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Effect of acupuncture at Shaofu acupoint on the cardiovascular system of healthy individuals

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Abstract

Background: Clinical and experimental observations show that acupuncture has been utilized as adjuvant therapy for a number of conditions, including hypertension, coronary heart disease, dysrhythmia, and myocardial infarction.

Objective: To determine the cardiovascular (CV) reactivity in terms of blood pressure (BP), heart rate (HR), pulse wave velocity (PWV), and left ventricular ejection time (LVET) in response to acupuncture stimulation of the Shaofu (HT8) acupoint

Methods: Resting systolic blood pressure (SBP) and diastolic blood pressure (DBP), HR, PWV, and LVET were recorded in 8 healthy subjects (age 20 years) in a supine position after 10 minutes of rest, 20 minutes after needle stimulation of Shaofu acupoint, and 10 minutes after removal of the acupuncture needle. Data were analyzed using one-way ANOVA.

Results: SBP, DBP, HR, PWV, and LVET all remained on the same levels during acupuncture intervention and after the removal of the acupuncture needle relative to baseline values.

Conclusion: Acupuncture at Shaofu acupoint has no CV effects.

Keywords: acupuncture; Shaofu acupoint; pulse wave velocity (PWV); pulse transit time (PTT); left ventricular ejection time (LVET).

Introduction

Clinical and experimental observations show that acupuncture has been utilized as adjuvant therapy for a number of conditions, including coronary heart disease, dysrhythmia, myocardial infarction[1] and hypertension[2]. Auricular acupoints (4 studies, 23.5%), ST36 (6 studies, 35.3%), and PC6 (10 studies, 64.7%) were the next most often used acupoints.[3] The PC6 acupoint (PC6), one of the most widely utilized key acupoints, is used to treat CV-related ailments.[4,5] Healthcare practitioners are increasingly using traditional medicine techniques, including acupuncture, electroacupuncture, and transcutaneous electrical acupoint stimulation (TEAS), despite the dearth of research on their benefits on CV diseases.[6] Various mechanisms have been described for the effect of acupuncture on CVDs.[6] Acupuncture at the Shaofu (HT8) acupoint has been used in traditional Chinese medicine (TCM) for the treatment of heart failure and patients with hypertrophic obstructive cardiomyopathy.[7] However, to the best of our knowledge, no previous study in the field of Western medicine has ever been conducted to verify the effect of acupuncture at the Shaofu acupoint per se on CV parameters in healthy individuals. Only one previous study has been found, whereby acupuncture at the Shaofu acupoint had been conducted, but that was in simultaneous association with the activation of another acupoint, namely, the Neiguan (PC6) acupoint.[7] In addition, the latter study had been applied to patients with idiopathic cardiomyopathy rather than to healthy volunteers.[7] One previous study investigated the hemodynamic changes caused by acupuncture in healthy volunteers, but still, the used acupoint wasn't the Shaofu acupoint.[8,9] In addition, three previous studies investigated the effect of acupuncture on carotid atherosclerosis, radial artery pressure pulse wave and artery elasticity, yet none of them had included the Shaofu acupoint among the used acupoints.[9-11]

PWV and its determinant, the pulse transit time (PTT), are indices of arterial stiffness, and their prognostic value has been repeatedly emphasized.[12] The whole-body cardiovascular events are partially reflected by the PWV (and PTT).[13] Clinically significant PWV and PTT tests can be used to help diagnose diabetes, coronary atherosclerosis, and hypertension.

Additionally, PWV (and PTT) can reveal physiological data such as arrhythmia, growth hormone imbalances, smoking, thyroid dysfunction, and other conditions in addition to cerebrovascular illness, congestive heart failure, peripheral

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vascular disease, and renal failure.[14] The time it takes for the pressure wave generated by the left ventricular contraction to move from one artery site to another is known as the PTT.[15] The aortic valve's opening and closing, which is primarily governed by pressure variations across the valve, defines the LVET. LVET is a composite measure of left ventricular function that is impacted by preload and afterload and affected by cardiac inotropic function.[16] In the ailing heart, the LVET will change during diseases, such as ischemic heart disease, heart failure, hypertension, and aortic stenosis.[17] The ability of the failing heart to maintain a high LV pressure during the ejection period declines as the left ventricular function deteriorates, which lowers the heart's capacity to generate contractile force and lowers the LVET.[17]

Although numerous studies[3] have documented the effects of PC6 on the cardiovascular system (CVS), other acupoints on the PWV and LVET remain poorly studied. Therefore, the current study seeks to investigate the effect of acupuncture at the Shaofu acupoint (HT8) on several CV parameters, including PTT, LVET, SBP and DBP, and pulse rate, (PR) in healthy individuals.

Methodology

This study was conducted at the Department of Physiology/College of Medicine/Mustansiriyah University between September 2022 and April 2023. All subjects provided verbal and written informed consent. All procedures and protocols followed the standard principles in the Declaration of Helsinki. We conducted a prospective clinical study to observe the effect of acupuncture stimulation of the Shaofu acupoint on the CVS in healthy young participants.

Eight healthy young adult males were recruited for the study. All were second-year medical students (age 20 years). None reported any symptoms or signs of cardiovascular or respiratory disease, or had any major medical illness or were taking medications for a major illness. The volunteers were neither smokers nor drinkers of alcohol, and they fasted overnight. Height and weight were measured. The volunteers were instructed to relax in a darkly lighted room for 10 minutes while lying supine with their heads slightly bent and entirely supported by the couch surface. The subjects' SBP and DBP were determined repeatedly until stable readings were obtained to ensure hemodynamic stability. BP and HR measurements were taken with an automated sphygmomanometer (Rossmax Swiss GmbH, Tramstrasse 16, CH-9442 Berneck, Switzerland) on the right brachial artery. Throughout the protocol, the individuals were instructed to maintain spontaneous breathing. The volunteer was connected to a piezoelectric finger pulse transducer to record the fingertip digital pulse wave (DPW) signals of the left terminal phalanx of the middle finger and the Lead II ECG through three surface electrodes, all of which were connected to a PowerLab data acquisition unit 26T (ADInstruments Pty Ltd, New South Wales, Australia). The most common procedure for determining the PTT is to measure the time difference between the R peak of the ECG and a reference point of the DPW, such as the point that corresponds to the maximum first derivative of DPW (at which the photoplethysmographic (PPG) signal reaches 50% of amplitude between apex and onset points)[18] (**Figure 1**). PWV is calculated as follows: PWV = PTT / D, where "D" is the artery length between the heart and the terminal phalanx of the left middle finger (in cm and is calculated as 0.5 × body height[19] and PTT [in sec]). The LVET was measured from the foot to the dicrotic notch (inflection point) of the DPW.[20] The foot and dicrotic notch of the DPW was identified by the "a" and "e" wave of the second derivative of the DPW[21] (**Figure 1**). LVET was also expressed after correction for the HR using the following formula: cLVET = 1.7 HR + LVET.[22]

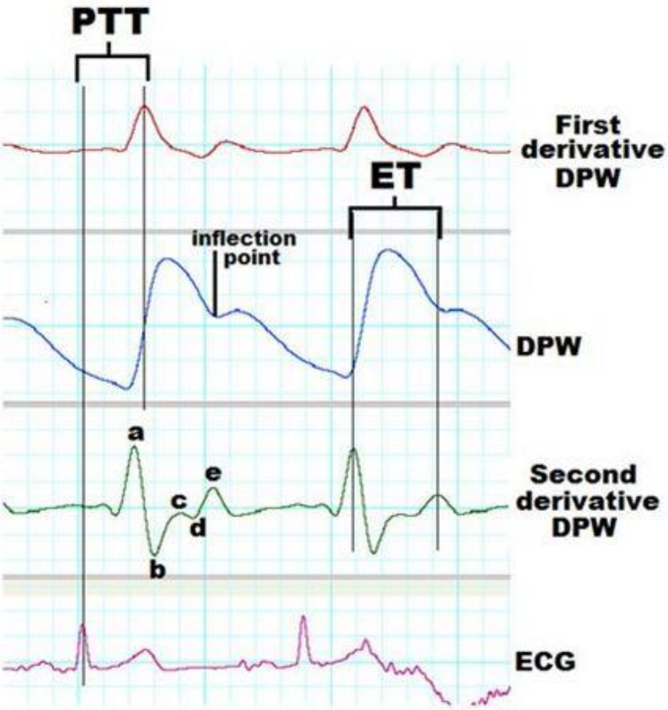

Figure 1. A representative case to illustrate the measurements of pulse transit time (PTT) and left ventricular ejection time (LVET) from digital pulse wave (DPW).

The right Shaofu (HT8) acupuncture point was chosen. It is located on the palm where the tip of the little finger touches the space between the fourth and the fifth metacarpal bones, proximal to the metacarpal joint. The researcher sterilized the skin of the volunteer's hand with 75% alcohol after localization of the chosen acupoint. We used sterile disposable stainless steel needles of the YIDAIFU brand, size 0.25 × 25 mm, without any further electrical or laser stimulation. Right arm 1.5 cm deep acupoint selected, acupuncture needle placed unilaterally, manually stimulated till acupuncture characteristic sensation (DeQi) was obtained.

Table 1. Cardiovascular indices for the Shaofu acupoint stimulation.

	Baseline (before intervention)	20 min after the start of intervention	Recovery time (10 min after the end of intervention)	*P*
BMI (kg/m^2)	27.0 ± 5.6			
SBP (mmHg)	128.6 ± 10.8	125.0 ± 10.4	123.6 ± 10.5	NS
DBP (mmHg)	67.6 ± 7.2	67.4 ± 7.3	66.6 ± 7.2	NS
HR (beat/min)	78.0 ± 8.5	73.3 ± 9.3	73.3 ± 11.6	NS
PTT (msec)	249.6 ± 24.6	242.9 ± 24.4	243.9 ± 27.4	NS
PWV (m/sec)	3.6 ± 0.4	3.7 ± 0.5	3.6 ± 0.5	NS
LVET (msec)	307.4 ± 16.0	314.0 ± 14.7	316.7 ± 12.7	NS
cLVET (msec)	440.0 ± 14.8	438.7 ± 20.6	441.3 ± 15.6	NS

BMI = Body mass index, SBP & DBP = Systolic & diastolic blood pressure, HR = Heart rate, PTT = Pulse transit time, PWV = Pulse wave velocity, LVET = Left ventricular ejection time, cLVET = Corrected Left ventricular ejection time for the heart rate. NS – non significant.

The needle was kept in place for 20 minutes before being taken out. PTT (average of 60–80 cardiac cycles), LVET (average of 20–30 cardiac cycles), BP, and PR (average of at least two readings) were measured during the last minute of rest (baseline measurements, i.e., before intervention, 20 minutes after acupuncture needle insertion (during intervention), and 10 minutes after acupuncture needle removal (after intervention).

Statistics

All the results were expressed using the mean and standard deviation (SD). To compare data between variables, one-way ANOVA test was used. The test was done using Excel software running on the Windows operating system. The result was considered statistically significant if $p \leq 0.05$.

Results

The CV responses to acupuncture are summarized in **Table 1**. The basic variables, that is, SBP, DBP, and HR, remained stable throughout the experiment, and the acupuncture intervention did not affect them. Likewise, the PWV and its determinant, PTT, did not change during acupuncture intervention, and their values were similar to those values before intervention (3.6 ± 0.4 m/sec and 249.6 ± 24.6 m/sec, respectively). Moreover, the LVET and the cLVET before acupuncture intervention (307.4 ± 16.0 m/sec and 440.0 ± 14.8 m/sec, respectively) were similar to those values during the intervention and 10 minutes after removal of the acupuncture needle (**Table 1**).

Discussion

Even before biomedicine and biomedical engineering began their global growth from their roots in Western Europe, interest in acupuncture, a centuries-old TCM procedure, was growing outside of Asia. Every culture that has adopted acupuncture has had an impact on it as it has developed. But reliable information regarding the measurable effects of acupuncture (needle, laser, and electroacupuncture) has just recently been made available.[23] For Western nations, acupuncture is a cutting-edge and reasonably priced therapy for the management and prevention of CVDs. The majority of its effects and processes, however, are not fully known. Therefore, there is a need to explain how acupuncture and acupuncture-like stimulations affect autonomic function. The objective of this work is to study one of the acupoints, the Shaofu acupoint, that has not been studied before. To achieve this goal, the effect of stimulation of the Shaofu acupoint on the CVS is demonstrated. Various parameters were chosen to identify the CV responses, namely, SBP, DBP, HR, PTT, and LVET. These parameters embraced the major CVS responses on various stimuli.[14,17,24,25] PWV and its determinant, PTT, were widely recognized as direct markers of arterial stiffness. Prior to acupuncture intervention, the PWV (heart-finger) and PTT reported in the current research are generally parallel to those reported by others.[19,25-27] The LVET is a measure of cardiac function in and of itself and can be connected to contractility and cardiac output.[16,17] The correlation between LVET derived from the noninvasive finger transducer waveform (whether photoplethysmographic pulse oximetry or piezoelectric finger pulse transducer) and the LVET derived from Doppler aortic flow velocity was high and significant.[26] Again, the LVET, whether corrected or uncorrected for the HR, that is reported hereby is in complete agreement with those recorded by others.[22] Moreover, all the rest of the CVS indices (SBP, DBP, and HR) did not change upon acupuncture at Shaofu acupoint.

Conclusion

Acupuncture at Shaofu acupoint has no CV effect in healthy individuals and could be used for the treatment of various comorbid non-cardiovascular medical conditions while sparing the CVS from its effect. However, further studies are required to verify these conclusions.

References

1. de Lima Pimentel R, Duque AP, Moreira BR, Rodrigues LF Junior. Acupuncture for the Treatment of Cardiovascular Diseases: A Systematic Review. Journal of Acupuncture and Meridian Studies. 2019;12(2):43-51. https://doi.org/10.1016/j.jams.2018.07.005
2. Termklinchan V, Wasin S, Choesomboon M, Praditbatuka C, Sukareechai S. Effect of acupuncture on blood pressure control in hypertensive patients. J Tradit Chin Med. 2019;39(2):246-250.
3. Shi L, Fang J, Zhao J, et al. Comparison of the Therapeutic Effects of Acupuncture at PC6 and ST36 for Chronic Myocardial Ischemia. Hsieh CL, ed. Evidence-Based Complementary and Alternative Medicine. 2017;2017(1). https://doi.org/10.1155/2017/7358059
4. Middlekauff HR. Acupuncture in the Treatment of Heart Failure. Cardiology in Review. 2004;12(3):171-173. https://doi.org/10.1097/01.crd.0000103650.71735.f0
5. Chen KB, Chen HY, Chen KC, Chen CYC. Treatment of Cardiovascular Disease by Traditional Chinese Medicine against Pregnane X Receptor. BioMed Research International. 2014;2014:1-17. https://doi.org/10.1155/2014/950191
6. HT 8 Acupuncture Point Theory. Available from: https://yinyanghouse.com/theory/acupuncturepoints/ht8/. [Last accessed: January/21/ 2024].
7. Chen SX, Bao SH, Chang PL, Zang DL, Lu HH, Yu GR, et al. Preliminary investigation on the effect of acupuncture of Neiguan (P. 6) and Shaofu (H. 8) on cardiac function of idiopathic cardiomyopathy. J Tradit Chin Med. 1983;3(2):113-120.
8. Kim TH, Ku B, Bae JH, et al. Hemodynamic changes caused by acupuncture in healthy volunteers: a prospective, single-arm exploratory clinical study. BMC Complement Altern Med. 2017;17(1). https://doi.org/10.1186/s12906-017-1787-z
9. Kim JU, Shin JY, Ku B, et al. Effects of Acupuncture Stimulation on the Radial artery's Pressure Pulse Wave in Healthy Young Participants: Protocol for a prospective, single-Arm, Exploratory, Clinical Study. J Pharmacopunct. 2016;19(3):197-206. https://doi.org/10.3831/kpi.2016.19.020
10. Wu X, Mo Q, Yang Z, et al. Comparative efficacy of different types of acupuncture as adjuvant therapy on carotid atherosclerosis: a protocol for systematic review and network meta-analysis. BMJ Open. 2022;12(4):e049778. https://doi.org/10.1136/bmjopen-2021-049778
11. Satoh H. Acute Effects of Acupuncture Treatment with Baihui (GV20) on Human Arterial Stiffness and Wave Reflection. Journal of Acupuncture and Meridian Studies. 2009;2(2):130-134. https://doi.org/10.1016/s2005-2901(09)60045-5
12. Swift DL, McGee JE, Grammer EE, et al. The effect of exercise training level on arterial stiffness after clinically significant weight loss. Clinical Obesity. 2023;13(5). https://doi.org/10.1111/cob.12584
13. An DW, Hansen TW, Aparicio LS, et al. Derivation of an Outcome-Driven Threshold for Aortic Pulse Wave Velocity: An Individual-Participant Meta-Analysis. Hypertension. 2023;80(9):1949-1959. https://doi.org/10.1161/hypertensionaha.123.21318
14. Bereksi-Reguig MA, Bereksi-Reguig F, Ali AN. A new system for measurement of the pulse transit time, the pulse wave velocity and its analysis. J Mech Med Bio. 2017;17(2):1750010. https://doi.org/10.1142/S0219519417500105
15. Bridges J, Shishavan HH, Salmon A, Metersky M, Kim I. Exploring the Potential of Pulse Transit Time as a Biomarker for Sleep Efficiency through a Comparison Analysis with Heart Rate and Heart Rate Variability. Sensors. 2023;23:5112. https://doi.org/10.3390/s23115112
16. Morbach C, Simon I, Danner E, Gelbrich G, Stefenelli U, Sahiti F, et al. Heart rate–corrected systolic ejection time: population-based reference values and differential prognostic utility in acute heart failure. European Heart Journal - Imaging Methods and Practice. 2023;1:1-10. Https://doi.org/10.1093/ehjimp/qyad020.
17. Biering-Sørensen T, Querejeta Roca G, Hegde SM, et al. Left ventricular ejection time is an independent predictor of incident heart failure in a community-based cohort. European J of Heart Fail. 2017;20(7):1106-1114. https://doi.org/10.1002/ejhf.928
18. Kameran adnan S, Neda FS, Al-Gailani BT. The influence of the digital pulse wave reference point on the pulse transit time measurement and variability. Samarra Journal of Pure and Applied Scienc. 2023;5(3):108-114. https://doi.org/10.54153/sjpas.2023.v5i3.504
19. Gesche H, Grosskurth D, Küchler G, Patzak A. Continuous blood pressure measurement by using the pulse transit time: comparison to a cuff-based method. Eur J Appl Physiol. 2011;112(1):309-315. https://doi.org/10.1007/s00421-011-1983-3
20. Su HM, Lin TH, Hsu PC, et al. A Comparison between Brachial and Echocardiographic Systolic Time Intervals. Hosoda T, ed. PLoS ONE. 2013;8(2):e55840. https://doi.org/10.1371/journal.pone.0055840
21. Elgendi M. On the Analysis of Fingertip Photoplethysmogram Signals. CCR. 2012;8(1):14-25. https://doi.org/10.2174/157340312801215782
22. Nurnberger J, Saez AO, Dammer S, Mitchell A, Wenzel RR, Philipp T, et al. Left ventricular ejection time: a potential determinant of pulse wave velocity in young, healthy males. J Hypertens. 2003;21(11):2125-2132. HTTPS://DOI.ORG/10.1097/01.hjh.0000098125.00558.40
23. Litscher G, Wang L, Gaischek I, Gao XY. Violet Laser Acupuncture—Part 4: Acute Effects on Human Arterial Stiffness and Wave Reflection. Journal of Acupuncture and Meridian Studies. 2011;4(3):168-174. https://doi.org/10.1016/j.jams.2011.09.004

24. Pilli R, Pingali U, Naidu M, Takallapally RK. Study of cardiovascular effects of caffeine in healthy human subjects, with special reference to pulse wave velocity using photoplethysmography. Int J Nutr Pharmacol Neurol Dis. 2012;2(3):243. https://doi.org/10.4103/2231-0738.99478
25. Budidha K, Kyriacou PA. Photoplethysmography for Quantitative Assessment of Sympathetic Nerve Activity (SNA) During Cold Stress. Front Physiol. 2019;9. https://doi.org/10.3389/fphys.2018.01863
26. Chan GSH, Middleton PM, Celler BG, Wang L, Lovell NH. Automatic detection of left ventricular ejection time from a finger photoplethysmographic pulse oximetry waveform: comparison with Doppler aortic measurement. Physiol Meas. 2007;28(4):439-452. https://doi.org/10.1088/0967-3334/28/4/009
27. Cho J, Baek HJ. A Comparative Study of Brachial–Ankle Pulse Wave Velocity and Heart–Finger Pulse Wave Velocity in Korean Adults. Sensors. 2020;20(7):2073. https://doi.org/10.3390/s20072073