t*-student test was used for the comparison of paired data. Besides, a $p < 0.05$ was considered significant. For all tests, two tails were used. For the statistical analysis, the software Origin (v.7.0 SR1; Northampton, MA, USA) was used.

3. Results

A total of 20 healthy subjects with outright measures of normal R-R intervals of the electrocardiogram were included in these analyses. The demographic characteristics of the subjects are presented in Table 1.

Table 1 Demographic characteristics of the population

Parameters	All	Women	Men
Subjects	**20**	**12 (60%)**	**8 (40%)**
Age	22.7 ± 1.5	22.3 ± 1.4	23.1 ± 1.5
BMI	22.6 ± 2.1	22.5 ± 1.6	23.2 ± 2.7

Data are mean ± SD. BMI = body mass index.

Comparison of outcomes in heart rate changes during orthostatic stress in untreated subjects versus those treated with auriculopuncture in Sympathetic points are shown in Tables 2 and 3 for the right and the left ear lobes, respectively.

Table 2 Effect of auriculopuncture in right auricular Sympathetic point in immediate heart rate response after standing

Parameter	Basal	Post treatment	P-value
y1 of derivative (mean ± SD)	1.2 ± 0.6	1.6 ± 0.6	0.0129*
y2 of derivative (mean ± SD)	-3.2 ± 1.9	-2.3 ± 0.9	0.0352*
Delta x1 – x2(mean ± SD)	15.9 ± 6.3	14.8 ± 6.9	0.0284*

Data are mean ± SD. For explanations of parameters see Figure 4; * P-value < 0.05

Acupuncture at the Sympathetic auricular point of the right ear significantly modified the response to orthostatic stress. Sympathetic right point raised the velocity (y_1) of the primary increase in HR (p= 0.0129), decreased the velocity (y_2) of the secondary bradycardia response (p= 0.0352), and elicited a shortening of the period between the maximum increase in HR and its minimum in the secondary response, that is delta x1 – x2 (p= 0.0284), see Table 2. Otherwise, auriculopuncture in the Sympathetic point of the left ear did not produce significant changes in the variables studied, see Table 3.

Table 3 Effect of auriculopuncture in left auricular Sympathetic point on immediate heart rate response after active standing

Parameter	Basal	Post treatment	P-value
y1 of derivative (mean ± SD)	1.2 ± 0.5	1.1 ± 0.63	0.3271
y2 of derivative (mean ± SD)	-3.3 ± 2.0	-2.6 ± 0.9	0.1129
Delta x1 – x2 (mean ± SD)	14.8 ± 11.4	12.4 ± 10.7	0.1552

Data are mean ± SD. For explanations of parameters, see Figure 4; * P-value < 0.05

4. Discussion

The noteworthy findings of this study were that acupuncture at the Sympathetic point in the right ear raised the velocity of the primary HR augmentation, diminished the velocity of bradycardia response secondary to the immediate increase in HR, and elicited a shortening of the period between the maximum increase in HR and the minimum in the secondary response, in all cases significant. On the other hand, the puncture in the Sympathetic point of the left ear did not produce significant changes in the variables studied.

4.1. Physiological response to standing

The assumption of upright posture induces gravitational blood pooling in the lower extremities to reduce venous return to the heart. The above changes result in a rapid reduction in the central blood volume and subsequent reduction in the mean blood pressure.[17] Therefore, maintaining blood pressure upon the assumption of upright posture depends on rapid cardiovascular adaptations driven primarily by the autonomic nervous system and hormonal reflex mechanisms that compensate for impaired venous return.[18]

4.2. Changes in heart rate after standing

Baroreflex activation after standing stimulates the sympathetic nervous system, diminishes the activity of the parasympathetic nervous system, and increases HR. Therefore, the heart rate when standing increases in the first 10-15 s, then decreases and recovers to the baseline normal heart rate after 20-20 s. This biphasic response is attributed mainly to changes in the baroreceptor activity.[19] Besides, the initial surge in heart rate that occurs in the first few seconds after standing is followed by rapid inhibition of vagal activity.[20,21] The peak heart rate reached at about 10-15 s after standing is a product of vagal withdrawal and sympathetic activation acting in coordination. Heart rate declines rapidly after this point due to rebounding arterial pressure.[22] There is a particularly steep drop-in heart rate between 10 and 20. Vagal reactivation plays an essential role in regulating the rate at which the heart rate recovers, especially during the first 30 s.[23] Therefore, heart rate responses to standing are the mainstream in assessing the baroreflex function integrity. Accordingly, active standing is the standard orthostatic stress test to assess postural changes in blood pressure and HR in research and clinical practice.[24]

4.3. Sympathetic stimulation and heart rate

In our study, the change in HR concerning time represents a magnitude called speed, or velocity if we consider the direction of the change in HR, which we write: $v = dHR$; that is, the velocity represents the derivative (change) of the increase or decrease in HR concerning time (t). Therefore, the first derivative of the curve of changes in HR allows us to detect the magnitude of changes in velocity that occur in heartbeats related to orthostatic stress in our experiments. Therefore, the changes in the ANS that involve suppression of vagal function and enhanced sympathetic function in orthostatic stress,[25] could be characterized through the changes in the velocity of heart rate after standing. Besides, the failure of these adaptive mechanisms can cause orthostatic hypotension and other deleterious effects for the patient.[26] Otherwise, the observed effect of acupuncture on the Sympathetic right point was probably associated with the reduction in vagal tone and an increase in the activity of the sympathetic nervous system. These results align with the previous hypothesis that the evoked sudomotor response by Sympathetic point stimulation could be related to enhanced sympathetic activity.[27]

Hence, the response observed in this study related to the application of auricular acupuncture that could improve a pattern of optimum sympathetic activation and vagal withdrawal during the realization of the active standing test may be helpful in patients with an inadequate ANS adaptive response.

5. Conclusion

In conclusion, auriculopuncture at the Sympathetic point produced significant changes in the curve of the first derivative of changes in HR during orthostatic stress. These modifications are compatible with an improvement in the adaptive response of the organism to active orthostasis. In contrast, stimulation of the left Sympathetic point did not significantly modify the variables studied.

Finally, we believe this analysis is a convenient method for studying the effect of acupoints and clinical studies of pathological orthostatic responses. Besides, trials with a significant number of patients with orthostatic hypotension will establish whether acupuncture in Sympathetic auricular points can help in treat orthostatic disorders.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors have no conflict of interest to declare.

Statement of ethical approval

The Biological and Health Division Ethics Committee of the Institution approved the protocol that also conformed to the Declaration of Helsinki.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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