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The effect and safety of acupuncture as adjunctive therapy for STEMI patients after PCI: study protocol of a randomized controlled trial

Yi Zhao[1†], Fayang Ling[1,2†], Yalu Qin[3†], Wen Xie[4], Wenchuan Qi[1], Qian Nie[4], Hongcai Zhang[4], Mingjun Han[4], Jue Zhao[4], Lei Liu[4], Lin Hu[3], Juan Xiao[5], Wufeng Li[5], Fanrong Liang[1,2*] and Qianhua Zheng[1,2*]

Abstract

Background ST-elevation myocardial infarction (STEMI) is a common acute ischemia heart disease that causes serious damage to human health worldwide. Even though morbidity and mortality have significantly decreased by percutaneous coronary intervention (PCI), an additional cardiac protection strategy is still required. Acupuncture therapy has presented a dominant cardiac protection in many studies lately. Thus, we aim to evaluate the effect and safety of acupuncture as an adjunctive therapy in STEMI patients after PCI through a randomized controlled trial.

Methods/Design This study describes a protocol of multicenter, double-blinded, parallel-controlled, randomized controlled trial. Ninety-six patients with STEMI aged 18–85 years who undergoing PCI will be recruited from the Affiliated Hospital of Chengdu University of Traditional Chinese Medicine, The Affiliated Third Hospital of Chengdu Traditional Chinese Medicine University/Chengdu Pidu District Hospital of Traditional Chinese Medicine, and Zhaotong Municipal Hospital of Traditional Chinese Medicine. Participants will be randomly assigned (1:1 ratio) to the verum acupuncture plus basic therapy (i.e., treatment) group or the sham acupuncture plus basic therapy (i.e., control) group. These participants will be treated for 5 days and then will be followed up for 24 weeks. Any adverse events will be recorded throughout the study to evaluate safety.

Discussion The present study aims to investigate the effect and safety of acupuncture for patients with STEMI after PCI and set up standardized treatment programs for acupuncture of these patients.

Trial registration This study was registered in the Chinese Clinical Trial Registry (Registration ID: [ChiCTR2400081117]), on February 22, 2024.

†Yi Zhao, Fayang Ling and Yalu Qin contributed equally to this work.

*Correspondence:
Fanrong Liang
acuresearch@126.com
Qianhua Zheng
zhengqianhua@cdutcm.edu.cn

Full list of author information is available at the end of the article

Keywords Verum acupuncture, Sham acupuncture, ST elevation myocardial infarction, Percutaneous conronary intervention, Randomized controlled trial

Introduction

ST-elevation myocardial infarction (STEMI), caused by disruption of an atherosclerotic plaque with superimposed thrombus, results in near-total or total occlusion of the culprit coronary artery [1]. Percutaneous coronary intervention (PCI), as a timely and complete reperfusion strategy, plays a vital role in salvaging ischemic myocardium, reducing infarct size and improving the prognosis in STEMI patients. The mortality and morbidity have decreased following the use of PCI. Despite prompt reperfusion and optimal drug therapy, as much as 22% of STEMI patients experienced heart failure and were readmitted to hospital within 1 year, with a 1-year mortality rate of 7% [2]. As ischemia/reperfusion (I/R) injury induced by PCI aggravates the myocardial death, the infarct size caused by reperfusion accounts for as much as 50% of the final infarct area, [3] which is one of the main determinants of death, heart failure, arrhythmia and other adverse cardiovascular events in STEMI patients experienced PCI [4, 5]. In addition to aggravating myocardial infarction, arrhythmia, myocardial stunning, microvascular obstruction, and fatal reperfusion injury may be induced by I/R injury, among which microvascular obstruction and fatal reperfusion injury are irreversible [3]. Consequently, the prevention of reperfusion injury is considered pivotal goals for improving outcomes in STEMI patients.

The inflammatory reaction seems to contribute to the I/R injury [6–8]. I/R injury triggers a complex inflammatory reaction accompanied by intracellular K+, H+, histamine, prostaglandin and P-substance penetrating the extracellular. This kind of reaction rapidly activates the complement cascade, inducing cell pyrodeath through endogenous injury-related molecular patterns, and then producing inflammatory cytokines such as IL-1β and IL-18 to cause a local inflammation reaction [9]. IL-1β were strongly associated with impaired myocardial function and non-infarcted left ventricular function 1 year later, suggesting a potential role for IL-1β in predicting maladaptive myocardial remodeling after reperfusion myocardial infarction [10].

As a treasure of traditional Chinese medicine, acupuncture has become a hotspot of anti-inflammatory research for its remarkable effect and non-toxic side effects [11–14]. The study published by Ma Qiufu and his team provided a modern neuroanatomical basis and achieved a historic breakthrough in acupuncture research of anti-inflammatory [15]. Acupuncture also has shown a significant anti-inflammatory effect in myocardial ischemia of rat models [16, 17]. A Randomized Controlled Trial (RCT) displayed that acupoint electric stimulation in patients undergoing elective PCI surgery can significantly reduce the levels of cardiac biomarker, and decrease the incidence of adverse cardiovascular events 2 years post PCI [18]. To date, there has been no RCT about acupuncture therapy for patients with acute myocardial infarction, further evidence-based studies are needed on the safety and effects of acupuncture intervention post-PCI in acute myocardial infarction.

Methods and design

Objectives

We have designed a clinical trial to primarily investigate the effect of acupuncture, in addition to basic therapy, among patients with STEMI after PCI.

Study design

This study was a multicenter, assessor and statistician blinded, parallel-controlled trial in China. The protocol reporting follows the SPIRIT reporting guidelines [19]. In this study, 96 participants will be randomly assigned to two groups through blocked randomization in a 1:1 ratio. Eligible participants will be recruited from the inpatient departments of Cardiology at Chengdu University of Traditional Chinese Medicine, Chengdu Pidu District Hospital of Traditional Chinese Medicine, Sichuan, and Zhaotong Municipal of Traditional Chinese Medicine, Yunnan. The study flow chart is shown in Fig. 1, and the study time schedule is presented in Table 1.

Eligibility criteria of the participants

Diagnostic criteria

According to the guidelines for Diagnosis and Treatment of ST Elevation Myocardial Infarction issued by the Chinese Society of Cardiology in 2019 [20] and The European Society of Cardiology, annual meeting of the released version 4 myocardial infarction global unified definition in 2018 [21], patients with the diagnosis of STEMI will be included if meet the following inclusion criteria:

1. Intense squeezed pain in the poststernal or precardiac area (usually more than 10–20 min) that radiates to the left upper arm, jaw, neck, back, or shoulder; or is accompanied by nausea, vomiting, sweating and dyspnea, some patients may have syncope. And these symptoms cannot be relieved by taking nitroglycerin.
2. The electrocardiogram (ECG) showed ST segment elevation in at least 2 limb leads with

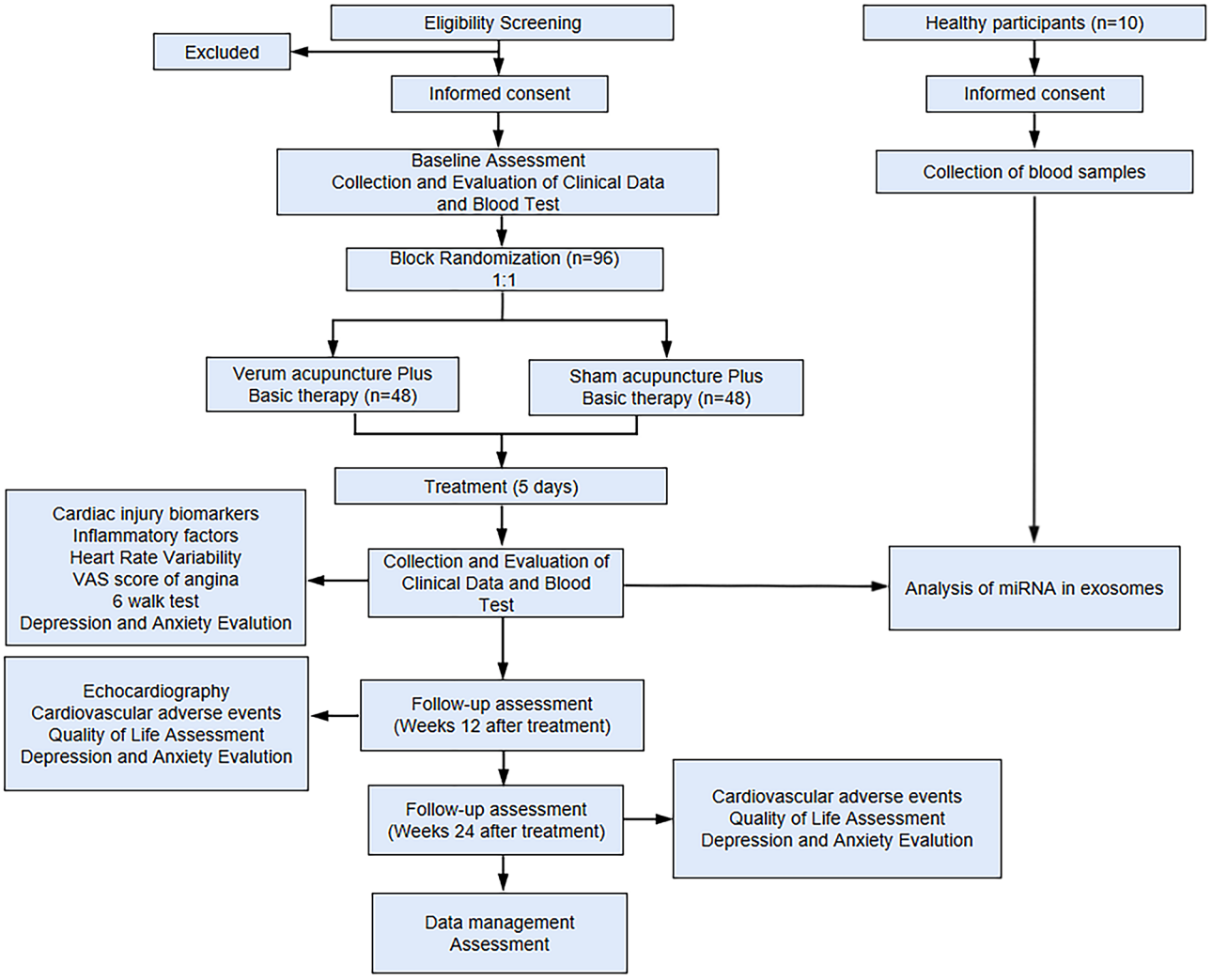

Fig. 1 Trial flow chart

consecutive lead elevation ≥ 1 mm, or ST segment elevation ≥ 2 mm in two or more consecutive leads in the thoracic region.

3. Patients whose symptoms and ECG can definitively diagnose STEMI do not need to wait for the results of myocardial injury markers or imaging. It is recommended to routinely detect the level of troponin (cTnI) in the acute stage, but reperfusion therapy should not be delayed because of this. The evolution of cardiac biomarkers should be dynamically observed.

Inclusion criteria

Eligible participants should match the diagnostic criteria for STEMI set by according to the classification criteria of ESC Guidelines for the management of acute myocardial infarction in patients presenting. Eligible participants in this study must meet the following inclusion criteria: (1) be diagnosed with STEMI according to the Guidelines described above; (2) receive PCI within 12 h of being hospitalized; (3) age between 18 and 85 years old; (4) consent to participation and completion of the full treatment process and be able to sign the informed consent form.

Exclusion criteria

Participants with any of the following conditions will be excluded: (1) combined with severe primary diseases such as digestive diseases, urinary diseases, respiratory diseases, blood diseases, nervous diseases and endocrine diseases that cannot be effectively controlled; (2) with severe complications after PCI, such as coronary artery occlusion, no reflow, coronary artery perforation, etc.; (3) with cardiac shock before PCI; (4) chest pain caused by heart valve diseases, hypertrophic cardiomyopathy and dilated cardiomyopathy, non-cardiac diseases including severe neurosis, climacteric syndrome, cervical spondylosis, esophagus, lungs, or chest wall, etc.; (5) with

Table 1 Trial process chart

Item	Baseline	Acupuncture					Follow-up	
	Before PCI	1 day	2 day	3 day	4 day	5 day	12 week	24 week
Eligible screen	×							
Informed consent	×							
Inclusion/exclusion criteria	×							
Medical history	×							
Combined disease treatment	×							
Crime vessels	×							
Number of stentings	×							
Allocation	×							
Outcomes								
cTnI	×					×		
Cardiac injury markers	×					×		
Inflammatory cytokines	×					×		
Serum exosomes miRNA	×					×		
Six minutes' walk test						×		
VAS score of angina		←	—	—	—	→		
SDS						←	—	→
SAS						←	—	→
echocardiogram							×	
Major adverse cardiovascular events							×	×
CQQC							×	×
Patient's satisfaction for acupuncture						×		
Blind evaluation						×		
Patient's compliance								×
Reasons of drop-out or withdrawals								×
Adverse events						×		
Safety evaluation								×

mental disorders and intellectual disabilities who could not cooperate with the questionnaire survey; (6) involvement in other researches.

Eligibility criteria of the healthy people

Inclusion criteria

Those who meet the following 5 criteria at the same time will be recruited in this study: (1) 18 years old ≤ age ≤ 85 years old, without gender restrictions; (2) without organic or functional diseases; (3) without mental disorders; (4) have not involvement in other researches recently; (5) voluntarily to sign the informed consent form.

Exclusion criteria

Those who meet any of the following criteria will be excluded: (1) smokers and alcoholics; (2) pregnant and lactating women; (3) involvement in other studies.

Culling and shedding criteria

Patients will be ruled out as meeting the following criteria: (1) Cases that do not meet the inclusion criteria and are mistakenly taken into account should be eliminated; (2) Cases with poor compliance and self-withdrawal during the course of treatment; (3) Cases in which the trial will be terminated due to serious adverse reactions or complications that make continuation of treatment inappropriate.

Treatment of culling and shedding cases

The patients ruled out in this study will be treated as following described: (1) Once the patients falls off, the assessors in charge will contact the patients to inquire about the reason, record the last treatment time, and complete the evaluation items that can be completed by visiting the subject, making an appointment by telephone, or sending letters, etc. (2) For patients who withdraw from the trial due to adverse events or ineffective treatment, the assessors in charge will take appropriate treatment measures according to the actual situation of the subjects. (3) Once the random number is obtained, it will be regarded as the patients, regardless of whether the diagnosis and treatment are complete, it will be processed according to the elimination of cases. (4) Intentionality analysis will be performed for all shedding cases after the experiment. (5) Reasons will be explained for cases removed or dropped, and the Case Report Form (CRF) will be correctly filled and recorded, and retained for future reference.

Dropout criteria

Patients who withdraw from the trial for any reason will be considered a drop-out. The common reasons for dropping out including AEs, poor compliance with the protocol, unsatisfied efficacy, withdraw and quit, disease progression, and others. Investigators should complete the case report form (CRF) and record the reason for dropping out. All the information from participants who have dropped out will be used for intention-to-treat (ITT) analysis.

Follow-up visits

The acupuncture treatment will last five days after PCI. And the duration of follow up will onging 3 months and 6 months after the end of acupuncture treatment. The assessors will in charge of the follow up the patients by outpatient, including echocardiography, scale measurement, the follow-up information storage. To enhance the rate of follow up, information of the patient or his/her family will be recorded rigorous. The assessors will make an appointment according to the follow-up date. If no contact can be made, a loss to follow-up will be recorded.

Calculation of sample size

The primary outcome of this study is the mean difference in serum cardiac troponin I concentrations for STEMI-PCI patients between the verum acupuncture group and the sham acupuncture group after acupuncture treatment. All patients will receive standard therapies as recommended in the guideline including aspirin, clopidogrel or ticagrelor Metoprolol sustained-release tablets, angiotensin converting enzyme inhibitors, angiotensin receptor blockers, calciumion blockers, angiotensin receptor enkephalase inhibitors and other drugs [20, 21]. The choice of pharmacologic treatment is individualized, with consideration of patient's coexisting conditions and adverse effects to the medications. Based on the previous RCT study, we expected that acupuncture would be more effective than sham acupuncture in decreasing the serum cardiac troponin I concentrations [22]. Assuming the difference between the verum acupuncture group and the sham acupuncture group is 0.68, and the standard deviation is 2.07, the bilateral $\alpha = 0.05$, $1\text{-}\beta = 80\%$, and the optimal effect test is performed. The sample size is 86 in total calculated by PASS (15th edition, NCSS). There will be 43 patients in the verum acupuncture group and the sham acupuncture group, respectively. To compensate for a loss 10% in follow-up, total of 96 patients with STEMI-PCI will be enrolled, with 48 patients in each group.

Statistical analysis

R statistical software package and SPSS21.0 statistical software (IBM, Armonk, NewYork, USA) will be used for data analysis. Statistical analysis will be performed by a statistician blinded to the whole trial process. Statistical analysis will be performed by an independent author. Normal continuous variables will be described as mean ± standard deviation, non-normal distributions will be described as median, P25, P75, maximum, minimum, and categorical variables will be described

as percentages. The hypothesis test gives the statistic and its corresponding *P*-value, and takes $P<0.05$ as the criterion of statistical significance. This study will be conducted according to the Intention-to-Treat (ITT) protocol. Participants who completed a baseline assessment of primary outcomes and received at least one acupuncture or sham acupuncture treatment were included in the ITT population. Missing data for exiting participants will be reduced multiple times via the package "Amelia" in R software (www.r-project). For participants who complete at least 80% of the treatment regimen after randomization, a Pre-protocol (PP) analysis will be performed. Independent samples *t*-test will be used for inter-group comparison, and paired samples *t*-test will be used for intra-group comparison respectively with normal distribution. The Mann-Whitney U test will be used for non-normal distributed variables.

The isolation and sequencing of exsomes miRNA from serum will be commissioned by Shanghai Personalbio Biotechnology Co., Ltd.

Randomization

Randomized allocation sequence will be generated using R software (blockrandom package) by an appointed investigator. The generated sequences will be placed in serialized, opaque, sealed envelopes to ensure concealment of allocation from the evaluators by an investigator who will not participant in the process of treatment, assessment and statistical analysis. After ensuring patients meet inclusion criteria and signed informed consent form. An independent assessor will interview and screen the participants. The acupuncturist in each center will require the randomized allocation sequence and group from the independent investigator by short message service (SMS) or phone and then acupuncture treatment is carried out by acupuncturist. This procedure guarantees that randomization concealment is adequate, and not influenced either by the acupuncturists or by the participants.

Blinding

As the nature of acupuncture manipulation, it is difficult to blind the acupuncturist of the study. Thus, we can only blind the participants, assessors and data statistician. Participants will be blinded to their treatment allocation, but they will be informed that there are two methods of acupuncture treatment provided in this study. Every patient will receive acupuncture treatment in a separate room to guarantee the blinding from each other. At the end of acupuncture therapy, all participants will be assessed blinded for the allocations of the different treatments.

Recruitment

All participants will be recruited in the inpatient departments and interventional rooms of the three hospitals separately. Before the recruitment, all eligible patients will be informed of the details of the study and all the benefits and risks that they may take from this trial including: the possible risks in this study, they could withdraw from the trial at any time without specifying reasons, they can provide written informed consent before enrollment voluntarily. Furthermore, participants will be clearly told about the equal chance of allocation to any one of the two groups before signing the informed consent.

Interventions

Standard treatment

1. Aspirin: Aspirin loading dose of 300 mg will be given or supplemented before PCI, and changed to 100 mg daily for long-term oral administration after PCI;
2. Clopidogrel or ticagrelor: 600 mg load dose of clopidogrel will be given or supplemented before PCI and changed to 75 mg daily orally for 12 months after surgery; or ticagrelor 180 mg before PCI and 90 mg twice daily for 12 months thereafter;
3. Metoprolol sustained-release tablets: 12.5-47.5 mg orally per day will be given after surgery, and the dosage will be adjusted according to the patient's heart rate and cardiac function;
4. Angiotensin converting enzyme inhibitors, angiotensin receptor blockers, calcium ion blockers, angiotensin receptor enkephalase inhibitors and other drugs.

Patients will be treated with drugs 1, 2, and 3 simultaneously post PCI. Drugs 4 should be used according to the specific situation of patients in accordance with the drug use specifications. Patients combined with hypertension, diabetes, hyperlipidemia and other diseases should actively control blood pressure, blood sugar, blood lipids. The use and dosage of medicine will be in accordance with the current guidelines. The name, specification, dosage, taking time, and remission time after taking of drugs will be recorded in CRFs in detail, and health education will be carried out for patients.

Verum acupuncture therapy

According to previous literature reviews and expert opinions, bilateral *Neiguan* (*PC 6*), *Yinxi* (*HT 6*) and *Zusanli* (*ST 36*) will be selected in this study (Fig. 2). The location of acupoints in conforms to the 2021 National Standards of the People's Republic of China (GB/T12346-2021). Acupuncture treatment will be performed by a licensed acupuncturist who holds a China Acupuncturist

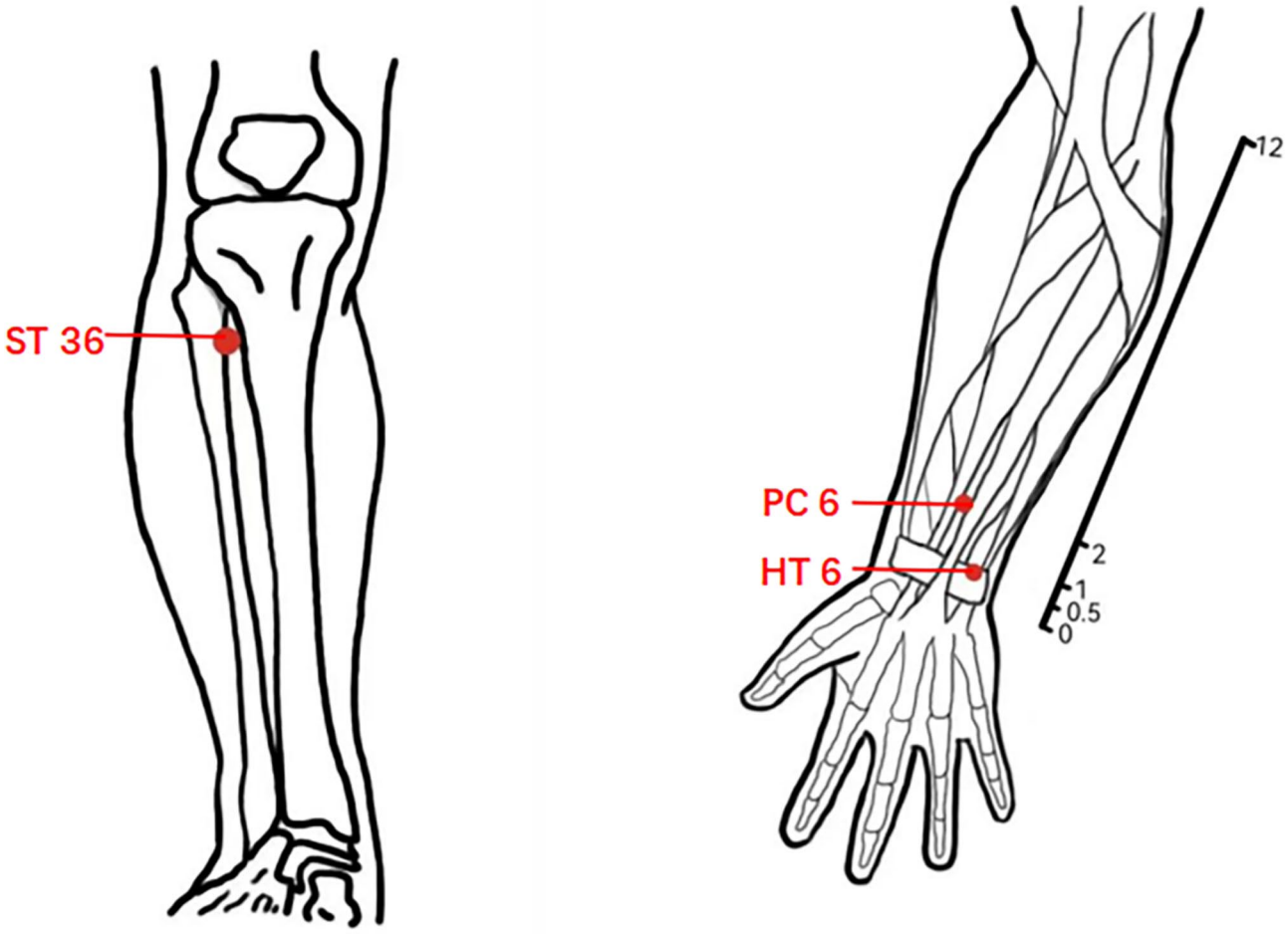

Fig. 2 Location of *Neiguan* (*PC 6*), *Yinxi* (*HT 6*) and *Zusanli* (*ST 36*)

Certification, with at least 2 years of clinical experience in acupuncture, as well as participating in the special training and acquired the certification of this study before clinical recruitment. Participants will be placed in a supine position with adequate exposure of the selected acupoints and disinfection with 75% medical alcohol. Disposable sterile acupuncture needles will be used. For *PC 6* and *HT 6*, 0.25×25 mm acupuncture filiform needles (0.25 mm in diameter and 25 mm in length, Hwatuo, Suzhou, China) will be inserted vertically in a depth of 15 mm to 20 mm at *PC 6*, and 7 mm to 15 mm cun at *HT 6*, respectively. For *ST 36* acupoint, 0.25×40 mm filiform needles (0.25 mm in diameter and 40 mm in length, Hwatuo, Suzhou, China) will be inserted vertically within 25 mm to 40 mm. Then, the needle is twisted between 90 and 180°, lifted and thrusted in an even amplitude between 0.3 cm and 0.5 cm, 60 times to 90 times per minute. After the deqi response (including soreness, numbness, distention, and heaviness) is obtained, electrical stimulation (HANS-200E; Nanjing Jisheng Medical Technology Co., Ltd, Nanjing, China) will be administered simultaneously for 30 min with a dense and dilatational wave (2/15 Hz), The electrical stimulation intensity will be adjusted from 0.2 mA to 1.0 mA according to the patient's tolerance. The first time of acupuncture treatment will be performed within 12 h post-PCI. The treatment course will last for consecutive 5 days (once a day).

Sham acupuncture therapy

Sham acupuncture therapy will use Park sham device (0.25 mm in diameter and 25 mm in length, Hwatuo, Suzhou, China) (Fig. 3) in the aforementioned acupoints. After skin disinfection, adhesive rubber pad and plastic catheter base will be attached to the skin, and the needle is pushed vertically down through the plastic catheter on the rubber pad, and the blunt needle is pressed into the rubber pad but cannot pierce the skin. The acupuncture

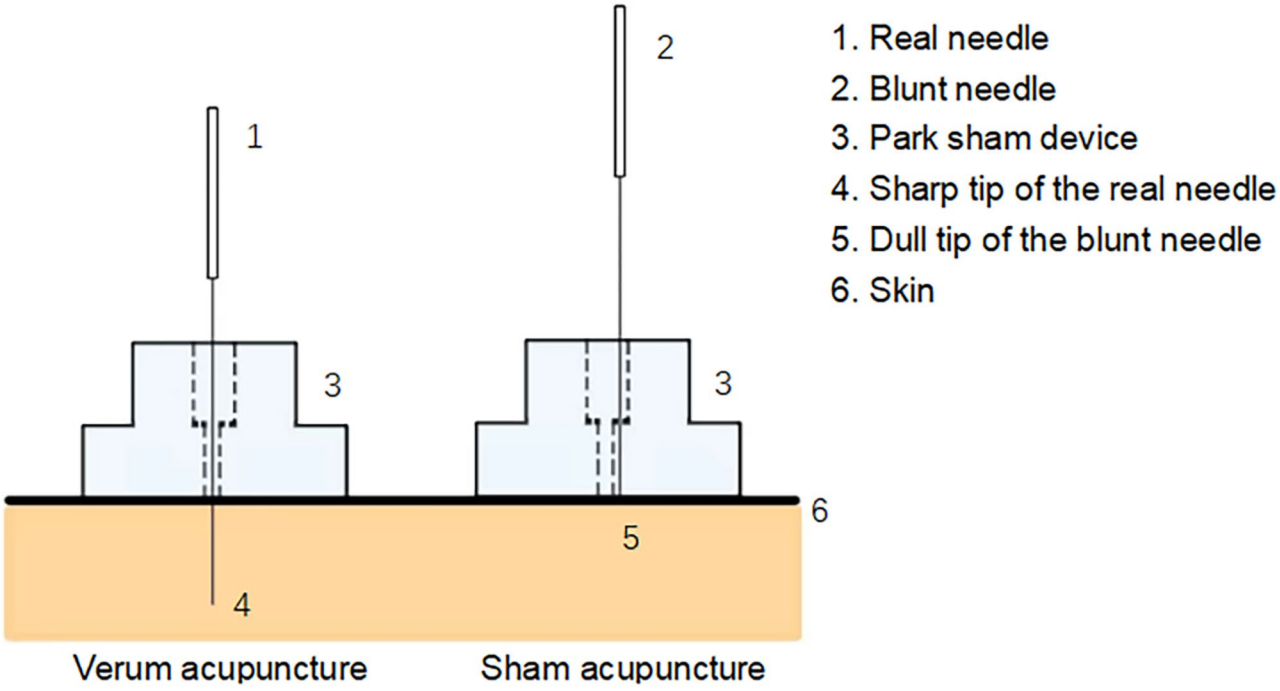

Fig. 3 Verum acupuncture and sham acupuncture

procedure is the same as that in the verum acupuncture group.

Outcome measurement

Primary outcome

The primary outcome is the cTnI value after acupuncture treatment, which is detected before PCI and on the day of EOT (end of treatment).

Other outcome measures

1. Cardiac injury biomarkers including creatine Kinase (CK), creatine KinaseIsoenzyme (CK-MB) and Lactate Dehydrogenase (LDH). These markers represent the degree of cardiac injury. And the test is performed before PCI and on the day of EOT.
2. Inflammatory cytokines including C-reactive protein (CRP), IL – 10 and TNF-α, IL – 1β, which is performed before PCI and on the day of EOT.

Blood samples of all patients will be collected before the PCI and on the day of EOT. The enzyme-linked immunosorbent assay (ELISA) kit will be used for detection mentioned above.

3. Serum exosomes miRNA, which is detected through high-throughput sequencing from 20 patients from verum acupuncture and sham acupuncture group, and 10 healthy participants.

In addition, predictive analysis of serum exosomes miRNA will be conducted after high-throughput sequencing. Blood samples of all patients will be collected before the PCI and on the day of EOT, blood samples of healthy participants will be collected in the morning.

4. Heart Rate Variability (HRV), refers to the variation of heart rate cycles, which contains information on the regulation of cardiovascular system by neurohumoral factors, in order to determine the condition and prevention of cardiovascular diseases. It may be a valuable indicator for predicting sudden cardiac death and arrhythmia events. The HRV test is performed on the end of EOT.
5. Echocardiogram, used to observe the cardiac function of patients with STEMI-PCI from the perspective of left ventricular ejection fraction (LVEF), left ventricular end-diastolic diameter (LVESD) three months after the acupuncture treatment.
6. The VAS pain scale, which is used to evaluate the degree of postoperative angina pain and the number of episodes within 24 h of onset. The evaluation is performed daily within 5 days after PCI.
7. Six minutes' walk test, to evaluate cardiac function of patients with STEMI-PCI, which is performed on the end of EOT.
8. Major adverse cardiovascular events, which is used to record cardiovascular adverse events within 3- and 6-month after acupuncture treatment including

psychogenic death, non-fatal stroke, recurrent angina.

9. Chinese cardiovascular patients life quality evaluation questionnaire (CQQC), to investigate the quality of life in patients with STEMI-PCI in 3, 6 months follow-up evaluation.
10. Respectively using Zung self rating anxiety scale and Zung depression self rating scale evaluation of postoperative patients with anxiety and depressive mood, suppression of the higher the score was worried.

Adverse events and safety

Any adverse events (AEs), including post-PCI complications and adverse acupuncture events will be recorded during the treatment. Adverse acupuncture events include bleeding, hematoma, fainting, severe pain, and local infection. Post-PCI complications include acute artery closure, embolization and no-reflow, side branch occlusion, and acute stent thrombosis [23]. Any serious adverse events (SAEs), including life-threatening SAEs, can lead to hospitalization or prolongation of existing hospitalization, and persistent or significant disability/incapacity. Therefore, intervention to prevent permanent impairment is required. Physicians should assess the causal-effect relationship of the intervention with AEs/SAEs and collect details related to the last treatment session. If participants suffer AEs or SAEs, all details will be documented. Moreover, if SAEs occur in participants, researchers should immediately provide the appropriate care to ensure their safety. In addition, researchers will report the SAEs and treatment to the principal investigator in each clinical center and the Ethics Committee within 24 h.

Data collection and management

All CRFs for each patient should be filled in by independent investigator in each clinical center timely. All data will be filed accurately in CRFs. Medical histories, original documents and CRFs will be stored in the clinical study office. When the data entry is complete, the database will perform consistency check automatically. Whenever inconsistencies are found, the data will be rechecked and corrected in according to the CRFs and original documents.

Dicusssion

PCI accompanied with antithrombotic/antiplatelet therapy remains the cornerstone in STEMI patients. Even though, the improvement of clinical outcomes requires additional strategies to provide cardioprotection during the acute phase of STEMI post PCI [24]. Acupuncture has displayed significant cardiac protection in the fundamental studies and clinical trials, raising concern in recent years [25]. Our previous RCT indicated that, as an adjunctive therapy, acupuncture is able to significantly reduce the frequency of angina attacks in patients with chronic stable angina [26]. In addition, acupuncture can be used as an approach to rehabilitation for intervention as soon as possible. Therefore, in this study, the first acupuncture intervention will be started within 12 h when the patients with STEMI underwent PCI.

The acupoints *PC 6*, *ST 36* and *HT 6* will be used in this study. *PC 6* manifests a significant effects in cardiovascular disease though multiple mechanisms such as reducing the cardiovascular sympathoexcitatory reflex response, [27] regulating signal pathway of related inflammation [28]. *ST 36* displays a prominent anti-inflammatory effects through vagus nerve activation, toll-like receptor 4 (TLR4)/NF-kB signaling, macrophage polarization, mitogen-activated protein kinase (MAPK) signaling pathway, and cholinergic anti-inflammatory pathway [12, 15]. A study showed that *PC 6* and *ST 36* obtained beneficial effects for cardiovascular parameters and clinical outcomes [29]. *HT* 6, as a specific acupoint belong to heart meridian, used to treat acute diseases concerning heart disease according to the theroy of TCM.

Exosomes, as a group of small lipid-bilayer vesicles with a 30–150 nm diameter, have recently attracted increased attention. It has been shown that exosomes play an important role in intercellular microcommunication, which achieved through the delivery of signaling molecules, including cytokines, chemokines, transcription factors, cyclic RNAs (circR-NAs) and microRNAs (miR-NAs) [30]. Exosomes are supposed to act as potential mediators in cardiac signaling and angiogenic processes after MI [31]. Some studies showed that acupuncture may be a potential treatment for inflammatory disease [32, 33]. In this study, we will explore the mechanism of acupuncture therapy for MIRI (Myocardial Ischemia Reperfusion Injury) from the prospective of exosomes to give explanations about the underlying mechanisms of acupuncture therapy in this topic.

Until the present moment, there are no studies that have effectively verify the cardioprotection of acupuncture therapy in cases of STEMI post-PCI. This research will be based on evaluating and comparing the changes in the level of serum cardiac injury biomarkers, inflammatory cytokines, analgesic effect and the functional capacity of the heart after the application of the acupuncture treatments. Based on the findings, it will be possible to establish the therapeutic potential of acupuncture treatment of MIRI.

There are some limitations in this research. First of all, due to the nature of the interventions, it is unable to blind the acupuncturist. To minimize a possible bias, acupuncturists will follow a script to standardize the

treatments of all study groups. Secondly, the short course of acupuncture treatment may not present the curative effects of acupuncture to the maximum. The long term of acupuncture therapy will be required in the base of this study. In addition, although we have performed the sample size calculation, the sample size is still small, and a large sample test will be needed in the future stage.

Abbreviations

STEMI	ST-elevation myocardial infarction
PCI	Percutaneous coronary intervention
I/R	Ischemia/Reperfusion
RCT	Randomized controlled trial
ECG	Electrocardiogram
CRF	Case report form
ITT	Intention-to-treat
SMS	Short message service
EOT	End of treatment
CK	Creatine Kinase
CK-MB	Creatine Kinaselsoenzyme
LDH	Lactate Dehydrogenase
CRP	C-reactive protein
HRV	Heart Rate Variability
LVEF	Left ventricular ejection fraction
LVESD	Left ventricular end-diastolic diameter
CQQC	Chinese cardiovascular patients life quality evaluation questionnaire
AEs	Adverse events
SAEs	Serious adverse events

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12906-024-04608-w.

Supplementary Material 1

Acknowledgements

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Author contributions

QZ and FL conceived the study and initiated the study design. All authors were involved in the design and writing of the research protocol from different perspectives. QZ, FL and YZ are responsible for writing the research proposal; WX and WL are responsible for subject consent and recruitment; YQ, QN, HZ, JZ, MH, JX are responsible for PCI surgery; FL, YZ, LH are responsible for acupuncture operation; LL and WL are responsible for subject scale assessment and data collection; WQ are responsible for statistical data analysis. All authors have read and approved the final draft.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The trial will be conducted in accordance with the requirements of the Declaration of Helsinki. The whole project has been approved by the Ethics Committee of the Affiliated Hospital of Chengdu University of Traditional Chinese Medicine (No. 2023KL-065) and registered in the China Clinical Trial Registry (https://www.chictr.org.cn/) with registration number ChiCTR2400081117, registered on February 22, 2024. Before randomization, patients are required to sign an informed consent form. Subject's personal information is confidential, participation in the study is entirely voluntary, with the right to withdraw at any time during any study phase.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Trial status

The trial began on April 1, 2023, and is expected to end on March 31, 2025.

Author details

[1]Acupuncture and Tuina School, Chengdu University of Traditional Chinese Medicine, Chengdu, People's Republic of China
[2]Acupuncture and Tuina School, Clinical Research Center for Acupuncture and Moxibustion in Sichuan Province, Chengdu University of Traditional Chinese Medicine, Chengdu, People's Republic of China
[3]Department of Cardiology, the Affiliated Third Hospital of Chengdu Traditional Chinese Medicine University/Chengdu Pidu District Hospital of Traditional Chinese Medicine, Chengdu, People's Republic of China
[4]Department of Cardiology, Affiliated Hospital of Chengdu University of Traditional Chinese Medicine, Chengdu, People's Republic of China
[5]Department of Cardiology, Zhaotong Municipal Hospital of Traditional Chinese Medicine, Zhaotong, People's Republic of China

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