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Research Progress on Acupuncture Therapy for Myocardial Ischemia-Reperfusion Injury

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Abstract: In recent years, with the deepening research on the pathogenesis of myocardial ischemia-reperfusion injury (MIRI) and the continuous development of acupuncture-moxibustion medicine, acupuncture, as a safe and effective non-pharmacological therapy, has shown unique advantages and promising prospects in the prevention and treatment of MIRI. MIRI refers to the pathophysiological process in which myocardial cell structural damage and dysfunction are aggravated when blood perfusion is restored after a period of myocardial ischemia, and it is one of the key factors affecting the clinical prognosis of acute myocardial infarction and other diseases. This paper first expounds the methodological innovation and standardization of acupuncture for MIRI, and then proposes the optimization of clinical application of acupuncture for MIRI, aiming to provide new ideas and practical evidence for improving the clinical prevention and treatment effect of MIRI, and promote the standardized application and popularization of acupuncture therapy in the field of cardiovascular disease rehabilitation.

Keywords: Acupuncture therapy; Myocardial ischemia-reperfusion injury (MIRI); Cardiovascular disease

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1. Introduction

Myocardial ischemia-reperfusion injury (MIRI) is a critical pathophysiological process that aggravates myocardial damage upon blood flow restoration, posing a major challenge to the clinical prognosis of acute myocardial infarction. Acupuncture, a key non-pharmacological therapy of traditional Chinese medicine, has shown unique advantages in preventing and treating MIRI due to its multi-target regulatory effects. However, issues such as methodological heterogeneity, lack of standardization, and ambiguous clinical indications still limit its widespread application. This paper systematically reviews recent advances in acupuncture for MIRI, focusing on methodological innovations, optimization of electroacupuncture and characteristic therapies, as well as clinical application strategies including individualized treatment, standardized timing, clear indications or contraindications, and the integrated traditional Chinese and Western medicine collaborative model, aiming to

provide practical evidence for improving clinical efficacy and promoting standardized application.

2. Methodological innovation and standardization of acupuncture for myocardial ischemia-reperfusion injury

2.1. Optimization and innovation of acupuncture therapy

On the one hand, in terms of acupoint selection, in addition to classic acupoints such as Neiguan (PC6), Danzhong (CV17) and Xinshu (BL15), clinical practice and research have shown that special acupoints including Ximen (PC4), Jianshi (PC5) and Jueyinshu (BL14) exert special effects in improving myocardial microcirculation and regulating myocardial energy metabolism. For example, studies comparing different acupoint combinations in rat models of myocardial ischemia-reperfusion have demonstrated that the combination of Neiguan and Ximen more significantly reduces serum levels of creatine kinase isoenzyme (CK-MB) and lactate dehydrogenase (LDH), and alleviates the degree of myocardial histopathological injury. The mechanism may be related to inhibiting inflammatory response and reducing the production of oxygen free radicals [1].

On the other hand, stimulation parameters are no longer fixed but adjusted according to the patient's condition, constitution and treatment stage. For patients in the acute ischemic stage, continuous wave and high-frequency (50–100 Hz) electroacupuncture are mostly used to rapidly relieve angina pectoris and improve myocardial blood supply. For patients in the recovery stage, sparse-dense wave or intermittent wave with low frequency (2–5 Hz) is applied to mainly regulate autonomic nerve function and promote myocardial repair [2].

In addition, the combined use of acupuncture with other therapies has become a new research direction. For instance, acupuncture combined with medication—electroacupuncture at Neiguan combined with nitroglycerin, can enhance the anti-myocardial-ischemia effect and reduce the dosage and adverse reactions of nitroglycerin. Acupuncture combined with stem cell transplantation improves the myocardial microenvironment through acupuncture pretreatment, increases the colonization rate and survival rate of stem cells in myocardial tissue, and promotes myocardial regeneration [3].

2.2. Promotion and optimization of electroacupuncture therapy

In terms of waveform selection, apart from the commonly used continuous wave and sparse-dense wave, studies on special waveforms such as sawtooth wave and triangular wave have increased in recent years. Sawtooth wave electroacupuncture exerts a stronger inhibitory effect on cardiomyocyte apoptosis in rabbit models of myocardial ischemia-reperfusion by upregulating the expression of anti-apoptotic protein Bcl-2 and downregulating the expression of pro-apoptotic protein Bax.

Regarding frequency combination, single high or low frequency stimulation can no longer meet the needs of complex conditions, and electroacupuncture protocols such as "alternating high and low frequency" and "multi-frequency superposition" have gradually become new research hotspots. For example, sparse-dense wave electroacupuncture with alternating 2 Hz and 100 Hz stimulation at Xinshu and Jueyinshu can more effectively improve left ventricular ejection fraction (LVEF) and left ventricular fractional shortening (LVFS) in rats with myocardial ischemia-reperfusion. The mechanism may involve synergistically regulating intracellular calcium homeostasis and improving mitochondrial function [4].

Furthermore, the timing of treatment has evolved. Electroacupuncture is no longer limited to post-ischemia-reperfusion intervention; "preconditioning" and "postconditioning" modes have gradually emerged. Electroacupuncture preconditioning refers to delivering electroacupuncture stimulation before myocardial

ischemia to activate endogenous protective mechanisms and reduce reperfusion injury. Electroacupuncture postconditioning is performed immediately or shortly after the onset of ischemia-reperfusion, which effectively inhibits oxidative stress and inflammatory response during reperfusion [5].

2.3. Application and exploration of other characteristic acupuncture-moxibustion therapies

Moxibustion therapy improves myocardial ischemia-reperfusion injury by warming and unblocking meridians, dispelling cold and promoting blood circulation. Ginger-partition moxibustion or mild moxibustion at Guanyuan (CV4) and Qihai (CV6) can enhance the body's antioxidant capacity, inhibit platelet aggregation, improve blood rheology, and thereby alleviate myocardial ischemia-reperfusion injury. Moxibustion preconditioning significantly reduces the myocardial infarct size in rat models, possibly by upregulating heat shock protein 70 (HSP70) to improve the tolerance of cardiomyocytes to ischemia and hypoxia [6].

Auricular acupuncture is an important part of acupuncture-moxibustion science. Featuring simple operation, non-invasiveness and painlessness, it is used as adjuvant therapy for myocardial ischemia-reperfusion injury. Clinically, auricular points including Heart, Shenmen, Sympathetic and Subcortex are selected and stimulated with Vaccaria seeds or magnetic beads. Auricular stimulation regulates autonomic nerve function, reduces myocardial oxygen consumption, relieves anxiety, and thus improves clinical symptoms and cardiac function indicators in patients with myocardial ischemia-reperfusion injury, effectively enhancing their quality of life [7].

3. Optimization of clinical application of acupuncture for myocardial ischemia-reperfusion injury

3.1. Formulation and implementation of individualized treatment plans

In clinical practice, different acupuncture plans are formulated based on the patient's age, gender, constitution, disease severity and course. For elderly patients, who often have underlying diseases and declining physical function, acupoints with tonifying effects such as Guanyuan and Qihai are appropriately added, while strong stimulation is reduced to avoid discomfort. For patients in the acute stage, the primary goal is to rapidly relieve symptoms and improve myocardial ischemia; first-aid acupoints such as Neiguan, Shanzhong and Ximen are selected with reducing or even reinforcing-reducing manipulation, and the needle retention time is appropriately shortened. For patients in the recovery stage, the focus is on regulating qi and blood and promoting cardiac function recovery; acupoints such as Xinshu, Jueyinshu and Zusanli (ST36) are selected with reinforcing manipulation or mild moxibustion, and needle retention time can be prolonged [8].

In addition, patients with hypertension, diabetes and other underlying diseases require corresponding adjustments in acupoint selection and treatment parameters. For hypertension, Taichong (LR3) and Quchi (LI11) are added to lower blood pressure; for diabetes, Sanyinjiao (SP6) and Taixi (KI3) are added to nourish yin and tonify the kidney. During implementation, the patient's response is closely observed, and the plan is adjusted timely according to therapeutic effect to ensure safety and efficacy [9].

3.2. Standardization of treatment timing and course protocols

Accurate timing of treatment directly affects acupuncture efficacy. For myocardial ischemia-reperfusion injury, acupuncture should be initiated as early as possible. After reperfusion, acupuncture can be started

once the patient's vital signs are stable and there are no contraindications such as severe bleeding tendency or malignant arrhythmia, so as to alleviate reperfusion injury and protect cardiomyocytes.

For patients undergoing emergency percutaneous coronary intervention (PCI), the first acupuncture treatment is administered after postoperative recovery from anesthesia and stabilization of vital signs. For patients receiving thrombolytic therapy, acupuncture is performed after vascular recanalization and exclusion of bleeding risk [10].

The course of treatment is adjusted according to the patient's recovery. In the acute stage, treatment is given once daily for 30–45 minutes per session for 5–7 consecutive days to rapidly control disease progression. In the subacute stage, treatment is switched to once every other day or three times weekly for 2–4 weeks to promote myocardial repair and cardiac function improvement. In the recovery stage, the treatment interval is gradually extended to once or twice weekly for 1–3 months to consolidate efficacy and prevent recurrence.

The course should consider the patient's tolerance and compliance to avoid fatigue or resistance caused by excessive treatment. After each course, efficacy is comprehensively evaluated using electrocardiogram, myocardial enzyme spectrum, cardiac function indicators and clinical symptom scores to determine whether to continue the next course or adjust the plan [11].

3.3. Clear definition of indications and contraindications

Defining the indications and contraindications of acupuncture for myocardial ischemia-reperfusion injury is a prerequisite for safe and effective treatment.

Indications mainly include patients with stable vital signs presenting clinical symptoms such as chest distress, chest pain, palpitations, shortness of breath and fatigue after myocardial ischemia-reperfusion injury, including patients after emergency PCI, thrombolytic therapy or coronary artery bypass grafting, and patients with old myocardial infarction complicated by reperfusion injury-related complications such as cardiac insufficiency and arrhythmia [12]. Acupuncture serves as an important adjuvant therapy for patients with poor response to Western medicine or contraindications to medication.

Contraindications are divided into absolute and relative. Absolute contraindications: acute myocardial infarction complicated by cardiogenic shock; severe heart failure; severe hemorrhagic diseases or patients under anticoagulant therapy with obvious coagulation abnormalities and bleeding tendency; infection, ulcer, tumor or severe skin injury at puncture sites; patients with extreme fear of acupuncture. Relative contraindications: fever over 38.5 ℃; pregnant women (acupoints with meridian-unblocking and blood-activating effects such as Hegu (LI4) and Sanyinjiao should be used with caution); severe hypertension with blood pressure persistently over 180/110 mmHg and uncontrolled. In clinical application, indications must be strictly observed and contraindications carefully checked. For patients with relative contraindications, acupuncture may be considered after disease improvement or stabilization with weighing of risks and benefits. Close monitoring of vital signs, symptom changes and puncture site reactions is required during treatment; treatment should be stopped immediately and corresponding measures taken if abnormalities occur [13].

3.4. Promotion of integrated traditional chinese and western medicine collaborative treatment model

The integrated traditional Chinese and Western medicine collaborative model for myocardial ischemia-reperfusion injury emphasizes the organic combination of acupuncture with modern medical treatments to

achieve complementary advantages and improve overall efficacy.

To promote this model, a multidisciplinary collaboration mechanism should be established, and a combined treatment team composed of cardiovascular physicians, acupuncturists and pharmacists should be formed to jointly participate in patient condition assessment, plan formulation and efficacy follow-up [14].

Meanwhile, acupuncture can serve as a beneficial supplement to routine Western medicine treatment. For angina patients with poor response to nitrates or intolerance due to side effects, additional electroacupuncture enhances analgesia and reduces medication dosage. For arrhythmias such as ventricular premature beats and atrial premature beats after reperfusion, auricular point pressing or acupuncture at Shenmen and Jueyinshu combined with Western antiarrhythmic drugs improves the control rate of arrhythmia and patients' quality of life.

In addition, acupuncture should be integrated with key nodes of Western medicine treatment. Electroacupuncture preconditioning before PCI improves myocardial microcirculation and alleviates oxidative stress, creating a better myocardial environment for surgery. In the postoperative rehabilitation stage, acupuncture combined with cardiac rehabilitation training regulates autonomic nerve function, improves exercise tolerance and promotes cardiac function recovery. To ensure the standardized promotion of the integrated model, standardized clinical pathways and efficacy evaluation systems need to be established [15].

4. Conclusion

In summary, acupuncture demonstrates unique advantages and broad application prospects in the treatment of myocardial ischemia-reperfusion injury. It not only directly improves myocardial ischemia and alleviates reperfusion injury through various innovative therapies, but also combines organically with routine Western medicine treatment to play a positive role in enhancing efficacy, reducing adverse drug reactions and improving patients' quality of life.

With the formulation of individualized treatment plans, standardization of treatment timing and courses, clear definition of indications and contraindications, and continuous promotion of the integrated traditional Chinese and Western medicine collaborative model, acupuncture will play an increasingly important role in the comprehensive prevention and treatment of myocardial ischemia-reperfusion injury.

In the future, further basic research is needed to elucidate the molecular mechanisms of acupuncture, and standardized clinical pathways and efficacy evaluation systems should be continuously improved. This will promote the more scientific, standardized and extensive application of acupuncture, a treasure of traditional medicine, in the field of modern cardiovascular disease treatment, bringing greater benefits to patients.

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