Clin Auton Res (2004) 14 : 182–188
DOI 10.1007/s10286-004-0175-1

RESEARCH ARTICLE

Peng Li
Olasimbo Ayannusi
Cheryl Reid
John C. Longhurst

Inhibitory effect of electroacupuncture (EA) on the pressor response induced by exercise stress

Received: 10 September 2003
Accepted: 24 February 2004

P. Li, M.D. (✉) · O. Ayannusi · C. Reid ·
J. C. Longhurst
Dept. of Medicine
University of California, Irvine
Medical Science I, C235
Irvine (CA) 92697-4075, USA
Tel.: +1-949/824-6123
Fax: +1-949/824-2200
E-Mail: pengli@uci.edu

This project is supported by the DANA Foundation, the Susan-Sameuli Center for Integrative Medicine at UCI, the Larry K. Dodge Chair in Integrative Biology (JCL), and the General Clinical Research Center of UCI (5M61RR000827).

Abstract We examined the effect of EA on the exercise stress-induced pressor response in healthy adult subjects of both sexes. Each subject was subjected to a bicycle exercise test using a ramp protocol once/week for three or four weeks. Subjects were asked to perform the following tests in random order: 1) a baseline exercise test without EA and 2) exercise after acupuncture at P 5–6, LI 4-L 7 and/or G 37–39 acupoints. Brachial systolic (SBP), diastolic (DBP), and mean blood pressures (MBP), heart rate (HR) and the rate-pressure product (RPP, systolic BP x HR/100) were measured every three min, while a 12 lead ECG was monitored continuously. We observed increases in MBP, SBP, HR and RPP in all 17 subjects during exercise. In 12 of the 17 subjects (71 %), EA for 30 min before exercise, either at Jianshi-Neiguan acupoints (P 5–6) or Hegu-Lique acupoints (LI 4-L 7), led to an increase in maximal workload, and reduced peak SBP, MBP and RPP responses to exercise; EA did not alter DBP or HR responses in these subjects. EA at control acupoints (Guangming-Xuanzhong acupoints, G 37–39) in five subjects did not alter the hemodynamic responses. Seven additional subjects were enrolled to study the effect of EA during a bicycle exercise test using a constant workload. The results were similar, in five of the seven subjects SBP, MBP and RPP after exercise were attenuated significantly by EA at P 5–6. We conclude that EA at specific acupoints improves exercise capacity and reduces the hemodynamic responses in approximately 70 % of normal subjects.

Key words electroacupuncture · bicycle exercise · blood pressure · heart rate · rate-pressure product

Introduction

Coronary artery disease is the greatest cause of death in middle-aged and elderly North Americans and Europeans [23]. Although western science has developed a number of effective treatment strategies for this disease, treatment is not perfect and often is associated with side effects. As such, there has been increasing interest in the western countries in exploring alternative medicinal treatments and considering new therapies such as acupuncture for coronary artery disease. Chinese and Southeast Asian medical professionals have long utilized acupuncture, and its more potent alternative, electroacupuncture, to treat disease. According to the World Health Organization, acupuncture is effective in more than 40 medical conditions [34]. In this regard, clinical and basic science reports indicate that acupuncture's usefulness may include the management of cardiac pain, arrhythmias, and hypertension.

There are a number of small clinical reports suggesting that acupuncture may reduce blood pressure (BP) in

CAR 175

hypertensive subjects and angina in patients with coronary artery disease. As early as the 1950's, acupuncture was shown to reduce BP in hypertensive patients [7, 26, 35]. Radzievsky et al. [21] confirmed that in hypertensive patients acupuncture exerts a stable hypotensive effect, improves contractile function and reverses myocardial hypertrophy. Williams et al. [32] found that EA induces a significant immediate post-stimulation short-term reduction of diastolic BP. Chiu et al. [8] also reported that 30 min acupuncture decreases BP in patients with hypertension. Richter et al. [22] showed that acupuncture improves electrocardiographic (ECG) evidence of myocardial ischemia in patients with coronary heart disease. In a series of studies Ballegaard et al. [2–4] confirmed that, as a consequence of hemodynamic alterations, acupuncture might improve angina pectoris, when the procedure is used in addition to standard drug treatment. Although exercise stress tests often are used to induce angina in patients with coronary heart diseases, there are no data on the influence of acupuncture on exercise performance and cardiovascular response, even in healthy subjects.

In the last several years our laboratory has demonstrated experimentally that EA at certain acupoints such as Neiguan (P 6) inhibits sympathetically-induced increases in blood pressure and has a beneficial effect on reversible myocardial ischemia (Li et al. [14]). We also have shown that blockade of opioid receptors in the rostral ventrolateral medullary cardiovascular center abolishes the inhibitory effect of EA on reflex-evoked hypertension during stress in animals [6, 15, 16].

We therefore hypothesized that EA reduces the hemodynamic response during exercise stress. The present study represents our first attempt to translate our findings from animals to humans to determine whether acupuncture evokes similar responses in both species. The goal of this study was to investigate the influence of EA on the hemodynamic response to dynamic exercise in healthy subjects.

Methods

Human subjects

A racially mixed group of twelve healthy male and twelve female subjects, ranging in age from 19 to 54, were used in this study. Their good health was confirmed by medical history and physical examination. Subjects were non-smokers, were not taking medication and abstained from caffeine on the day of the study. All subjects were volunteers from the University of California, Irvine (UCI) campus, medical center and surrounding communities, and signed a written informed consent form. Study protocols and consent forms were approved by the UCI Human Subjects Institutional Review Board. All procedures took place at the UCI Medical Center or on the main UCI campus.

Hemodynamic measurements

The overall goal of this study was to assess the influence of EA on cardiovascular responses, including BP, heart rate (HR), and the ECG in healthy subjects at rest and during exercise. Brachial arterial blood pressure was measured every three min with a sphygmomanometer cuff. Heart rate was measured either by palpitation of the radial artery pulse (for at least 15 s) or from the ECG. The ECG was monitored continuously (GE Marquette Medical System, Milwaukee, Wisconsin) before, during and after exercise for a brief period. The rate-pressure product (RPP), systolic blood pressure (SBP) x HR x 10^{-2}, was calculated as an index of myocardial oxygen demand [13].

Electroacupuncture

Acupuncture was performed by the same experienced investigator with a certified California acupuncture license. The skin was cleaned with alcohol. Disposable, sterile stainless steel acupuncture needles (2.5–4 cm, 0.25–0.3 mm diameter; Suzhou Medical Appliance Factory, China) were inserted bilaterally into the Neiguan (P 6) and Jianshi (P 5) acupoints (on the palmar side of both arms, two and three cm above the crease of the wrist, respectively, between the tendon of the long palmar muscle and radial flexor muscle of the wrist), at a position overlying the median nerve, since these points are reported to have beneficial effects in patients with angina, hypertension and arrhythmias ([7], Fig. 1). During acupuncture volunteers generally described the sensation of a paraesthesia (including numbness, heaviness, distension, soreness, or itching) a sensation that the acupuncturists call "De Qi". Electrical stimulation of acupoints was administered with low current (1–2 mA) and low frequency (2 Hz) for 30 min derived from a 6V battery Multi-purpose Health Device (G6805–2, Shanghai Medical Instrumentation Factory, China).

Ramp exercise protocol

Seventeen of the 24 subjects were tested on an electronically braked cycle ergometer (Sensormedic, Ergolin 800, Yorba Linda, Ca) using a standard ten-watt ramp protocol. Heart rate was monitored with a 12-lead ECG GE Marquette Medical System (Milwaukee, Wisconsin). The exercise stress test protocol was standardized to allow comparisons of HR and BP data. A ten-watt per minute ramp protocol was chosen to accommodate for gender and age variations. This protocol resulted in nearly linear increases in workload and heart rate. Subjects were encouraged to exercise to volitional exhaustion. Exercise testing was repeated on visits two, three and four; each time volunteers were asked to exercise as long as possible. Blood pressure was measured every three min, while HR and a 12 lead ECG were monitored continuously during the test.

Subject selection

Subjects were requested to be present once each week over a four week period to allow: 1) control ramp exercise without EA, 2) EA at P 5–6 followed by the ramp exercise protocol, 3) EA at Lique (L 7, lung meridian) and Hegu (LI 4, large intestine meridian) and exercise, or 4) EA at Guangming (G 37, gallbladder meridian) and Xuanzhong (G 39) acupoints and exercise. Previous investigations have observed that, while most subjects respond to acupuncture, some (approximately 30 %) do not [1, 25, 29]. With this principle in mind, we initially screened our subjects during exercise to identify responders comparing the hemodynamic response, in the absence of EA, to the response following EA at P 5–6. This acupoint has been shown by many studies to exert a particularly strong influence on the cardiovascular system [7, 17, 24]. The order of control exercise and EA at P5–6 was randomized. Any reduction in the exercise-related increase in both systolic and mean blood pressure compared to control was defined as

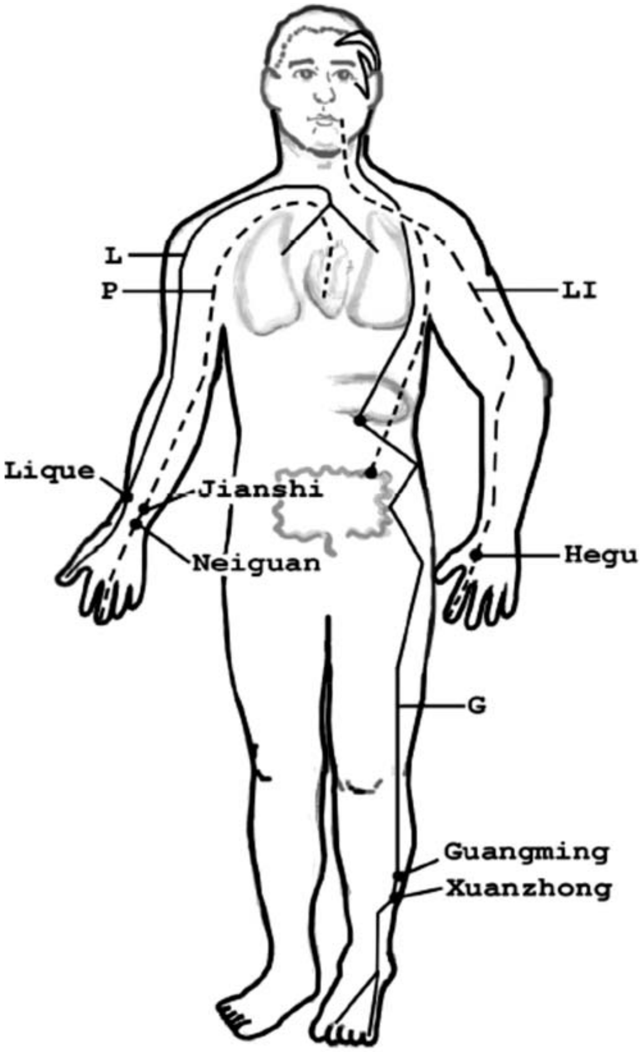

Fig. 1 Location of acupoints along meridians. Note, although all meridians are bilateral, they are only drawn on one side for simplicity. Abbreviations of meridians: *G* Gallbladder; *L* lung; *LI* large intestine; *P* pericardium

a response and the subject was classified as a responder. Those subjects, whose exercise blood pressure responses (after EA) were observed to be unchanged from the control test during exercise, were classified as non-responders and excluded from our further observation. Once a group of responders were identified, we compared this group using EA at other acupoints in two subgroups, one for EA at LI 4-L 7 and another for EA at G 37–39 (order randomized). In Traditional Chinese Medicine [24] LI 4-L 7 and G 37–39 acupoints are used to treat non-cardiovascular diseases. Therefore, these alternative acupoints were used to check specificity of acupoints and meridians with regard to their effects on the cardiovascular responses to exercise.

Constant load exercise-protocol

In another group of seven subjects (five males, two females), we investigated the effect of EA at P 5–6 during constant load exercise using a bicycle ergometer. This protocol was used to provide a supplementary analysis to determine the influence of EA on the exercise hemodynamic response induced by a different exercise protocol. Each of these seven subjects participated in three exercise sessions, performed weekly on the same day and at the same time. During the first visit, following a general medical assessment, we used a ramp-type maximal exercise test on an electronically braked cycle ergometer to evaluate functional capacity. Gas exchange was measured by breath-breath analysis to provide maximal oxygen consumption ($\dot{V}O_2$) peak, anaerobic (lactate) threshold was detected by an increase in respiratory gas exchange ratio, which was calculated according to the following formula: CO_2 production ($\dot{V}CO_2$)/O_2 consumption ($\dot{V}O_2$) [5, 30, 31, 33]. The exercise protocol was scaled so that all subjects reached their maximal capacity between 8 and 12 min. Results from visit one, in the absence of acupuncture, were used to determine exercise intensity for visits two and three when constant load exercise was applied. In the second or third visit EA at P 5–6 was employed in a randomized fashion. During the second and third visits subjects performed 30 min of constant workload exercise using an electronically braked recumbent Cateye (EC 3700, Dallas, Texas) bicycle. Work load was chosen from the $\dot{V}O_2$ peak values and work rates determined by the visit one ramp test. During the first 20 min the work load corresponded to 80 % of the $\dot{V}O_2$ peak, the remaining ten min of exercise, consisted of a work load that corresponded to 30 % of the $\dot{V}O_2$ peak [31].

Data collection and analysis

Stress testing was performed in a single blinded fashion (subject) with regard to treatment. The results were interpreted in a blinded fashion by the reviewer. As noted previously, subjects were studied once each week over a three- to four-week period. During one session the subject underwent stress testing without acupuncture, while during the other weeks of testing the subject performed stress after acupuncture. The order of the baseline ramp exercise stress test without EA and EA at P 5–6 followed by the ramp exercise stress was randomized. Also, EA at LI 4-L7 or EA at G 37–39 followed by the ramp exercise stress were randomized as noted previously. Each visit was completed within a maximum of two hours. Before testing, subjects were asked to lie down and rest for at least 20 min, then resting BP, HR and ECG were measured. If the visit did not involve EA, the subjects were immediately asked to perform the exercise test. Otherwise, EA was applied bilaterally to one of the above listed sets of acupoints for 30 min. The subject was asked to perform exercise to exhaustion immediately following acupuncture. All measurements were continued for 5–10 min after termination of exercise.

Data are presented as means ± SE. Statistical comparisons between control exercise and after EA at different acupoints were made using a Wilcoxon test on paired data. We originally performed the power test to determine the number of subjects required to determine statistically significant differences at a power of 0.8 and with 95 % confidence assuming an effect of 7–12 mmHg. We found that 9–10 subjects were required for this evaluation, depending upon the treatment effect (i. e., 10 for 7 mmHg and 9 for 12 mmHg). Because we assumed no treatment effect for the control acupoint, G 37–39, a power analysis was not performed. P < 0.05 was considered to represent statistically significant differences.

Results

Effect of EA on resting BP of healthy subjects

Resting mean arterial blood pressure (MBP) was not altered by 30 min of EA at P 5–6 acupoints (84 ± 2 mmHg vs. 83 ± 2 mmHg,). EA at LI 4- L7 or G 37–39 likewise did not alter blood pressure at rest.

Effect of EA on healthy subjects during exercise using a variable loading protocol

Mean blood pressure, SBP, HR and the calculated RPP increased during exercise, whereas diastolic blood pressure (DBP) was not significantly altered (Fig. 2). In 12 (70.6 %) of the 17 subjects the maximum systolic and mean blood pressure responses induced by exercise were reduced significantly (P < 0.05) after EA at either P 5–6 (n = 12) or LI 4-L7 (n = 9) in comparison to the control responses (Fig. 2), while workload was increased significantly from 154 ± 10 to 166 ± 12 W and 166 ± 14 W, respectively (P < 0.05). The increase in RPP also was inhibited (P < 0.05) by EA at both acupoints (Fig. 3). Exercise-related DBP and HR were unchanged by EA (Fig. 2). In five of the 12 subjects EA at the control acupoints, G 37–39, did not inhibit the increases in blood pressure or the RPP during exercise (Figs. 2 and 3).

In the other five of the 17 subjects studied (29.4 % of the total population) resting mean arterial pressure (90 ± 7 mmHg) was increased by exercise (111 ± 6 mmHg) but was not altered by 30 min of EA at P 5–6. These latter individuals were classified as non-responders. They were excluded from our further study and their data were not included in the statistical analyses.

Effect of EA P5–6 during constant load exercise

The results in seven adult volunteers (five males, two females) using constant load exercise were similar to the variable load bicycle exercise study. We observed that during exercise systolic blood pressure, mean blood pressure and calculated rate-pressure product were significantly attenuated by EA at P 5–6 acupoints while heart rate and diastolic blood pressure remained unchanged (Table 1).

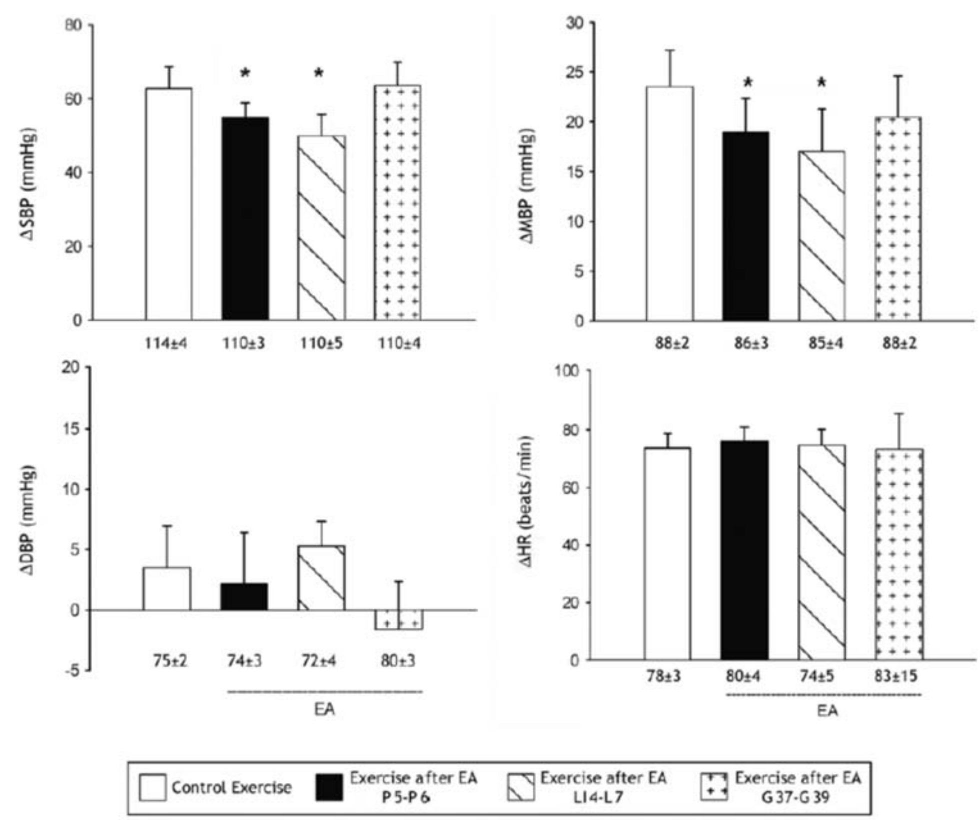

Fig. 2 Effect of EA at different acupoints on hemodynamic responses to bicycle exercise with ramp protocol. Numbers on the bottom of each figure indicate resting blood pressure (mmHg). * P < 0.05 compared to control (pre EA) exercise. Control exercise, n = 12; exercise after EA at P 5–6, n = 12; LI 4-L7, n = 9; G 37–39, n = 5

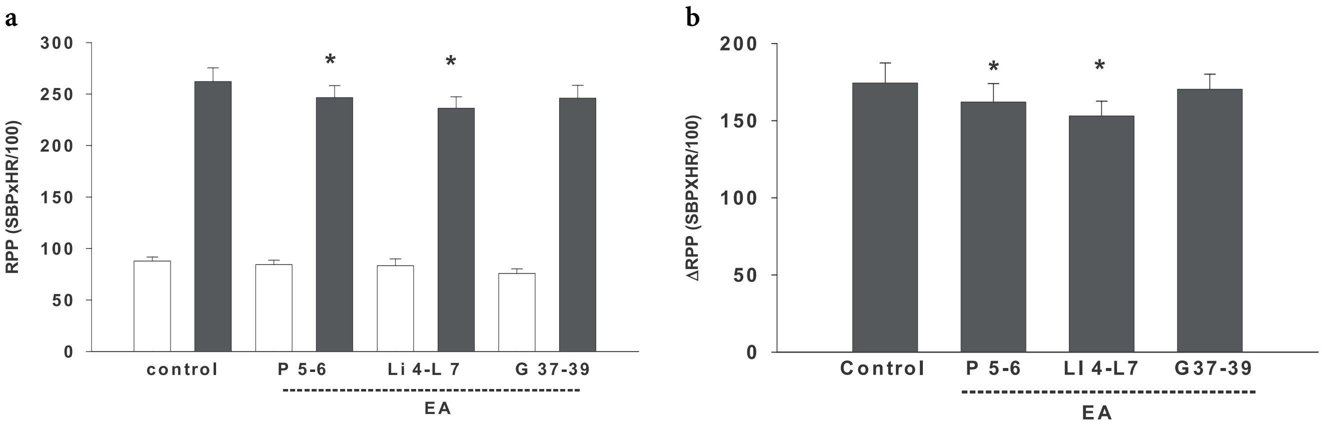

Fig. 3 Effect of EA on maximal rate-pressure product (RPP) during ramp protocol. **a** Effect of EA on RPP before and after exercise. Open bar: rest; Black bar: peak of exercise. **b** Effect of EA on change of RPP from rest to peak exercise. * $P < 0.05$ compared to control exercise. Control exercise, n = 12; exercise after EA at P 5–6, n = 12; LI 4-L7, n = 9; G 37–39, n = 5

Table 1 Effect of EA on hemodynamic responses to constant load exercise

N = 6	Rest	Exercise	Rest + EA P 5–6	Exercise + EA P 5–6
MBP (mmHg)	90±4	120±6†	85±5	105±6*
HR (b/min)	81±5	166±4†	70±7	160±6
RPP	106±13	344±22†	81±9	269±20*

† $P < 0.05$ compared to rest
* $P < 0.05$ compared to after exercise without EA

Discussion

The present study demonstrates, for the first time, that EA at two separate sets of acupoints, P 5–6 and LI 4-L7, increases the workload yet reduces the hemodynamic response to dynamic exercise in normal subjects. Conversely, acupuncture at a non-cardiovascular site, G 37–39, does not alter the hemodynamic response. In addition, we found that EA either at P 5–6, LI 4-L7 or G37–39 did not alter blood pressure or heart rate at rest, consistent with previous observations in animals [7]. It was suggested in the review article of Pelham et al. [20] that acupuncture may enhance human performance. Ehrlich and Haber [10] observed that, after the subjects were treated with acupuncture every week for five weeks, their maximum performance capacity significantly increased. However, Karvelas et al. [12] reported that a single acupuncture treatment has no significant immediate effect on the perceived exertion and physiological responses during submaximal dynamic exercise. Our results in healthy subjects demonstrate that EA significantly increase the exercise workload. Thus, acupuncture attenuates the exercise-related pressor response when either an increasing ramp or a constant workload is imposed. These data are mutually supportive and suggest that the inhibitory effect of EA on blood pressure is not influenced by the exercise protocol.

We found that the heart rate and diastolic blood pressure were not changed by acupuncture. Therefore, it is possible that acupuncture lowers systolic blood pressure through an influence on the peripheral capacitance vessels and cardiac preload rather than through a direct effect on the heart. Such speculation will require confirmation by measurement of cardiac volumes and cardiac output. However, these data are consistent with our previous studies in experimental animals [7, 14, 17].

We found that approximately 70 % of the healthy subjects responded to EA with a reduction in the exercise-evoked pressor response; regardless of whether the exercise workload increased or remained constant. These observations are consistent with previous studies showing that acupuncture acts in the majority but not in all patients treated with this modality [1, 25, 29].

Our initial working hypothesis was that P 5–6 would be an active acupuncture while LI 4-L7 and G 37–39 would serve as control points that would not influence the hemodynamic response to exercise. However, our results showed that LI 4-L7 acupoints were as effective as P 5–6 in inhibiting the exercise-induced pressor response. After examining the neural anatomy underlying LI 4-L 7 acupoints, we realized that these acupoints are served by branches of both the median and ulnar nerves [24]. Furthermore, our recent experimental studies have shown that both acupoints modulate sympathetic premotor cardiovascular neuronal activity in the rVLM is as well as cardiovascular excitatory reflexes [16, 27, 28]. Thus, it is understandable that this pair of acupoints modulates the blood pressure response during exercise. We did find that G 37–39 acupoints, located over the superficial peroneal nerve, do not influence the exercise-induced pressor response, suggesting that the influence of EA on the cardiovascular response to exercise is not simply a non-specific or a placebo-type response resulting from placement of an acupuncture needle anywhere in the body. Interestingly, this acupoint has been shown experimentally to provide less input into the rVLM [28].

The rate-pressure product is a commonly used index of myocardial oxygen demand [13]. Our results demonstrate that EA inhibits mean arterial pressure as well as the rate-pressure product, thereby, confirming our initial working hypothesis that EA can decrease oxygen demand. Patients with symptomatic coronary artery disease can develop an imbalance between oxygen supply and demand during stress, which in turn, may induce myocardial ischemia [11]. By reducing myocardial oxygen demand, EA may be beneficial clinically. This suggestion is consistent with our previous experimental studies in which EA was shown to reduce demand-induced ischemia [14] as well as in studies that have suggested a beneficial influence of acupuncture in patients with coronary artery disease [2–4, 22]. It is of interest to note that our experimental studies have shown that acupuncture does not increase coronary flow during stress [14].

Our results demonstrated that the workload was improved by EA at P 5–6 as well as at LI 4-L7. Therefore the decrease in the blood pressure response during exercise was not due to a reduction in workload. Also, since the order of the protocol was randomized, the increase of workload after EA was not an ordering effect. We speculate that the reason for the increase in workload may involve a reduction in cardiac after load or vasodilatation of vessels supplying active muscle. However, the mechanism of the increase in workload requires further investigation.

In summary, the present study demonstrates that in approximately 70 % of the patients, EA reduces the exercise-induced blood pressure response as well as myocardial oxygen demand during stress, in comparison to exercise without acupuncture or exercise and acupuncture at control (inactive) acupoints. Interestingly, this reduction in hemodynamic response occurred following stimulation of two separate sets of acupoints and was unrelated to the exercise protocol. The active acupoints share a common denominator, stimulation of the underlying median nerve. This modulatory effect of EA may have clinical significance in patients with ischemia heart disease, a hypothesis that requires further testing.

Acknowledgement This work is performed in General Clinical Research Center (GCRC) of UC Irvine. We greatly appreciate the technical support of Ms. Christine Rose-Gottron as well as the nursing staff in the GCRC. We also thank Dr. M. R. Movahed, and A. Salami, A. Vahdat, B Kasravi, and JF Jiang for their clinical support. This project is supported by the DANA Foundation and the Susan-Sameuli Center of Alternative and Complementary Medicine at UCI, and the Larry K. Dodge Chair in Integrative Biology (JCL).

References

1. Acupuncture, NIH Consensus Statement (1997) Nov. 3–5; 15(5):1–34
2. Ballegaard S, Jensen G, Pedersen F, Nissen VH (1986) Acupuncture in severe, stable angina pectoris: a randomized trial. Acta Med Scand 220:307–313
3. Ballegaard S, Meyer CN, Trojaborg W (1991) Acupuncture in angina pectoris: does acupuncture have a specific effect? J Intern Med 229:357–362
4. Ballegaard S, Karpatrschoff B, Holck JA, Meyer CN, Trojaborg W (1995) Acupuncture in angina pectoris: do psycho-social and neurophysiological factors relate to the effect? Acupunct Electrother Res 20:101–116
5. Beaver WL, Wasserman K, Whipp BJ (1986) A new method for detecting anaerobic threshold by gas exchange. J Appl Physiol 60:2020–2027
6. Chao DM, Shen LL, Tjen-A-Looi S, Pitsillides KF, Li P, Longhurst JC (1999) Naloxone reverses inhibitory effect of electroacupuncture on sympathetic cardiovascular reflex responses. Am J Physiol 276 (Heart Circ Physiol 45): H2127–2134
7. Cheung LL, Li P, Wong C (2001) The mechanism of acupuncture therapy and clinical case studies. Taylor & Francis, London & New York
8. Chiu YJ, Chi A, Reid IA (1997) Cardiovascular and endocrine effects of acupuncture in hypertensive patients. Clin & Exper Hypertension 19: 1047–1063
9. Dovgiallo OG, Rapkin MS, Tkachenko G Ia (1987) Results of using acupuncture and therapeutic physical exercise for preventing the development of arterial hypertension in persons with borderline arterial pressure. Terapevtitheskii Arkhiv 59:16–19 (in Russian)
10. Ehrlich D, Haber P (1992) Influence of acupuncture on physical performance capacity and haemodynamic parameters. Intern J Sports Medicine 13:486–491
11. Graham TP Jr, Ross J Jr, Covell JW, Sonnenblick EH, Clancy RL (1967) Myocardial oxygen consumption in acute experimental cardiac depression. Circ Res 21:123–138
12. Karvealas BR, Hoffman MD, Zeni AI (1996) Acute effects of acupuncture on physiological and psychological responses to cycle ergometry. Arch Phys Med Rehabil 77:1256–1259
13. Kitamura K, Lorgensen CR, Gobel FL, Taylor HL, Wang Y (1972) Hemodynamic correlates of myocardial oxygen consumption during upright exercise. J Appl Physiol 32:516–522
14. Li P, Pitsillides KF, Rendig SV, Pan HL, Longhurst JC (1998) Reversal of reflex-induced myocardial ischemia by median nerve stimulation – a feline model of electroacupuncture. Circulation 97:1186–1194
15. Li P, Tjen-A-Looi S, Longhurst JC (2001) Rostral ventrolateral medullary opioid receptor subtypes in the inhibitory effect of electroacupuncture on reflex autonomic response in cat. Autonomic Neuroscience: Basic and Clinical 89:38–47

16. Li P, Rowshan K, Crisostomo M, Tjen-A-Looi S, Longhurst JC (2002) Effect of electroacupuncture on pressor reflex during gastric distension. Am J Physiol Regul Integr Comp Physiol 283: R1335–R1345
17. Li P, Yao T (1992) Mechanism of the modulatory effect of acupuncture on abnormal cardiovascular functions. Shanghai Med Univ Press, Shanghai
18. Lin JG, Yang SH (1999) Effects of acupuncture on exercise-induced muscle soreness and serum creatine kinase activity. Am J Chin Med 27:299–305
19. Mayer DJ (2000) Acupuncture: An evidence-based review of the clinical literature. Annu Rev Med 51:49–63
20. Pelham TW, Holt LE, Stalker R (2001) Acupuncture in human performance. J Strength and Cond Res 15:266–271
21. Radzievsky SA, Lebedeva OD, Fisenko LA, Majskaja SA (1989) Function of myocardial contraction and relaxation in essential hypertension in dynamics of acupuncture therapy. Am J Chin Med 17:111–117
22. Richter A, Herlitz J, Hjalmarson A (1991) Effect of acupuncture in patients with angina pectoris. Eur Heart J 12:175–178
23. Rosanki A, Blumental JA, Kaplan J (1999) Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. Circulation 99:2192–2217
24. Shi XM, Zhang MC (1998) A Chinese-English dictionary of acupuncture and moxibustion. Huxia Publishing House. Beijing
25. Stux G, Pomeranz B (1998) Basics of acupuncture. 4th ed. Springer Berlin, p 23
26. Tam KC, Yiu HH (1975) The effect of acupuncture on essential hypertension. Am J Chin Med 3:369–375
27. Tjen-A-Looi S, Li P, Longhurst JC (2003a) Prolonged Inhibition of rostral ventral lateral medullary premotor sympathetic neurons by electroacupuncture. Autonomic Neuroscience: Basic and Clinical 106:119–131
28. Tjen-A-Looi S, Li P, Longhurst JC (2003b) Medullary substrate for cardiovascular (CV) differential response to stimulation of specific acupoints overlying somatic nerves. FASEB Journal 17:A892, 578.3
29. Vincent CA, Richardson PH (1986) The evaluation of therapeutic acupuncture: concept and methods. Pain 24:1–13
30. Wasserman K, McIlroy MB (1964) Detecting the threshold of anaerobic metabolism in cardiac patients during exercise. Am J Cardiol 14:844–852
31. Wasserman K (1984) The anaerobic threshold measurement to evaluate exercise performance. Am Rev Respir Dis 129(Suppl.):S35–S40
32. Williams T, Mueller K, Cornwall MW (1991) Effect of acupuncture-point stimulation on diastolic blood pressure in hypertensive subjects: a preliminary study. Physical Therapy 71: 523–529
33. Withers RT, Sherman WM, Miller JM, Costillo DL (1981) Specificity of the anaerobic threshold in endurance trained cyclists and runners. Eur J Appl Physiol 47:93–101
34. World Health Organization (1996) Acupuncture review and analysis of reports on controlled clinical trials. Cervia, Italy
35. Zhang CL (1956) Clinical investigation of acupuncture therapy. Clin J Med 42:514–517 (in Chinese)