Acupuncture therapy for essential hypertension: a network meta-analysis

Xiaodong Tan[1,2#], Yujing Pan[1#], Wei Su[2], Shaoyu Gong[2], Hongjun Zhu[2], Hao Chen[1], Shu Lu[2]

[1]The Graduate School, Nanjing University of Chinese Medicine, Nanjing 210023, China; [2]Department of Cardiology, Wuxi Hospital of Traditional Chinese Medicine, Wuxi 214071, China

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[#]These authors contributed equally to this work.

Correspondence to: Shu Lu. Department of Cardiology, Wuxi Hospital of Traditional Chinese Medicine, 8#, Zhongnan West Road, Wuxi 214071, China. Email: lushu1963@163.com.

Background: To evaluate the efficacy and safety of acupuncture therapies for the treatment of essential hypertension.

Methods: We performed a systematic electronic search of PubMed, Embase, the Cochrane Library, Chinese Biomedical Literature Database (CBM), Chinese National Knowledge Infrastructure (CNKI), and Wan-fang Data Database. The main outcome indicators measured were the amount of major adverse cardiovascular events (MACE), a change of blood pressure, and the response rate. STATA15.0 software was used for the network meta-analysis.

Results: A total of 31 trials with 2,649 patients were included. Patients were allocated to 15 kinds of interventions. These including acupuncture types were electroacupuncture, moxibustion, warm needle therapy, sham acupuncture, behavioral therapy, angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs), calcium channel blocker (CCB), beta-blocker, acupuncture combined ACEI, acupuncture combined CCB, acupuncture combined behavior, electroacupuncture combined CCB, and non-treatment. The results of the network meta-analysis showed that there was no significant clinical or statistic difference in systolic blood pressure (SBP) change magnitude between acupuncture treatment and the other 14 therapies. Moxibustion may be better than acupuncture in reducing diastolic blood pressure (DBP) [mean difference (MD): 15.9, 95% confidence interval (CI): 5.96–25.85]. There was no significant difference in reducing DBP between acupuncture and the other 13 interventions. The effective rate of acupuncture combined with AECI [odds ratio (OR) =7.96, 95% CI: 1.11–56.92] and acupuncture combined with behavioral therapy (OR =3.53, 95% CI: 1.08–11.51) in treating hypertension was better than that of acupuncture alone, and there was no statistically significant difference in the effective rate between acupuncture and the other therapies.

Conclusions: The existing evidence shows that acupuncture could be used for treating hypertension, and it may have the same effects as common medication. However, due to the low qualities of the original studies, the quality of this evidence is poor. Therefore, it is recommended that more scientific research be performed to confirm the efficacy of acupuncture.

Keywords: Acupuncture; hypertension; network meta-analysis

Introduction

Essential hypertension is a significant risk factor for cardiovascular disease and stroke, which are the most frequent causes of deaths in the world (1,2). Hypertension has caused a tremendous burden on the overall health of the people of China. A cohort study in 2016 has indicated that among the Chinese population aged between 35 and 79 years old, nearly one-third of cardiovascular deaths were related to a failure in hypertension control (3,4).

Anti-hypertension medication still serves as a major therapy choice for treating hypertension now. However, due to the adverse effects and drug resistance of the medication, there are more and more clinical physicians quickening their expansion to the field of traditional non-pharmaceutical therapy in the practice of hypertension treatment. Acupuncture, a traditional Chinese treatment, can lower blood pressure (BP) by putting needles into certain points on the body. The published study demonstrated that acupuncture could normalize decreased parasympathetic nerve activity (5). This result indicates that the potential mechanism whereby acupuncture can lower BP may be related to the nervous system. In the Web of Science, an international database, there were altogether 202 studies on the application of acupuncture in the treatment of hypertension published until the end of February 2018. The most influential one is the randomized control trial (RCT) published in *Circulation* (6). At the same time, there were some studies opposed to the application of acupuncture in the treatment of hypertension (7). Therefore, it is still controversial whether or not acupuncture therapy should be used in the clinical treatment of hypertension, hence comprehensive analysis and evaluation of the relevant evidence are still needed. We have systematically collected the evidence of acupuncture for the treatment of hypertension and conducted a pooled analysis to assess the safety and efficacy of acupuncture therapy in the treatment of primary hypertension.

Methods

Inclusion criteria

(I)   Types of study: randomized controlled trials (RCTs) of acupuncture for hypertension;
(II)   Types of patients: patients were diagnosed as having hypertension, and there were no limitations to gender, age, race, or the course of the disease;
(III) Types of interventions: acupuncture therapy (includes acupuncture, electroacupuncture, moxibustion, and needle warming therapy) with or without concomitant non-acupuncture hypertensive treatment, formed the treatment group, while non-acupuncture hypertensive treatment (life modification, medication), sham acupuncture, and no-treatment were employed in the control group;
(IV)   Types of outcomes: primary outcomes were major adverse cardiovascular events (MACE); post-treatment BP changes (BP changes = prior treatment BP value – post-treatment BP value). Secondary Outcomes were the response rate of the treatment (defined as 10 mmHg with a lowering down in SBP or 5 mmHg in DBP) and adverse effects.

Exclusion criteria

(I)   Duplicated literatures;
(II)   Studies only with abstracts and no specific data available;
(III) Studies neither in Chinese nor English;
(IV)   Mutual comparison between different acupuncture methods or different points;
(V)   Studies that employed KPa as the unit of blood pressure and failure in the conversion of original data.

Search strategy

A systematic search was conducted on PubMed, Embase, CENTRAL, CBM, CNKI and Wan-fang Data Database from the inception to February 2018. The following keywords combined with Medical Subject Headings (MeSH) terms were used for searching: "acupuncture" "moxibustion" "electroacupuncture" "needle warming" "hypertension" "high blood pressure" "clinical study" "clinical trial" and "clinical research". We did not apply any language restrictions. The detailed search strategy (search strategy for PubMed) is listed in *Table S1*.

Study selection and data extraction

EndNote X 8.0 software was used to process the management of the literature. Two reviewers (X Tan, Y Pan) screened all the trials for inclusion and conducted the data extraction. An electronic form was established using Excel for data extraction. The main extract content included research topic, author, year of publication, specific information of the treatment groups and control groups, and outcome index. In case of a dispute,
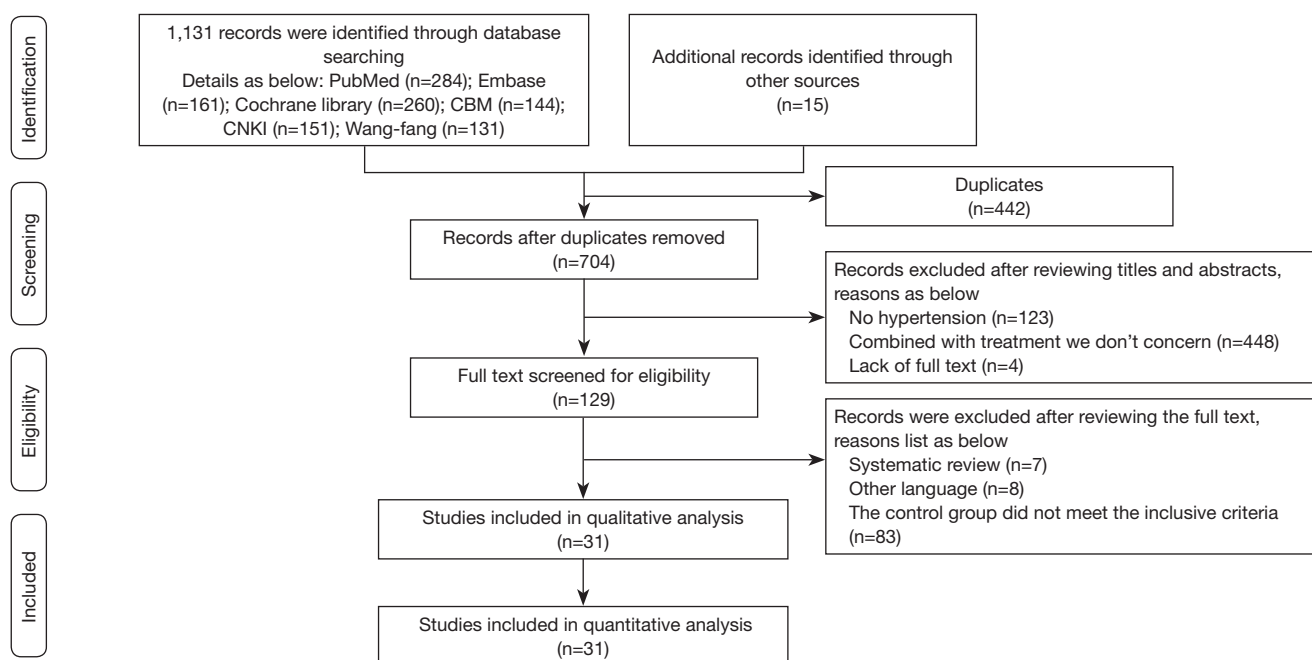
Figure 1 Flow chart of study selection.

adjudication would be done by the third person. In the case of any disagreement between the 2 reviewers, a final decision was made by the third reviewer (H Chen).

Assessment of the risk of bias

Two reviewers (W Su, S Gong) assessed the risk of bias of the included RCTs using the Cochrane Collaboration tool for assessing risk of bias (8). Each trial was scored as high, low, or unclear risk for the following seven domains: "random sequence generation (selection bias)" "allocation concealment (selection bias)" "blinding of participants and personnel (performance bias)" "blinding of outcome assessment (detection bias)" "incomplete outcome data (attrition bias)" "selective reporting (reporting bias)" and "any other bias". Disagreements were resolved in consultation with the third reviewer (H Chen).

Data synthesis and statistical analysis

As the length of the course of treatment is a clinically relevant factor for the antihypertensive effect, we synthesized the effects based on different course lengths. According to clinical settings, we divided the course treatment lengths into categories, immediacy (within 1

day), short-term (one day to 4 weeks), and long-term (over 4 weeks). All analysis was conducted using Stata 15.0 software (Stata Corporation, College Station, TX, USA) (9,10). For the continuous outcomes, weighted mean difference (WMD) was calculated to pool the effects and odds ratios (OR) for the dichotomous outcomes. First, a pair-wise meta-analysis was conducted using the DerSimonian and Laird method. Second, a network meta-analysis was processed using the mvmeta package of Stata software. The REML Wald test was used to assess the evidence of inconsistency (11). Funnel plots were conducted to assess the small sample size. Results were reported with 95% confidence intervals (CIs), A $P<0.05$ was considered a significant statistical effect.

Results

Literature searching

In total, 1,146 pieces of literature were included via the original search, and 442 pieces were excluded due to duplication. After screening for title and abstract, 575 pieces of literature that failed the inclusion criteria were deleted, and after reading the whole text, 98 pieces of studies were removed. Finally, 12 studies (6,12-22) published before and 19 ones (23-41) after 2010 were included (*Figure 1*).

Characteristics of the included studies

Among the 31 pieces of literature, there were 5 pieces of literature in English (6,20,28,30,34), and 26 in Chinese. The earliest publication was in 2001 (16), and the latest was in 2018 (34). Four studies (27,37,39,41) were three-arm trials, and 27 were two-arm trials. Altogether, 2,649 patients were included in the 31 studies. The outcomes of the included studies were mainly the post-treatment BP value, the response rate of the treatment, and the adverse effects. The characteristics of the included studies are shown in *Table 1*.

Assessment of the risk of bias

Based on the risk of bias tool, most of the included studies were rated as high risk. Only 4 studies (6,16,28,30) described the detail method of allocation concealment. None of the included studies mentioned the method of blinding. As the protocol of the trials are lacking, it is difficult to assess the attrition bias and the reporting bias (*Table 2*).

Results of the network meta-analysis

MACE
None of the included studies evaluated MACE as a primary outcome. Therefore, the pooled-analysis for MACE was not conducted in this review.

Pre-post treatment BP change value (immediacy)
Two studies (15,16) with 110 cases of participants reported an immediate pre-post treatment BP change value. As shown in *Figure 2*, acupuncture seemed to have a better effect on SBP reduction than CCB at 3, 6, and 60 mins after treatment, while there was no significant difference between acupuncture and CCB at 9, 12, 15, and 30 mins. What is more, CCB may gain much more SBP reduction than acupuncture at 120 mins after treatment (*Figure 2A*).

These two studies also reported a DBP reduction in acupuncture and CCB. The results showed that there was no significant difference between acupuncture and CCB at 3, 6, 9, 12, 15, 30, and 60 mins after treatment, while CCB may have a better effect on DBP reduction at 120 mins after treatment (*Figure 2B*).

Pre-post treatment BP change value (short-term)
Fifteen studies (12-14,18,21-25,31,32,35,38-40) involving

1,142 cases of participants reported pre-post treatment BP change value after 11 types of short-term treatment (*Figure 3*). One study (35) which focused on two types of treatments did not form a connected loop with the other therapies. The study reported that acupuncture combined with life modification might gain a larger reduction on both SBP and DBP than life modification alone (MD$_{SBP}$ =10.48, 95% CI: 8.47–12.49; MD$_{DBP}$ =10.38, 95% CI: 8.03–12.73).

The network analysis showed that there was no statistical significance in the inconsistency test of the pre-post BP change for the other 9 therapies (SBP: P=0.6434, DBP: P=0.9001). The pooled results showed that acupuncture seemed to have a better effect on SBP reduction than ARB (MD =11.15, 95% CI: 3.99–18.31) and there was no significant difference on both SBP and DBP reduction between acupuncture and conventional medication (*Figures S1,S2*). Furthermore, the results showed that acupuncture combined with medication may have more SBP reduction than medication alone (*Figure S1*), while there was no significant difference between combined therapies and monotherapies on DBP reduction (*Figure S2*).

Pre-post treatment BP change value (long-term)
Eleven studies (6,17,19,20,26,28-30,34,37,41) with 903 participants reported a pre-post treatment BP change value after 10 types of long-term treatment (*Figure 3B*). The study compared CCB with acupuncture combined with CCB (29), but it did not form a connected loop with the other 8 types of treatments. This study showed that a combined therapy had a better effect than monotherapy on both SBP and DBP reduction (MD$_{SBP}$ =10.75, 95% CI: 5.70–15.84; MD$_{DBP}$ =5.85, 95% CI: 2.98–8.74).

The network analysis showed that there is no statistical significance of the inconsistency test of the Pre-Post BP change for the other 8 therapies (SBP: P=0.8131, DBP: P=0.5306). The pooled results showed that acupuncture might gain more reduction both on SBP and DBP than sham acupuncture and no-treatment, while there was no significant difference between acupuncture and other monotherapies on BP reduction (*Figures S3,S4*).

The response rate of treatment (immediacy)
Only one study (15) that compared acupuncture with nifedipine reported the response rate of treatment. It showed that there was no significant difference between acupuncture and nifedipine 30 min after treatment, while a significantly higher response rate was observed in the acupuncture group at 60 min after treatment, and an

Table 1 Characteristics of included studies

Authors	Year	Arms	Number of patients			Age			Intervention			Course	Outcome
			Treatment	Control	Control*	Treatment	Control	Control*	Treatment	Control	Control*		
Flachskampf et al. (6)	2007	2	83	77	–	58.8	58	–	Acu	SA	–	6 weeks	1/2/4
Kim et al. (28)	2012	2	12	16	–	52.08	52.38	–	Acu	SA	–	8 weeks	1/2
Liu et al. (30)	2015	2	15	15	–	49.4	53.4	–	Acu	NA	–	8 weeks	2/4
Terenteva et al. (34)	2018	2	27	24	–	57	57	–	Acu	NA	–	8 weeks	1/4
Yin et al. (20)	2007	2	15	15	–	52	54	–	Acu	SA	–	8 weeks	1/2/4
Chen et al. (12)	2006	2	30	30	–	54.75	51.72	–	Acu	MET	–	4 weeks	1/2/3
Chen et al. (15)	2008	2	30	30	–	56.6	57.77	–	Acu	NIF	–	Now	1/3
Chen et al. (32)	2010	2	40	40	–	61.3	62	–	Acu	VAL	–	4 weeks	1/3/4
Chen et al. (33)	2011	2	30	30	–	59	59	–	Acu	MET	–	4 weeks	3
Gao et al. (21)	2007	2	30	30	–	54.46	53.04	–	Acu	CAP	–	3 weeks	1/3/4
Guo et al. (19)	2007	2	40	40	–	43.83	44.2	–	Acu	ENA	–	30 days	1
Hang et al. (14)	2007	2	30	30	–	56.51	58.12	–	Acu + CAP	CAP	–	4 weeks	1/3
Huo et al. (36)	2017	2	145	145	–	59.3	–	–	MO	AML	–	–	3/4
Kong et al. (29)	2014	2	53	55	–	59.03	57.47	–	Acu + FEL	FEL	–	60 days	1
Lai et al. (41)	2016	3	102	96	100	56.71	58.98	57.82	EA	SA	NA	6 weeks	1/2/4
Luo et al. (24)	2015	2	44	46	–	45–75	–	–	Acu + FEL	FEL	–	20 days	1/3
Ma et al. (31)	2011	2	40	40	–	66.39	64.58	–	EA	NIC	–	15 days	1/3
Qian et al. (13)	2005	2	30	30	–	54.75	51.72	–	Acu	MET	–	4 weeks	1/2/3
Qiu et al. (26)	2015	2	18	18	–	40.24	44.96	–	MO	CAP	–	30 days	1
Si et al. (22)	2009	2	20	20	–	40.25	39.5	–	EA	CAP	–	2 weeks	1/2/3
Wan et al. (18)	2009	2	30	30	–	63.72	65.24	–	EA	NIC	–	15 days	1/3
Wang et al. (39)	2012	3	40	40	48	66.39	64.58	64.29	EA	NIC	EA + NIC	4 weeks	1/3/4
Wu et al. (17)	2003	2	40	40	–	48.55	47.85	–	NW	CAP	–	30 days	1
Wu et al. (35)	2015	2	49	50	–	48.08	49.1	–	Acu + Life	Life	–	4 weeks	1/3/4
Wu et al. (40)	2011	2	60	60	–	54.75	51.72	–	Acu	MET	–	20 days	1/3
Xie et al. (23)	2014	2	30	30	–	56	53	–	Acu	CAP	–	3 weeks	1/3/4
Xing et al. (25)	2016	2	31	32	–	61.83	57.14	–	Acu	CAP	–	4 weeks	1/3
Yang et al. (27)	2017	3	40	39	37	45–72	43–71	44–74	Acu	Life	Acu + Life	40 days	3
Zhang et al. (16)	2001	2	25	25	–	64.75	61.72	–	Acu	NIF	–	Now	1
Zhang et al. (38)	2011	2	50	40	–	53.62	52.16	–	Acu + ENA	AML	–	4 weeks	1/3
Zhang et al. (37)	2012	3	14	14	14	42–60	–	–	Acu + Life	Acu	CAP	8 weeks	1

*, there are some studies were three arms, so the two control are the same. Outcome: 1, BP value after treatment; 2, Pre-post BP change value; 3, response rate of treatment; 4, adverse effects. Acu, acupuncture; EA, electroacupuncture; SA, sham acupuncture; NA, no treatment; MET, metoprolol; NIF, nifedipine; VAL, valsartan; CAP, Captopril; AML, amlodipine; FEL, felodipine; NIC, nicardipine.

Table 2 Risk of bias assessment of the included studies

| Author	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias
Flachskampf *et al*. (6)	Low risk	Unclear	Unclear	High risk	Unclear	Unclear
Kim *et al*. (28)	Low risk	Unclear	Unclear	High risk	Unclear	Unclear
Liu *et al*. (30)	Low risk	Unclear	Unclear	High risk	Unclear	Unclear
Terenteva *et al*. (34)	Unclear	Unclear	Unclear	High risk	Unclear	Unclear
Yin *et al*. (20)	Unclear	Unclear	Unclear	High risk	Unclear	Unclear
Chen *et al*. (12)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Chen *et al*. (15)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Chen *et al*. (32)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Chen *et al*. (33)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Gao *et al*. (21)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Guo *et al*. (19)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Hang *et al*. (14)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Huo *et al*. (36)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Kong *et al*. (29)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Lai *et al*. (41)	Unclear	Unclear	Unclear	Low risk	Low risk	Unclear
Luo *et al*. (24)	Unclear	Unclear	Unclear	High risk	Unclear	Unclear
Ma *et al*. (31)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Qian *et al*. (13)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Qiu *et al*. (26)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Si *et al*. (22)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Wan *et al*. (18)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Wang *et al*. (39)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Wu *et al*. (17)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Wu *et al*. (35)	Unclear	Unclear	Unclear	High risk	Unclear	Unclear
Wu *et al*. (40)	Allocation	Unclear	Unclear	Unclear	Selective	Unclear
Xie *et al*. (23)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Xing *et al*. (25)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Yang *et al*. (27)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Zhang *et al*. (16)	Low risk	Unclear	Unclear	Unclear	Unclear	Unclear
Zhang *et al*. (38)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Zhang *et al*. (37)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
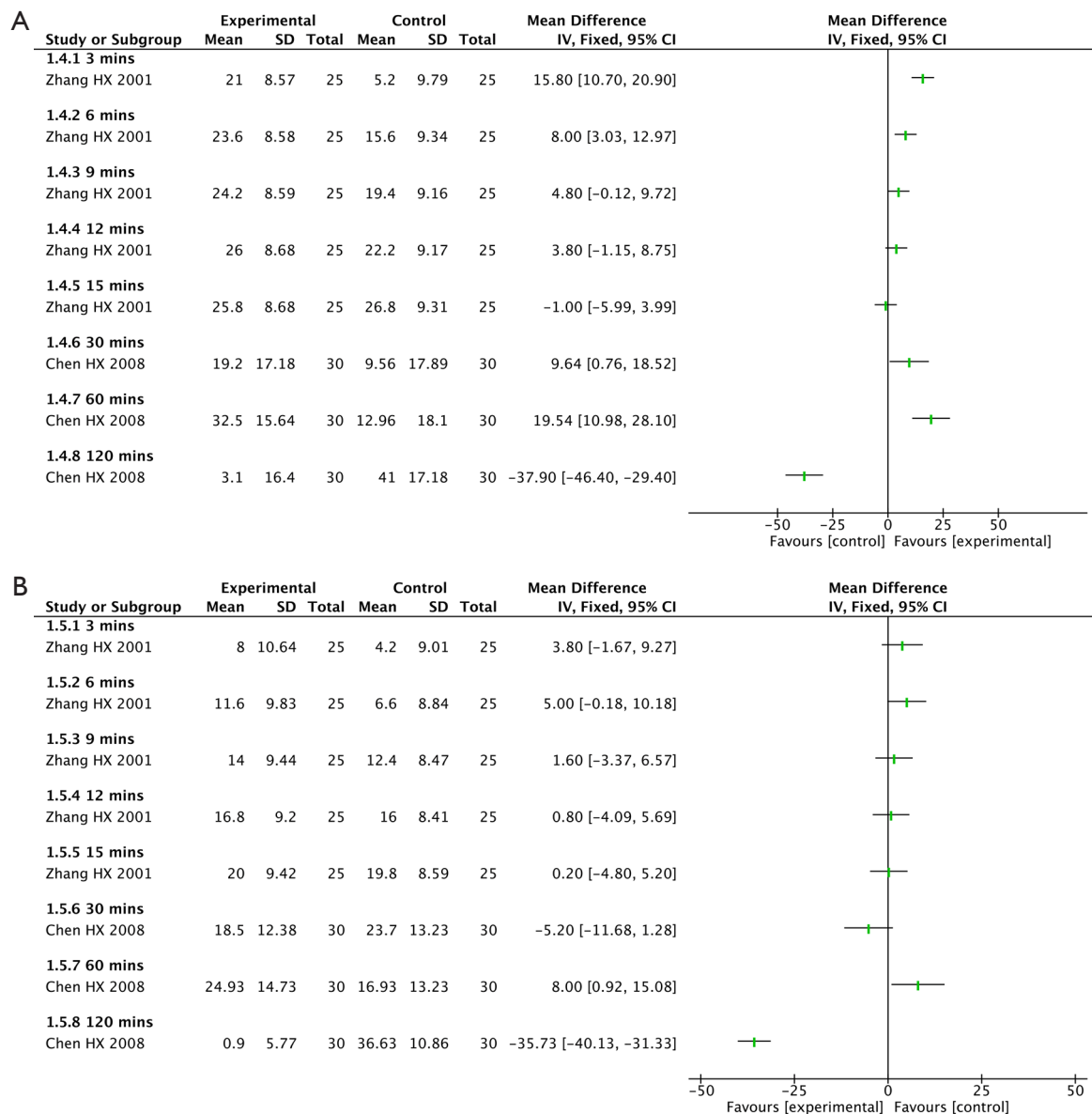
Figure 2 Pre-post treatment BP change value (immediacy) (A for SBP, B for DBP). SBP, systolic blood pressure; DBP, diastolic blood pressure.

extremely lower rate in the acupuncture group at 120 mins after treatment (*Figure 4*).

The response rate of treatment (short-term)
Fifteen articles (12-14,18,22-25,31-33,35,36,39,40) comprising 1,350 cases of participants reported a short-term response rate for the treatment. Twelve types of treatments are worth noting (*Figure 5*). One study (35), which did not form a loop with the other therapies, reported

acupuncture combined with life modification compared with life modification alone. The results showed that the combined treatment seemed to have a higher response rate than monotherapy (OR =4.14, 95% CI: 1.38–12.43). The inconsistency analysis showed that there was no statistical significance (P=0.9142). The pooled results showed that acupuncture seemed to have a higher response rate than β-blockers, and there seemed to be no significant statistical differences between acupuncture and other treatments. The
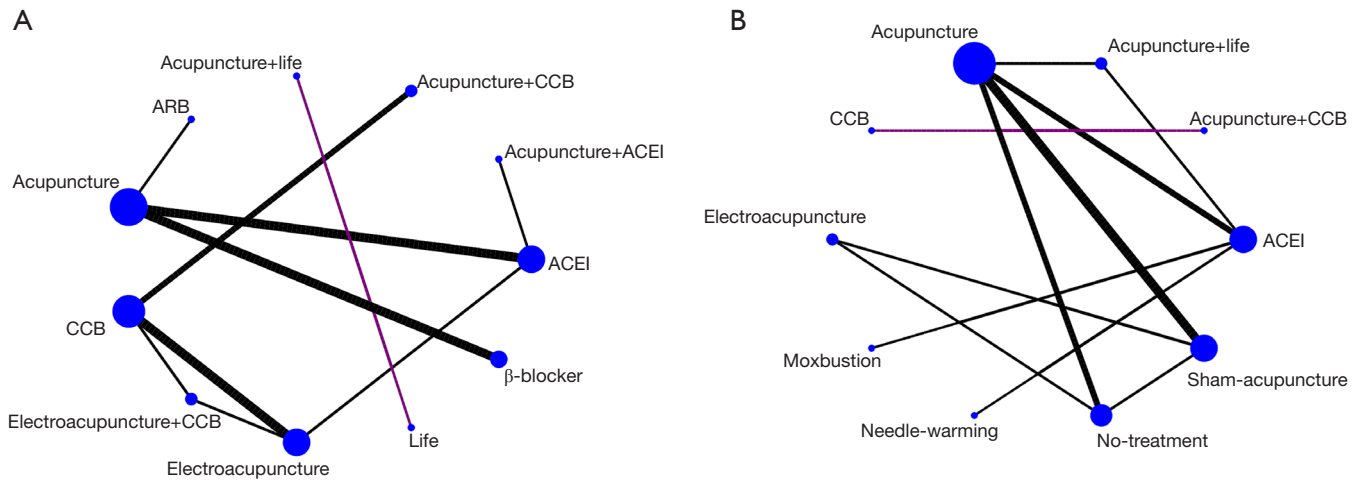
A

B

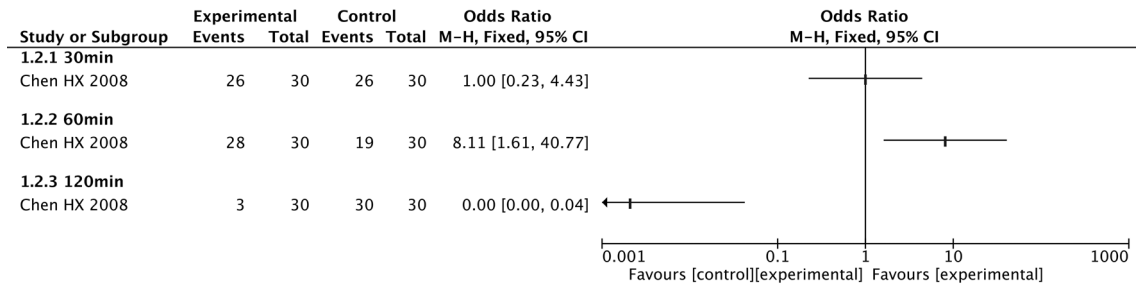**Figure 3** Network diagrams of BP change value (A for short-term, B for long-term). BP, blood pressure.

Study or Subgroup	Experimental Events	Total	Control Events	Total	Odds Ratio M–H, Fixed, 95% CI	Odds Ratio M–H, Fixed, 95% CI
1.2.1 30min						
Chen HX 2008	26	30	26	30	1.00 [0.23, 4.43]	
1.2.2 60min						
Chen HX 2008	28	30	19	30	8.11 [1.61, 40.77]	
1.2.3 120min						
Chen HX 2008	3	30	30	30	0.00 [0.00, 0.04]	

0.001　0.1　1　10　1000
Favours [control] [experimental]　Favours [experimental]

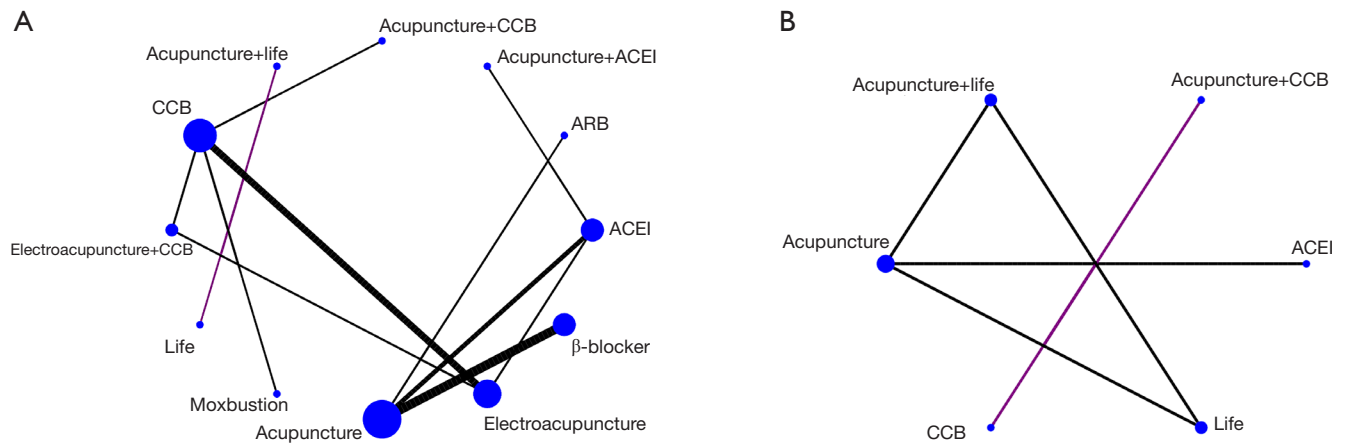**Figure 4** The response rate of immediacy.

A

B

Figure 5 Network diagrams of response rate (A for short-term, B for long-term).

Life	1.78 (0.20, 15.72)	1.56 (0.24, 10.05)	4.41 (0.42, 45.74)
0.56 (0.06, 4.97)	Acupuncture	0.88 (0.28, 2.70)	2.48 (0.59, 10.42)
0.64 (0.10, 4.15)	1.14 (0.37, 3.53)	ACU + Life	2.83 (0.69, 11.63)
0.23 (0.02, 2.35)	0.40 (0.10, 1.70)	0.35 (0.09, 1.45)	ACEI

Figure 6 Network analysis of response rate (long-term). ACU, acupuncture; ACEI, angiotensin-converting enzyme inhibitor.

results also demonstrated that combined therapies might have a better effect than monotherapies (*Figure S5*).

The response rate of treatment (long-term)

Three articles (21,27,38) that involved 266 participants reported a long-term response rate of treatment. Six types of interventions were focused on in these three articles, and four types formed a connected loop (*Figure 5B*). The pooled results showed that there was no significant difference between the four treatments (*Figure 6*). The disconnected study which focused on acupuncture combined with CCB and CCB alone also showed that there was no difference between the two treatments (OR =2.4, 95% CI: 0.93–6.16).

Adverse effects

Eleven studies (6,20,21,23,30,32,34-36,39,41) reported adverse effects. Based on these studies, there were few cases of serious adverse effects during acupuncture therapy, which were mainly represented by specific pain or discomfort. As most of the studies failed to report the adverse effects in a standard way (42), it was impossible to conduct a quantitative analysis of the adverse effects in this review.

Small sample size effect

As shown in *Figure 7*, there was a significant small sample size effect between the included studies.

Discussion

The current situation of clinical on acupuncture therapy in the treatment of hypertension

This review included 31 original articles on acupuncture therapy for hypertension. Higher methodological bias risk existed in all of the included studies. Hypertension is a common cardiovascular disease and also an important risk factor for cardiovascular and cerebrovascular diseases. The main target for hypertension control is reducing MACE. MACE and the control rates of BP should be regarded as the main outcomes in the clinical research of hypertension.

However, among these original pieces of research included in this meta-analysis, none of the studies focused on this type of indicator. Therefore, it is impossible to evaluate the exact efficacy of acupuncture therapy for hypertension. Additionally, there was little research focusing on the health-economic indicators and patients' preference for acupuncture in the treatment of hypertension. Thus, it is hard to establish a comprehensive evidence system for acupuncture therapy in the treatment of hypertension (43).

Meanwhile, in the preliminary studies, we found out there is a lack of standardization in the reporting of clinical randomized control trials about acupuncture therapy for the treatment of primary hypertension. They were not reported in accordance with the Consolidated Standards for Reporting of Trials (CONSORT) standard (44) and its expansion version, Standards for Reporting Interventions in Controlled Trials of Acupuncture (STRICTA) (45). This made it impossible to acquire accurate partial information, resulting in a loss of readability and credibility of the articles, and a reduction in the evidence quality.

Summary of findings in this review

In this study, we found that it seems likely that acupuncture therapy has a therapeutic effect on hypertension, and, irrespective of being long-term or short-term treatment, there is no significant clinical difference between acupuncture therapies with medication. Moreover, the findings in this review also showed that acupuncture combined with medication might have more BP reduction than medication alone, which demonstrated combined therapy may have a better effect in clinical practice.

Nevertheless, the credibility and precision of the results were not stable, and the evidence quality was very low. Although some of the results showed there to be a significant statistical difference, they still had no clinical difference. The main causes of which were the low quality of the methodological design (such as incomplete allocation concealment), incomplete blinding, small sample size, etc.
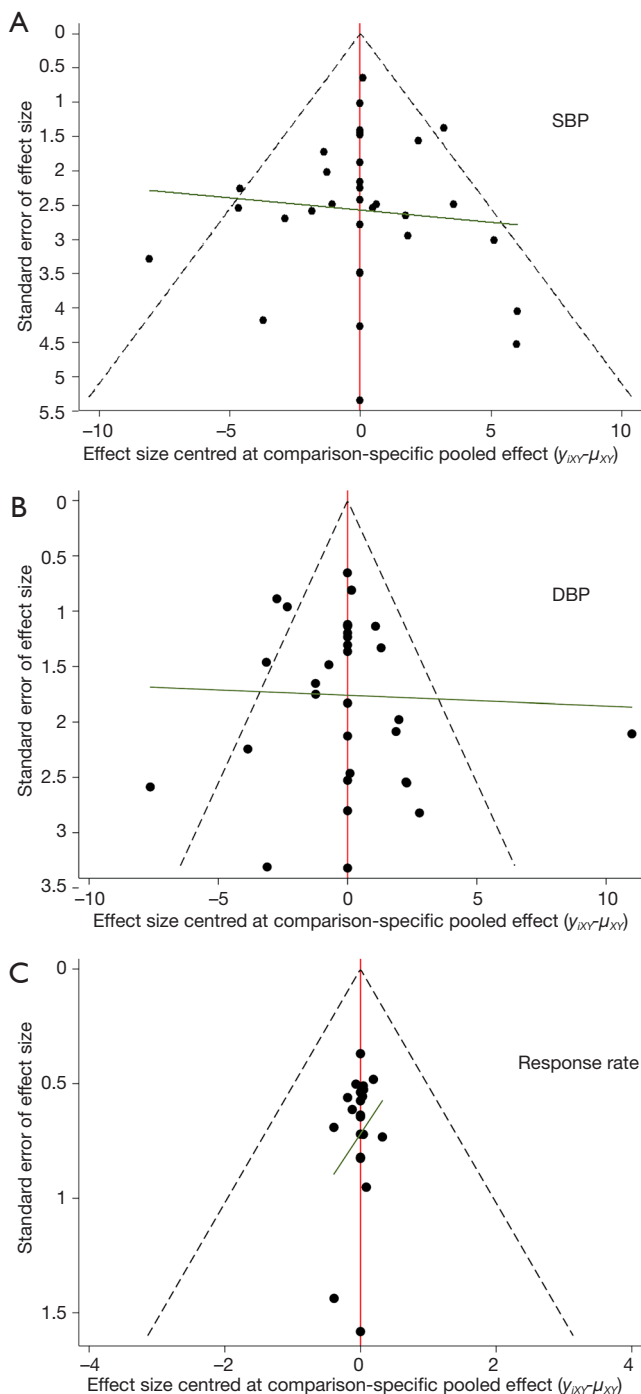
Figure 7 Funnel plots. (A) SBP, (B) DBP, (C) the response rate of the treatment. SBP, systolic blood pressure; DBP, diastolic blood pressure.

This bias, taken together, leads to the inability to precisely evaluate the effect of acupuncture for hypertension.

Strength and limitations

Compared with the traditional head-to-head meta-analysis, the results of the direct comparisons and indirect comparisons were taken into account in the network meta-analysis, which can increase the sample size for the final pooled analysis. Until now, there has been no study that has evaluated the efficacy and safety of acupuncture therapy on hypertension based on network meta-analysis. The current study may provide a reference for the clinical practice in the way of a network meta-analysis.

However, due to the likelihood of bias and lack of results assessing the endpoint of hypertension, the value of this review for guiding clinical practice is limited.

Therefore, the precise effects of acupuncture therapy for treating hypertension remain unknown as a consequence of the lack of robust evidence and high overall risk of bias in our included studies.

Conclusions

In conclusion, the existing evidence indicates that the combination of acupuncture with conventional treatment can reduce the BP value of hypertensive patients; there was no statistical and clinical difference between acupuncture and medication. Nevertheless, due to the lower quality of original research, the evidence quality of this conclusion is low, and high quality RCTs with larger sample sizes are still required to assess the efficacy of acupuncture therapy for hypertension.

Acknowledgments

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Table S1 Search strategy for PubMed

#1 acupuncture[TW] OR moxibustion[TW] OR electroacupuncture[TW] OR needle warming[TW]

#2 hypertension[TW] OR high blood pressure[TW]

#3 acupuncture[MeSH] AND hypertension[MeSH]

#4 #1 AND #2

#5 #4 OR #3

#6 random*[tw] OR blinding[tw] OR "sham acupuncture"[tw] OR placebo[tw] OR "controlled clinical trial"[pt] OR "controlled clinical trials as Topic"[MeSH] OR "randomized controlled trial"[ti/ab]

#7 #5 AND #6

β-blocker	4.69 (–2.58, 11.95)	12.81 (4.26, 21.35)	6.05 (–1.85, 13.94)	0.78 (–1.97, 3.52)	–10.37 (–18.05, –2.70)	13.40 (4.58, 22.22)	3.03 (–6.63, 12.68)	–1.81 (–6.11, 2.48)
–4.69 (–11.95, 2.58)	Electroacupuncture	8.12 (3.63, 12.61)	1.36 (–1.74, 4.46)	–3.91 (–10.62, 2.80)	–15.06 (–24.88, –5.24)	8.71 (4.08, 13.34)	–1.66 (–12.11, 8.79)	–6.50 (–12.36, –0.64)
–12.81 (–21.35, –4.26)	–8.12 (–12.61, –3.63)	EA + CCB	–6.76 (–11.20, –2.33)	–12.03 (–20.11, –3.95)	–23.18 (–33.98, –12.38)	0.59 (–5.02, 6.20)	–9.78 (–21.15, 1.59)	–14.62 (–22.00, –7.24)
–6.05 (–13.94, 1.85)	–1.36 (–4.46, 1.74)	6.76 (2.33, 11.20)	CCB	–5.27 (–12.66, 2.12)	–16.42 (–26.72, –6.13)	7.35 (3.90, 10.80)	–3.02 (–13.91, 7.88)	–7.86 (–14.49, –1.23)
–0.78 (–3.52, 1.97)	3.91 (–2.80, 10.62)	12.03 (3.95, 20.11)	5.27 (–2.12, 12.66)	Acupuncture	–11.15 (–18.31, –3.99)	12.62 (4.45, 20.79)	2.25 (–7.00, 11.50)	–2.59 (–5.87, 0.69)
10.37 (2.70, 18.05)	15.06 (5.24, 24.88)	23.18 (12.38, 33.98)	16.42 (6.13, 26.72)	11.15 (3.99, 18.31)	ARB	23.77 (12.90, 34.64)	13.40 (1.70, 25.10)	8.56 (0.68, 16.44)
–13.40 (–22.22, –4.58)	–8.71 (–13.34, –4.08)	–0.59 (–6.20, 5.02)	–7.35 (–10.80, –3.90)	–12.62 (–20.79, –4.45)	–23.77 (–34.64, –12.90)	ACU + CCB	–10.37 (–21.80, 1.06)	–15.21 (–22.68, –7.74)
–3.03 (–12.68, 6.63)	1.66 (–8.79, 12.11)	9.78 (–1.59, 21.15)	3.02 (–7.88, 13.91)	–2.25 (–11.50, 7.00)	–13.40 (–25.10, –1.70)	10.37 (–1.06, 21.80)	ACU+ACEI	–4.84 (–13.49, 3.81)
1.81 (–2.48, 6.11)	6.50 (0.64, 12.36)	14.62 (7.24, 22.00)	7.86 (1.23, 14.49)	2.59 (–0.69, 5.87)	–8.56 (–16.44, –0.68)	15.21 (7.74, 22.68)	4.84 (–3.81, 13.49)	ACEI

Figure S1 Network analysis of pre-post treatment SBP change value(short-term). ACU, acupuncture; CCB, calcium channel blocker; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; SBP, systolic blood pressure.

β-blocker	1.33 (–11.43, 14.09)	6.26 (–8.92, 21.45)	4.58 (–9.22, 18.38)	0.97 (–4.17, 6.10)	–2.71 (–13.36, 7.93)	8.84 (–6.38, 24.07)	–3.32 (–15.86, 9.22)	–3.72 (–11.37, 3.93)
–1.33 (–14.09, 11.43)	Electroacupuncture	4.93 (–3.30, 13.17)	3.25 (–2.01, 8.51)	–0.36 (–12.04, 11.32)	–4.04 (–18.99, 10.90)	7.51 (–0.80, 15.82)	–4.65 (–18.89, 9.59)	–5.05 (–15.26, 5.16)
–6.26 (–21.45, 8.92)	–4.93 (–13.17, 3.30)	EA + CCB	–1.68 (–9.91, 6.54)	–5.30 (–19.59, 9.00)	–8.98 (–26.04, 8.09)	2.58 (–7.86, 13.02)	–9.58 (–26.04, 6.87)	–9.98 (–23.10, 3.13)
–4.58 (–18.38, 9.22)	–3.25 (–8.51, 2.01)	1.68 (–6.54, 9.91)	CCB	–3.62 (–16.43, 9.20)	–7.30 (–23.14, 8.55)	4.26 (–2.17, 10.69)	–7.90 (–23.09, 7.28)	–8.30 (–19.79, 3.18)
–0.97 (–6.10, 4.17)	0.36 (–11.32, 12.04)	5.30 (–9.00, 19.59)	3.62 (–9.20, 16.43)	Acupuncture	–3.68 (–13.00, 5.64)	7.88 (–6.46, 22.21)	–4.29 (–15.73, 7.15)	–4.69 (–10.36, 0.99)
2.71 (–7.93, 13.36)	4.04 (–10.90, 18.99)	8.98 (–8.09, 26.04)	7.30 (–8.55, 23.14)	3.68 (–5.64, 13.00)	ARB	11.56 (–5.54, 28.65)	–0.61 (–15.36, 14.15)	–1.01 (–11.92, 9.91)
–8.84 (–24.07, 6.38)	–7.51 (–15.82, 0.80)	–2.58 (–13.02, 7.86)	–4.26 (–10.69, 2.17)	–7.88 (–22.21, 6.46)	–11.56 (–28.65, 5.54)	ACU + CCB	–12.16 (–28.65, 4.33)	–12.56 (–25.73, 0.60)
3.32 (–9.22, 15.86)	4.65 (–9.59, 18.89)	9.58 (–6.87, 26.04)	7.90 (–7.28, 23.09)	4.29 (–7.15, 15.73)	0.61 (–14.15, 15.36)	12.16 (–4.33, 28.65)	ACU+ACEI	–0.40 (–10.33, 9.53)
3.72 (–3.93, 11.37)	5.05 (–5.16, 15.26)	9.98 (–3.13, 23.10)	8.30 (–3.18, 19.79)	4.69 (–0.99, 10.36)	1.01 (–9.91, 11.92)	12.56 (–0.60, 25.73)	0.40 (–9.53, 10.33)	ACEI

Figure S2 Network analysis of pre-post treatment DBP change value (short-term). ACU, acupuncture; CCB, calcium channel blocker; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; DBP, diastolic blood pressure.

Sham-acupuncture	−0.98 (−6.29, 4.33)	2.11 (−10.03, 14.24)	7.52 (−6.97, 22.01)	4.61 (−2.28, 11.51)	5.75 (1.21, 10.28)	13.63 (4.95, 22.32)	5.51 (−1.86, 12.87)
0.98 (−4.33, 6.29)	No-treatment	3.08 (−9.20, 15.37)	8.49 (−6.12, 23.11)	5.59 (−1.32, 12.51)	6.72 (1.80, 11.64)	14.61 (5.72, 23.50)	6.48 (−1.13, 14.09)
−2.11 (−14.24, 10.03)	−3.08 (−15.37, 9.20)	Needle-warming	5.41 (−10.36, 21.18)	2.51 (−11.01, 16.02)	3.64 (−7.61, 14.88)	11.53 (−0.81, 23.87)	3.40 (−6.24, 13.04)
−7.52 (−22.01, 6.97)	−8.49 (−23.11, 6.12)	−5.41 (−21.18, 10.36)	Moxibustion	−2.90 (−18.56, 12.76)	−1.77 (−15.52, 11.98)	6.12 (−8.54, 20.78)	−2.01 (−14.49, 10.47)
−4.61 (−11.51, 2.28)	−5.59 (−12.51, 1.32)	−2.51 (−16.02, 11.01)	2.90 (−12.76, 18.56)	Electroacupuncture	1.13 (−6.35, 8.61)	9.02 (−1.50, 19.54)	0.89 (−8.58, 10.36)
−5.75 (−10.28, −1.21)	−6.72 (−11.64, −1.80)	−3.64 (−14.88, 7.61)	1.77 (−11.98, 15.52)	−1.13 (−8.61, 6.35)	Acupuncture	7.89 (0.51, 15.27)	−0.24 (−6.02, 5.54)
−13.63 (−22.32, −4.95)	−14.61 (−23.50, −5.72)	−11.53 (−23.87, 0.81)	−6.12 (−20.78, 8.54)	−9.02 (−19.54, 1.50)	−7.89 (−15.27, −0.51)	ACU + Life	−8.13 (−15.82, −0.43)
−5.51 (−12.87, 1.86)	−6.48 (−14.09, 1.13)	−3.40 (−13.04, 6.24)	2.01 (−10.47, 14.49)	−0.89 (−10.36, 8.58)	0.24 (−5.54, 6.02)	8.13 (0.43, 15.82)	ACEI

Figure S3 Network analysis of pre-post treatment SBP change value (long-term). ACU, acupuncture, ACEI, angiotensin-converting enzyme inhibitor; SBP, systolic blood pressure.

Sham-acupuncture	−1.37 (−3.24, 0.51)	6.71 (1.57, 11.85)	22.93 (15.76, 30.10)	2.17 (−0.25, 4.59)	4.10 (2.11, 6.10)	7.73 (4.55, 10.91)	4.14 (1.44, 6.84)
1.37 (−0.51, 3.24)	No-treatment	8.08 (3.02, 13.14)	24.30 (17.18, 31.41)	3.54 (1.10, 5.97)	5.47 (3.72, 7.22)	9.10 (6.05, 12.14)	5.51 (2.96, 8.05)
−6.71 (−11.85, −1.57)	−8.08 (−13.14, −3.02)	Needle-warming	16.22 (8.27, 24.17)	−4.54 (−10.03, 0.95)	−2.61 (−7.40, 2.18)	1.02 (−4.10, 6.14)	−2.57 (−6.94, 1.80)
−22.93 (−30.10, −15.76)	−24.30 (−31.41, −17.18)	−16.22 (−24.17, −8.27)	Moxibustion	−20.76 (−28.18, −13.33)	−18.83 (−25.75, −11.91)	−15.20 (−22.36, −8.04)	−18.79 (−25.43, −12.15)
−2.17 (−4.59, 0.25)	−3.54 (−5.97, −1.10)	4.54 (−0.95, 10.03)	20.76 (13.33, 28.18)	Electroacupuncture	1.93 (−0.83, 4.69)	5.56 (1.84, 9.28)	1.97 (−1.35, 5.29)
−4.10 (−6.10, −2.11)	−5.47 (−7.22, −3.72)	2.61 (−2.18, 7.40)	18.83 (11.91, 25.75)	−1.93 (−4.69, 0.83)	Acupuncture	3.63 (1.09, 6.17)	0.04 (−1.91, 1.99)
−7.73 (−10.91, −4.55)	−9.10 (−12.14, −6.05)	−1.02 (−6.14, 4.10)	15.20 (8.04, 22.36)	−5.56 (−9.28, −1.84)	−3.63 (−6.17, −1.09)	ACU + Life	−3.59 (−6.25, −0.93)
−4.14 (−6.84, −1.44)	−5.51 (−8.05, −2.96)	2.57 (−1.80, 6.94)	18.79 (12.15, 25.43)	−1.97 (−5.29, 1.35)	−0.04 (−1.99, 1.91)	3.59 (0.93, 6.25)	ACEI

Figure S4 Network analysis of pre-post treatment DBP change value (long-term). ACU, acupuncture; ACEI, angiotensin-converting enzyme inhibit; DBP, diastolic blood pressure.

β-blocker	0.56 (0.02, 20.95)	0.58 (0.02, 19.59)	2.17 (0.05, 89.07)	0.70 (0.02, 24.77)	4.32 (2.35, 7.94)	0.91 (0.16, 5.13)	2.99 (0.07, 136.32)	29.92 (2.94, 304.47)	3.21 (0.60, 17.04)
1.78 (0.05, 66.27)	Moxibustion	1.03 (0.45, 2.35)	3.86 (1.03, 14.42)	1.24 (0.70, 2.20)	7.68 (0.22, 271.56)	1.62 (0.03, 81.16)	5.32 (1.22, 23.13)	53.22 (1.47, 1928.87)	5.70 (0.23, 141.17)
1.73 (0.05, 58.50)	0.97 (0.42, 2.22)	Electroacupuncture	3.75 (1.15, 12.22)	1.20 (0.66, 2.18)	7.46 (0.23, 239.40)	1.57 (0.03, 72.19)	5.17 (1.18, 22.67)	51.71 (1.57, 1701.61)	5.54 (0.25, 123.07)
0.46 (0.01, 18.92)	0.26 (0.07, 0.97)	0.27 (0.08, 0.87)	EA + CCB	0.32 (0.10, 1.05)	1.99 (0.05, 77.65)	0.42 (0.01, 23.01)	1.38 (0.23, 8.34)	13.79 (0.35, 551.19)	1.48 (0.05, 40.80)
1.44 (0.04, 51.15)	0.81 (0.46, 1.43)	0.83 (0.46, 1.51)	3.12 (0.95, 10.22)	CCB	6.20 (0.18, 209.47)	1.31 (0.03, 62.87)	4.30 (1.11, 16.63)	43.00 (1.24, 1488.31)	4.61 (0.20, 108.32)
0.23 (0.13, 0.43)	0.13 (0.00, 4.61)	0.13 (0.00, 4.31)	0.50 (0.01, 19.63)	0.16 (0.00, 5.45)	Acupuncture	0.21 (0.04, 1.06)	0.69 (0.02, 30.08)	6.93 (0.74, 65.04)	0.74 (0.16, 3.52)
1.10 (0.20, 6.21)	0.62 (0.01, 31.09)	0.64 (0.01, 29.29)	2.39 (0.04, 131.23)	0.77 (0.02, 36.88)	4.75 (0.94, 23.98)	ARB	3.29 (0.05, 199.34)	32.94 (2.08, 521.85)	3.53 (0.37, 33.33)
0.33 (0.01, 15.26)	0.19 (0.04, 0.82)	0.19 (0.04, 0.85)	0.73 (0.12, 4.39)	0.23 (0.06, 0.90)	1.44 (0.03, 62.71)	0.30 (0.01, 18.42)	ACU + CCB	10.01 (0.23, 444.83)	1.07 (0.03, 33.30)
0.03 (0.00, 0.34)	0.02 (0.00, 0.68)	0.02 (0.00, 0.64)	0.07 (0.00, 2.90)	0.02 (0.00, 0.80)	0.14 (0.02, 1.35)	0.03 (0.00, 0.48)	0.10 (0.00, 4.44)	ACU + ACEI	0.11 (0.02, 0.54)
0.31 (0.06, 1.66)	0.18 (0.01, 4.34)	0.18 (0.01, 4.01)	0.68 (0.02, 18.68)	0.22 (0.01, 5.10)	1.35 (0.28, 6.38)	0.28 (0.03, 2.68)	0.93 (0.03, 28.94)	9.33 (1.87, 46.68)	ACEI

Figure S5 Network analysis of response rate (short-term). ACU, acupuncture; EA, electroacupuncture; CCB, calcium channel blocker; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker.