Integrating acupuncture into the cardiology clinic: can it play a role?

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Abstract: Despite continued improvement in risk factor recognition and aggressive medical management, heart disease remains the number one killer in the world. Medications for primary or secondary prevention of heart disease can cause unpleasant side effects leading to non-compliance. Novel therapies are needed to serve as a complement to or alternative for current medical management. Acupuncture and more specifically electroacupuncture may serve as a safe and viable option in the cardiology clinic. This review article focuses on both mechanistic and clinical studies evaluating acupuncture’s effectiveness with symptomatic heart disease. Although continued research is needed, currently evidence warrants consideration of acupuncture’s use with myocardial ischemia, hypertension, arrhythmias, heart failure as well as autonomic dysfunction.

Key words: acupuncture; electroacupuncture; mechanisms; cardiology

1 Introduction

Heart disease remains the number one killer of men and women in the United States \cite{1, 2}. Despite aggressive management of traditional risk factors (e.g., hyperlipidemia, tobacco use and hypertension) and ever-evolving pharmaceutical options, the majority of patients with established coronary heart disease (CHD) will have recurrent cardiovascular events \cite{3, 4}. Thus there is continued need for safe, viable treatment options for patients with heart disease. Acupuncture and more specifically, electroacupuncture (EA) modalities within traditional Chinese medicine (TCM) may provide a viable therapy for integration into current biomedical treatment protocols.

As one of the oldest healing practices in the world, acupuncture has been used for several thousand years to treat many illnesses. In 2003, the World Health Organization published a list of evidence-based conditions for which acupuncture could be used \cite{5}. Specific to
cardiology, angina pectoris, hypotension and hypertension were listed. Within the past few decades, however, acupuncture’s effectiveness in the treatment of these and other manifestations of cardiovascular disease such as ischemia, arrhythmias, heart failure as well as its effect on heart rate variability (HRV) have been studied. Likewise, acupuncture’s mechanistic actions and point specificity responsible for these cardiovascular benefits also have been explored. Dissemination of this information to physicians and other health care practitioners has the potential to influence attitudes and incorporation of this therapeutic strategy into their clinical practice.

2 Mechanisms of acupuncture actions in cardiovascular regulation

Recently, experimental studies have identified regulatory mechanisms responsible for EA’s cardiovascular effects through inhibition of sympathetic outflow. Many acupuncture points overlie nerve bundles containing both motor and sensory nerves. These include, for example, the median nerve underlying pericardium meridian (P)5-P6 and the deep peroneal nerve underlying stomach meridian (ST)36-ST37. The sensory components, including both Group III and IV finely myelinated and unmyelinated afferents, provide the critical pathway since local anesthesia rather than motor paralysis blocks acupuncture’s cardiovascular effects[6]. These sensory nerves project to cardiovascular regions in the hypothalamus, midbrain and brainstem where neurotransmitters lead to EA-associated neural processing[6].

One of the more important regions where EA exerts its actions is the rostral ventrolateral medulla (rVLM), an important region in the brainstem that regulates sympathetic outflow[9–11]. Several studies suggest that EA causes release of opioids, gamma-aminobutyric acid (GABA), nociception and serotonin (5-hydroxytryptamine) in this region[10, 12, 13]. Endorphin, enkephalins and perhaps endomorphin, but not dynorphin, contribute to the EA modulatory response in the rVLM[14–16]. Immunohistochemical staining studies have demonstrated that EA activates enkephalinergic neurons in the rVLM and endorphinergic neurons in the arcuate nucleus (ARC), which project directly to the rVLM[17]. EA modulates sympathoexcitatory reflexes through opioid-mediated inhibition of glutamate in the rVLM[18].

As diagrammed in Fig. 1, 20–30 min of EA modulates sympathoexcitatory reflex responses through activation of a long-loop pathway extending from the hypothalamus to the midbrain and ultimately to the medulla[19]. Specifically, the hypothalamic ARC, ventrolateral periaqueductal gray (vPAG) and medullary raphe (nucleus raphe obscurus), as well as the rVLM each play a role during EA[8, 10, 17, 20, 21]. These actions are mediated by the EA-induced release of both excitatory and inhibitory neurotransmitters including glutamate in the ARC and vPAG[22, 23], acetylcholine in the ARC[22], endocannabinoids in the vPAG[19, 24], serotonin[25], opioids, GABA and nociceptin in the rVLM[12, 26], ultimately modulate autonomic outflow.

Experimental studies also have shown that EA can modulate parasympathetic outflow in two models of reflex induced bradycardia and hypotension, one involving gastric distension in rats ventilated with a hypercapnic gas mixture that leads to a respiratory acidosis and a second using phenylbiguanide to stimulate cardiopulmonary receptors to evoke a vasovagal reflex[21, 27]. Through both opioid and GABA mechanisms in the nucleus ambiguus and the caudal ventrolateral medulla, EA inhibits parasympathetic and sympathetic outflow. These studies indicate that acupuncture has the potential to regulate both branches of the autonomic nervous system.

3 Point specificity

The lack of a consistent method of determining the ideal acupuncture point prescription remains an inherent limitation of acupuncture research. Recent studies employing objective measures have afforded more precise methods to evaluate point specificity. Cardiovascular studies have found that during exercise EA at points P5-P6 and large intestine meridian (LI)7 increase maximum workload, reduce systolic and mean blood pressure (BP) and rate pressure (or double) product (RPP), an index of myocardial oxygen demand[28], as well as reduce sympathoexcitatory reflex responses, while EA applied to gallbladder meridian (GB)37-GB39 did not alter cardiovascular function[29]. In another study, manual stimulation of acupoint P6 led to decreases in heart rate and increases in the high-frequency HRV, an index of cardiac vagal modulation, while stimulation of a sham acupoint (1 cm to the ulnar side of P6) decreased heart rate without changing vagal outflow[30]. A comprehensive laboratory study of point specificity evaluated changes induced by stimulating several sets of acupuncture points with respect to reflex increases in BB[31]. It was discovered that EA at P5-P6,
ST36-ST37, LI4-LU7 and LI10-LI11 reduced the pressor response while LI6-LI7 and kidney meridian (K)1-UB67 did not \[31\]. The authors then looked at the neural activity in the rVLM evoked by stimulating these points and found that EA at P5-P6, ST36-ST37 and LI10-LI11 induced a significantly higher evoked activity in the rVLM than the other points. In a study examining the specific effects of manual acupuncture and different EA intensities at P5-P6, Zhou et al. found that thirty minutes of low-current, low-frequency (0.3–0.5 mA, 2 Hz) EA at these points significantly decreased reflex pressor responses as did two minutes of manual acupuncture at P5-P6 every 10 min for 30 min, while needle insertion without stimulation or higher frequencies of stimulation (40 Hz, 100 Hz) did not influence the sympathoexcitatory reflexes \[32\]. Thus, it appears that P6 is an important acupoint that can be used to treat cardiovascular disease and often times is paired with P5 using 2 Hz electrostimulation. It also appears that combining these points with EA at ST36-ST37 may be ben-
4 Myocardial ischemia

Myocardial ischemia, cell starvation resulting from a lack of blood flow to the heart muscle, can lead to cell death or infarction\textsuperscript{30}. The severity and duration of postischemic changes depend on the length and intensity of the ischemia and can ultimately lead to heart failure\textsuperscript{34}. Norepinephrine, a neurotransmitter released by the sympathetic nervous system, can increase the extent of ischemia by increasing myocardial oxygen demand and causing coronary vasoconstriction\textsuperscript{35}. Increases in sympathetic activation during myocardial ischemia can also lead to arrhythmias and increase infarct size\textsuperscript{36}. Preventing ischemic events, therefore, is an important goal in the management of patients with coronary artery disease.

A recent laboratory trial by Zhou and coworkers examined the response to EA in a model of myocardial ischemia-reperfusion (MIR) injury\textsuperscript{37}. To induce ischemia, six different groups of rabbits had the left anterior descending (LAD) artery occluded for 30 min followed by 90 min of reperfusion. One group had no EA, one had EA at P5-P6 (2 Hz for 30 min) immediately after onset of LAD occlusion, and one group (for control) had needles inserted at P5-P6 after occlusion with no stimulation. The other three groups had EA at P5-P6 after the onset of occlusion and were pretreated with either naloxone (non-selective opioid inhibitor), chelerythrine [a non-selective protein kinase C (PKC) inhibitor], or naloxone and chelerythrine together. EA significantly improved MIR-induced systolic and diastolic left ventricular dysfunction, lowered heart rate and the RPP, attenuated ST segment elevation during ischemia, reversed ST elevation to baseline after 90 min of reperfusion and reduced infarct size and arrhythmia scores. Control acupuncture had no effect. Administration of either naloxone or chelerythrine separately as a pretreatment to EA, blocked the infarct reduction and the anti-arrhythmic effect was partially reversed. Both drugs given together completely eliminated the anti-arrhythmic effect of EA. The increase in interstitial norepinephrine associated with MIR was suppressed by 40% in the EA group while no suppression was observed in the controls. Once again, this reduction was partially blocked by either naloxone or chelerythrine given separately as a pretreatment and completely eliminated when they were administered together. The authors concluded that EA reduces ischemia-reperfusion injury through both opioid and PKC-dependent mechanisms and has the potential to play an important role in the clinical treatment of cardiac ischemia.

In contrast, another animal study using rats did not find EA at P5-P6 to be cardioprotective\textsuperscript{38}. In this study, similar EA protocols were used, although EA was started 5 min prior to LAD occlusion rather than immediately after onset of occlusion as in Zhou’s study\textsuperscript{37}. EA did not alter heart rate, arrhythmias or infarct size. Unlike studies showing cardioprotective effects\textsuperscript{37, 39}, there was no change in heart rate, BP or RPP in the EA group compared to the control group after the onset of occlusion thus eliminating the potential for EA to reduce myocardial oxygen demand and ameliorate ischemia, which EA is capable of doing in ischemia exacerbated by sympathoexcitatory reflex stimulation\textsuperscript{40}.

In human trials, early work by Ballegaard demonstrated that three weeks of manual acupuncture (seven treatments) at P6, ST36, and urinary bladder meridian (BL)14 in normotensive patients with >50% coronary stenosis, positive stress tests and severe refractory angina, significantly increased cardiac work capacity, expressed as difference in RPP comparing rest to maximal exercise as well as maximal RPP during exercise compared to sham (outside meridians, same dermatome)\textsuperscript{41}. In this same study they observed no decrease in angina attacks or nitroglycerin consumption. A subsequent study using the same active acupuncture and sham protocol in patients with moderate angina revealed an increase in exercise tolerance and delayed onset of chest pain only in the acupuncture group\textsuperscript{41}. Both the acupuncture and sham groups, however, reduced angina and nitroglycerin consumption by 50%. Ballegaard et al. also conducted a two-year prospective, non-randomized trial to explore the cost savings potential of acupuncture followed by acupressure as part of a lifestyle program incorporating stress reduction, Shiatsu massage and healthy eating for patients with severe angina\textsuperscript{42}. Of the 69 patients followed in this study, 49 were candidates for coronary bypass grafting (CABG) while the other 20 had been rejected for surgery. After following patients for two years, researchers compared their endpoint findings with those of a large prospective, randomized trial comparing CABG with percutaneous transluminal coronary angioplasty (PTCA). The incidence of death and myocardial infarction was 21% among the patients undergoing CABG, 15% among the patients undergoing PTCA and 7% among acupuncture.
patients. No significant difference in pain relief was found in the three groups. Hospital stays were reduced by 90% and invasive treatment (angioplasty and bypass) by 61%. The researchers estimated that this program produced an approximate cost savings of $12,000 per patient. Another five-year study saved $32,000 per patient over the course of the project and demonstrated a 90% reduction in hospitalization and a 70% reduction in surgery\(^{[43]}\). An investigation by Richter et al. demonstrated that manual acupuncture (manipulated only once upon insertion) at P6, heart meridian (HT)5, UB15, UB20 and ST36 administered three times each week for 30 min for four weeks reduced the number of anginal attacks, intensity of pain and ST segment depression compared with a tablet placebo. They also observed an increased exercise threshold for angina but no improvement in maximal workload\(^{[44]}\). Antianginal medications remained constant over the duration of the study.

In conclusion, research conducted in patients with symptomatic coronary artery disease supports the possibility that acupuncture in situations associated with demand-induced ischemia can reduce both the intensity and frequency of anginal attacks, improve quality of life and is cost-effective\(^{[42–44]}\). Interestingly, these clinical improvements were gained using manual acupuncture with little manipulation and conducted prior to recent work demonstrating the cardiovascular benefits of using EA at P5-P6 and ST36-ST37 in non-ischemic patients, which include increasing maximal workload and reducing BP, RPP and sympathoexcitatory reflex responses\(^{[29]}\). We hypothesize that using these points on ischemic patients would produce even greater benefit; however, research to confirm this postulate is needed.

5 Hypertension

A large study examining data from 14 international trials on patients with either unstable angina/non-ST elevation myocardial infarction and/or percutaneous coronary intervention showed that 59% of females and 39% of males had hypertension\(^{[45]}\). There is a general agreement that overactivity of the sympathetic nervous system commonly initiates and sustains BP elevation in patients with essential hypertension\(^{[46]}\). Hypertension also can be caused by overactivity of the renin-angiotensin-aldosterone system (RAAS)\(^{[47, 48]}\). This hormonal system is responsible for regulating BP and fluid balance in the body. Regulation of one or both of these systems has been the cornerstone of hypertension pharmacological interventions for decades\(^{[49]}\). Unfortunately, many patients with hypertension require two or more drugs for optimal control\(^{[49]}\) and people often become non-compliant due to adverse side-effects\(^{[50, 51]}\). Recently a preliminary study has suggested that acupuncture reduces elevated BP in hypertensive patients by reducing sympathetic overactivity and modulating the RAAS suggesting that this therapy may serve as a viable option for some patients\(^{[52]}\).

A few high quality trials examining the effect of acupuncture and EA have been conducted, but their results have not been universally consistent. In studies using acupuncture as an adjunct to patients on anti-hypertensive medications, the results have been encouraging. Yin et al. examined the use of individualized manual acupuncture versus non-invasive sham as an add-on therapy for hypertensive patients concurrently treated with various anti-hypertensive medications\(^{[53]}\). Patients received three to four treatments per week for eight weeks. A significant reduction in both systolic and diastolic BP was observed in the acupuncture compared to sham group. Flachskampf et al. also compared individualized treatments to sham. However in this study, the sham was invasive and applied to acupuncture points believed not to influence hypertension\(^{[54]}\). Of the 160 subjects in this study, all but 35 were on some type of anti-hypertensive medication and each received 22 manual treatments over six weeks. A significant difference in post treatment mean systolic and diastolic BP between the active and sham acupuncture groups was observed at the end of treatment. This finding was consistent in both medicated and non-medicated groups.

Studies conducted on non-medicated patients have yielded more varied results. Kim et al. found that manual stimulation involving insertion only at P6, ST36 two times a week for eight weeks reduced nocturnal diastolic BP when compared to sham (1 cm lateral to verum points and superficially inserted)\(^{[55]}\). There were no acupuncture-associated responses in the diurnal BP. Likewise, the Stop Hypertension with the Acupuncture Research Program (SHARP) trial compared manually stimulated individualized and standard acupuncture to invasive sham at non-acupuncture points applied twice weekly for six to eight weeks (12 total treatments)\(^{[56]}\). No difference between groups was observed. Recently, a preliminary study examining point specific responses as the hypertension control found that applying EA at P5-P6 and ST36-ST37 once weekly for eight weeks
reduced peak and average systolic and peak diastolic BP by 5 mmHg or more in 70% of patients while EA at LI6-LI7 and GB37-GB39 did not consistently lower BP \[52\]. More interestingly, when patients who had no decrease in BP in the LI/GB treated group were allowed to crossover into the P/ST group, the investigators observed an average decrease in peak systolic blood pressure (SBP) of 16 mmHg and 6 mmHg in average SBP confirming that these BP changes were point specific. This study also reported that plasma norepinephrine, renin activity and aldosterone were reduced in responders but not in non-responders, suggesting that EA may lower elevated BP by reducing sympathetic outflow and the RAAS. Baseline norepinephrine and renin activity pre-EA were higher in responders versus non-responders, suggesting that patients with elevated sympathetic and renin activities are more responsive. A small subset of patients who responded to the initial eight weeks of treatment participated in a maintenance arm of the study. EA reinforcement treatment at P5-P6 and ST36-ST37 once per month maintained the reduction in BP over the six-month period. Interestingly, when EA is used on normotensive patients, reductions in resting BPs are not seen \[29\].

In a recent meta-analysis examining randomized controlled trials using real versus sham acupuncture for the treatment of hypertension, four trials qualified for analysis as they were considered higher quality with Jadad scores of 4–5 \[57\]. Jadad evaluates the general quality of research trials, including randomization procedures, blinding, description of withdrawals and drops and methods of both randomization and blinding \[58\]. This meta-analysis suggested that acupuncture significantly lowers SBP and diastolic blood pressure (DBP) in patients taking antihypertensive medications while only lowering DBP in unmedicated patients. The majority of these patients received individualized manual acupuncture treatment according to TCM principles to guide the selection of acupoints.

Inconsistent findings between studies are not surprising given that varied acupuncture protocols have been administered. Stimulation of a variety of points falls in line with TCM theory, which bases point prescriptions on individualized pattern diagnosis rather than an all-encompassing clinical diagnosis and selection of standardized points \[59\]. A single diagnosis like hypertension can have several different underlying Chinese pattern diagnoses, thus warranting different point prescriptions for optimal treatment. Although clinically relevant for individual practitioners, using this theory in clinical trials is challenging at best, since a variety of different acupoints may be stimulated from patient to patient. Likewise, studies assessing reliability of inter-practitioner pattern diagnoses have shown there is little agreement on diagnosis, diagnosis related variables and/or point prescriptions \[60–63\]. Although debate continues over the use of individualized versus standardized point specific protocols, the future use of standardized acupoints in clinical trials, including for example EA at 2 Hz for 30 min at P5-P6 and ST36-ST37 improves reproducibility and efficiency in research as well as practical application for practitioners in the clinical setting.

### 6 Arrhythmias

Cardiac arrhythmias have been implicated both as a risk factor and an etiology for sudden cardiac death, the most lethal manifestation of heart disease \[64\]. Ischemia and increases in sympathetic activity are causal factors for both supraventricular and ventricular arrhythmias \[65–67\]. Given that acupuncture reduces ischemia and inhibits sympathetic outflow, it could also be used as a modality in the treatment of cardiac arrhythmias that are related to augmented sympathetic outflow and sympathetic/parasympathetic imbalance \[6, 19, 44, 52, 68\].

In early experimental models, it was demonstrated that EA at P6 and ST36 reduced premature ventricular contractions (PVCs) and ventricular tachycardia \[69\]. Likewise, reperfusion-related ventricular tachycardia in rats was reduced by EA at P5-P6 in association with a decrease in myocardial oxygen demand, measured as a reduced RPP and decreased ST segment elevation \[70\]. A recent meta-analysis by Kim et al. was published examining the effectiveness of acupuncture in the treatment of cardiac arrhythmias \[71\]. This review evaluated the response of paroxysmal supraventricular tachycardia (PSVT), PVCs and atrial fibrillation (AFib) to acupuncture. One trial found that long-term acupuncture treatment for PSVT had similar rates of conversion to sinus rhythm as did diltiazem \[72\]. Three trials demonstrated that acupuncture was effective in reducing the number of PVCs \[73–75\]. Two studies suggested a beneficial effect of acupuncture in conversion from AFib to sinus rhythm \[76, 77\]. Specifically, the Lomuscio trial examined the role of acupuncture in preventing arrhythmia recurrences after cardioversion in patients with AFib \[78\]. Eighty patients with persistent AFib who un-
derwent electrical cardioversion were randomized to receive active acupuncture (P6), sham acupuncture (needling outside of meridian), amiodarone or no anti-arrhythmic medication. Overall, AFib reoccurred in 44% of patients. In patients receiving acupuncture, AFib reoccurred in only 35% compared to 69% in sham and 54% in the no drug group. In the amiodarone group, 27% developed recurrent AFib. The study concluded that active acupuncture was almost as good as amiodarone in reducing the reoccurrence of AFib after cardioversion. All patients were on anti-coagulants and no serious side effects, like bleeding, occurred during acupuncture. Given that the majority of studies were low methodological quality and included small sample sizes, Kim et al. cautiously concluded that acupuncture may be an effective treatment for arrhythmias. Although it is agreed that additional high quality studies in this area are warranted, it appears that acupuncture could be used as a complement or possibly in place of antiarrhythmic drugs.

7 Heart failure

Left ventricular dysfunction begins with injury to, or stress on, the myocardium and is generally a progressive process, even in the absence of a new identifiable insult to the heart. Increased sympathetic nerve activity is a characteristic feature of heart failure. A strong link has been demonstrated between the level of cardiac sympathetic outflow in patients with heart failure and the development of ventricular arrhythmias, progressive left ventricular deterioration, and reduced survival. Other consequences of the increase in sympathetic tone include an increase in local and circulating concentrations of norepinephrine, which induces cardiac myocyte hypertrophy either directly or secondarily through activation of the RAAS. Norepinephrine also is directly toxic to myocardial cells.

These deleterious effects are mitigated by the use of β-adrenergic blockade or combined β- and α-adrenergic blockade, i.e. drugs that block the activity of the sympathetic nervous system. Once thought to be contraindicated in the treatment of heart failure due to the short-term support the sympathetic nervous system provides by partly restoring cardiac output and optimizing the distribution of limited blood flow to vital organs, β blockade is now known to prolong life and improve symptoms and quality of life. In fact, the benefits of β-blockers are greatest in patients with the highest level of sympathetic activation. Given that acupuncture works by inhibiting sympathetic outflow and has been shown to reduce levels of norepinephrine, renin and aldosterone, it has the potential to reduce morbidity and mortality associated with increased sympathetic activity in heart failure.

Only a few small human trials examining the effect of acupuncture in heart failure are available. Middlekauff et al. (2002) examined the effect of 15 min of manual acupuncture at LI4, liver meridian (LV)3 and P6 versus non-acupoint stimulation and no needle stimulation on sympathetic activation during mental stress in advanced heart failure patients. They demonstrated that acupuncture eliminated the increase in muscle sympathetic nerve activity seen in mental stress testing while the control did not and concluded that the immediate effect of acupuncture is to attenuate sympathoexcitation in advanced heart failure patients. Another trial employing acupuncture twice weekly found that it increased submaximal exercise tolerance, increased HRV, decreased the inflammatory cytokine tumor necrosis factor alpha (TNF-α) and improved patient satisfaction in patients with class II-IV heart failure, while the non-penetrating, telescoping placebo needle placed 2 mm outside the verum acupoint placement was ineffective. Left ventricular ejection fraction and maximal exercise capacity were, however, unchanged.

A recent, interesting animal study employed EA at P5-P6 and L6-L7 in rats with heart failure. In this experiment, heart failure was induced by coronary artery ligation, and EA intervention began four weeks later. Subjects were divided into three groups: EA at P5-P6, EA at L6-L7 (control) or no EA. EA was delivered once daily for seven days at 2 Hz for 30 min. For comparison of the effects of EA on heart function, metoprolol was administered for seven days in the medicated control group. One week of EA significantly improved ejection fraction, left ventricular fractional shortening, and reversed enlargement of left ventricular end-diastolic and systolic dimension as well as reduced infarct size compared to control and no EA rats. These results were similar to those observed with metoprolol although the reduction in infarct size was slightly smaller. This laboratory study is the first of its kind to directly examine EA effects on progression of heart failure and the improvement observed in cardiac function, remodeling and infarct size.

Given the lack of adequately powered, randomized, blinded clinical trials on the effectiveness of acupunc-
ture in heart failure, it is hard to draw a concrete conclusion on its use in the clinical setting. However, given that increased sympathetic activity is deleterious in heart failure and EA at P5-P6 and ST36-ST37 has been shown to modulate the autonomic nervous system, its use should be considered.

8 HRV

HRV is a measure of the naturally occurring beat-to-beat changes in heart rate\(^{[95]}\). HRV analysis can serve as a relatively reliable marker for parasympathetic (vagal) tone and to a lesser extent, sympathetic activity.\(^{[96,97]}\). Individuals at rest showing higher vagal tone than average tend to be more resilient to stress, adapting well across a number of different situations\(^{[98]}\). Specific to heart disease, low levels of vagal modulation may not adequately counteract sympathetic stimulation, leaving the heart vulnerable to ventricular arrhythmias and sudden cardiac death, especially in heart failure.\(^{[99–101]}\). Given that EA has been shown to modulate both sympathetic and parasympathetic activity\(^{[15,21]}\), one would expect that it might alter HRV in heart failure patients.

A meta-analysis examining the effect of acupuncture on HRV concluded that acupuncture elicited no substantial impact\(^{[102]}\). In a more recent meta-analysis of 14 studies, the authors reported moderate support for acupuncture’s effect on decreasing low frequency (LF, a low grade marker of sympathetic tone) and the sympathovagal balance marker LF/HF (high frequency, a marker of vagal tone) in non-healthy individuals and LF in healthy subjects\(^{[68]}\). One group of the non-healthy individuals included individuals with heart disease\(^{[103]}\). This decrease in LF activity led the authors to suggest that acupuncture may modulate parasympathetic outflow. ST36 and P6 seemed to be key points in modulating HRV although this was stated with caution because information on needling technique is lacking. In a study by Sakatani et al. (2010) not included in this last meta-analysis, acupuncture at LI4 but not sham acupuncture (2–3 mm outside of LI4) decreased the LF/HF ratio, and increased the HF power again indicating a shift to parasympathetic dominance.\(^{[104]}\)

Manual acupuncture applied three times per week for 12 weeks at P4, P6, HT7, ST36, spleen meridian (SP)6, Ren17, LI4 and LV3 in patients with known heart disease revealed an increased HRV during mental arithmetic stress (rapid mental math calculations) more than a sham (off channel, non-penetrating) group\(^{[105]}\). The high frequency component (indicative of parasympathetic activity) was 17% higher in the acupuncture group. These findings suggest that acupuncture inhibits the stress response in heart disease patients by modulating parasympathetic activity. In a cross-over study by Kim et al., manual acupuncture at LI4 and SP6 induced a significant decrease in LF/HF ratio and an increase in HF power compared to a non-penetrating sham at the same points\(^{[106]}\). Li et al. found similar results when using acupuncture at P6 and LI4 and a similar sham\(^{[107]}\). Similarly, Huang et al. found that acupuncture at P6 increased HF and decreased LF/HF markers compared to off-channel sham or no treatment\(^{[39]}\).

Chinese medical theory has long touted the ability of acupuncture to balance the body and achieve homeostasis\(^{[59]}\), a concept that appears to be supported by acupuncture’s action on the autonomic nervous system. Given that the majority of these studies support the use of acupuncture to modulate HRV, its use may be beneficial in patients with suspected sympathetic overactivity or parasympathetic dysfunction. Although there is no consistency in the acupoints used, it appears that P6 may be one of the important points to use for modulating HRV. Further high quality research is warranted to confirm more point specific protocols and to relate changes in HRV with arrhythmias in susceptible patients.

9 Conclusion

Although the number of high quality studies evaluating the efficacy of manual acupuncture or EA to treat symptoms of heart disease is small, it appears that this ancient therapy may be beneficial in several cardiovascular disease conditions. EA appears to be useful in patients with mild to moderate hypertension, whether or not anti-hypertensive drugs are used. Certainly it can provide a treatment alternative to those individuals who elect to remain unmedicated due to unwanted side effects. Given that EA inhibits sympathetic overactivation, it might be useful to prevent or slow the progression in heart failure. In patients with myocardial ischemia, acupuncture also may reduce angina and the need for nitroglycerin and when integrated into a holistic program, may produce cost savings. EA also may help treat arrhythmias. In this regard, it may be useful as a deterrent to the recurrence of atrial fibrillation after cardioversion. As an added benefit, acupuncture may modulate the autonomic nervous system, thus reducing the
risk of sudden cardiac death. Given the array of possible benefits, lack of side effects (0.13% incidence)\(^\text{[108]}\) and the relatively low cost, the use of acupuncture and more specifically EA, may be warranted.

In terms of treatment protocols, it appears that P6 is the most common point used in the treatment of cardiovascular conditions, probably because the underlying sensory neural pathways stimulated project to cardiovascular regulatory regions of the brain stem\(^\text{[30]}\). Given that the use of manual acupuncture can vary between clinicians, using EA at P5-P6 at 2 Hz for 30 min rather than the use of manual acupuncture can vary between clinicians, using EA at P5-P6 at 2 Hz for 30 min rather than just manual P6 stimulation will likely reduce inter-practitioner variability and lead to more consistent clinical outcomes. Although more research is needed to determine what other points may or may not provide an added benefit, at this time it appears that employing EA at ST36-ST37 in conjunction with P5-P6 might provide optimal clinical cardiovascular responses. The frequency of treatments has not been well studied, but it appears that EA once or twice weekly for four to eight weeks should be adequate to achieve desired clinical outcomes and then once monthly treatments may be enough to sustain benefit.

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