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Effect of electroacupuncture combined with rehabilitation training on hypertension: A systematic review and meta-analysis

Yongli Jiang [a,1], Yu Luo [b,1], Tian Li [b], Yun Gai [b,*]

[a] Department of Clinical Laboratory, Shanghai Pudong New Area Geriatric Hospital, China
[b] Department of General Medicine, Seventh People's Hospital of Shanghai University of TCM, No. 358, Datong Road, Pudong New Area, Shanghai 200137, China

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ABSTRACT

To evaluate the clinical effects of electroacupuncture combined with rehabilitation training (EART) versus conventional rehabilitation training (CRT) on hypertension. Multiple databases like PubMed, Embase, Web of Science and Wanfang database, China National Knowledge Internet database, and Chinese Biological Medical database were used to search for the relevant studies and full-text articles involved in evaluating EART versus CRT with hypertension. Review Manager 5.4 was used to estimate the effects of the results among included articles. Forest plots, sensitivity analysis, and funnel plots were also conducted on the included articles. In this *meta*-analysis study, there were 9 relevant studies were eventually satisfied the included criteria. There were significant differences between EART group and CRT group in systolic blood pressure after treatment (MD −16.62, 95 %CI = -21.84 to −11.39; $P < 0.00001$), diastolic blood pressure after treatment (MD = −16.03, 95 % CI = −21.55 to −10.50; $P < 0.00001$), and effective rate (MD = 1.22, 95 % CI = 1.13 to 1.32; $P < 0.00001$). Sensitivity analysis and funnel chart demonstrated that the study was robust and limited publication bias was observed. Our data showed that EART was clinically more significant than CRT in hypertension. Further studies need to be performed using large relevance references to verify the effectiveness of EART in the treatment of hypertension.

1. Introduction

Essential hypertension (EH) is a clinical syndrome characterized by increased systemic arterial pressure [1]. It predisposes to arteriosclerosis, cerebrovascular disease, and coronary heart disease. Hypertension is the most important and independent risk factor [2]. Humoral factors are one of the essential links in regulating blood pressure. The changes in plasma catecholamine (CA) [including epinephrine (AD), norepinephrine (NAD), and dopamine (DA)] are closely related with the circadian rhythm of blood pressure [3,4]. Therefore, controlling blood pressure and plasma content has positive clinical significance for preventing cerebrovascular disease and coronary heart disease [5].

Essential hypertension onset is hidden, with slow progress and long course. Its clinical symptoms are dizziness, forgetfulness, tinnitus, fatigue, and other neurological symptoms [6,7]. Blood pressure rises specifically common in the middle-aged and elderly [8]. Calcium channel blockers, angiotensin-converting enzyme inhibitors, and other drugs are commonly used in clinical antihypertensive drugs. Because antihypertensive medications need to be taken for a long time, drug safety and patient tolerance are particularly important for patients. In recent years, traditional Chinese medicine have significant progress in treating EH [9,10]. The in-depth study of the pathogenesis and treatment based on syndrome differentiation has unique advantages in improving symptoms and reducing adverse reactions.

Electroacupuncture (EA) in traditional Chinese medicine is a therapy that conforms to the change law of yin Yang, Qi and blood flow in one day [11,12]. Acupuncture corrects the abnormal change law of Qi and blood day and night through different intervention times, balances Yin and Yang, to regulate blood pressure [13,14]. Previous studies have shown that timing acupuncture can reduce the total systolic blood pressure (SBP) and diastolic blood pressure (DBP) in spontaneously hypertensive rats (SHR) [15–20].

Many studies reported the application of electroacupuncture combined with rehabilitation training (EART) compared with CRT in controlling hypertension. Because of the variability of the reported results, we conducted a systematic review and *meta*-analysis of the relevant

* Corresponding author.
E-mail address: gaiyunlucky@163.com (Y. Gai).
[1] Authors contributed equally.

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studies, aiming to increase the sample size and improve test efficiency. The objective is to provide an evidence-based medical basis for the clinical effect of EART on hypertension.

2. Materials and methods

2.1. Literature search strategy

A systematic search of relevant studies was performed in six electronic databases, including PubMed, Web of Science (WOS), Embase, Wanfang database, China National Knowledge Internet (CNKI) database, and Chinese Biological Medical (CBM) database (up to May 2021) with the following keywords: (1) electroacupuncture; (2) hypertension; these keywords were used in combination with the Boolean operators 'AND' and 'OR' to search literature. A comprehensive search of the literature was carried out using an electronic search with no restriction regarding the publication's date, language, or status. Two authors independently reviewed and assessed the eligibility of titles, abstracts, and studies deemed relevant for the review of their full texts. Any discrepancies were resolved through discussion with another author.

2.2. Study selection

Potentially relevant articles were reviewed to ensure that they satisfied all of the inclusion criteria, as follows:

(1) Researches comparing patients who receive EART and CRT;
(2) Patients with hypertension;
(3) Containing indicators evaluating effectiveness between EART group and CRT group;
(4) Available in full text.

The studies excluded were determined by the following exclusion criteria:

(1) Researches not met the inclusion criteria;
(2) The outcomes of interest were not reported or impossible to use;
(3) Review, abstract, duplicate publication.

2.2.1. Data extraction and quality assessment

The studies were reviewed, and the data were extracted independently by two investigators. The number of individuals in each study group was recorded. We also extracted data for study design, age, gender, year of outset, and several outcome variables concerned. The methodological quality assessment of each eligible article was assessed with the Cochrane Risk of Bias Tool, one of the most useful scales for evaluating the quality of randomized studies.

2.3. Statistical analysis

The review manager (Version 5.4, Cochrane Collaboration, 2020) was used to estimate the impact of the results in the selected report. Mean difference (MD) was used for measurement data, and a 95 % confidence interval (CI) was used. We evaluated the degree of statistical heterogeneity and inconsistency using the Chi 2 and I^2 statistics. Heterogeneity was considered significant at $P < 0.05$. I^2 with values ⩾of 50 % indicating high heterogeneity and values between 0 % and 50 % indicating moderate heterogeneity. If significant heterogeneity ($P < 0.05$ or $I^2 > 50$ %) existed, the random-effects model (the DerSimonian-Laird method) was applied. Otherwise, the fixed-effects model was utilized. For the sensitivity analysis of the primary outcome, we controlled for the study as a random effect. Publication bias was examined by visual inspection of funnel plot and using Egger's test.

3. Results

3.1. Search process

A total of 582 articles were identified by the screening electronic search strategy. By preliminary screening abstract, we exclude 471 documents, which obviously do not meet the inclusion criteria. In consideration of the study design and insufficient data presented, 63 articles were rejected. The full texts of articles were reviewed, and nine were retained for data extraction [21–29]. The literature search process, the inclusion and exclusion criteria, and the final sample size are illustrated in Fig. 1.

3.2. Characteristics of included studies

Table 1 lists the main characteristics of the nine trials. The study sample size was 1131 participants (40–300). The published year was between 2001 and 2021. The primary outcome contained Systolic blood pressure after treatment, Diastolic blood pressure after treatment, and Effect rate.

3.3. Results of quality assessment

Studies quality was assessed using the Cochrane risk of bias tool. Among the nine articles, a high risk of performance bias was found in one article, and reporting bias was found in another two studies (Fig. 2a). The summary risk of bias assessment of each included study was illustrated in Fig. 2b.

3.4. Results of heterogeneity test

For systolic blood pressure after treatment, an overall MD of −16.62 (95 %CI = -21.84 to −11.39) between the EART group and CRT group with statistical significance ($P < 0.00001$) was found (Fig. 3). The comparisons presented a high heterogeneity among selected studies ($P < 0.00001$ and $I^2 = 938$). The result demonstrated that the systolic blood pressure after treatment in the EART group was significantly lower than in the CRT group.

In terms of diastolic blood pressure after treatment, and overall MD of −16.03 (95 % CI = -21.55 to −10.50), statistical significance ($P < 0.00001$) was found (Fig. 4). The comparisons presented a high heterogeneity among seven included studies ($P < 0.00001$ and $I^2 = 98$ %). It suggested that the EART group lower diastolic blood pressure than the CRT group.

For effective rate, and overall MD of 1.22 (95 % CI = 1.13 to 1.32), with statistical significance ($P < 0.00001$) was found (Fig. 5). The comparisons presented a high heterogeneity among four included studies ($P < 0.00001$ and $I^2 = 56$ %). The results showed a significantly higher effective rate in the EART group than in the CRT group.

3.5. Results of sensitivity analysis and publication bias

Sensitivity analysis was conducted by deleting a single study each time to observe the influence of the individual outcome on the overall analysis. Still, the results had not changed, suggesting that our results were reliable.

The funnel plot for systolic blood pressure after treatment was shown in Fig. 6, and the shape showed some evidence of symmetry. In addition, we performed an Egger's test for diastolic blood pressure after treatment. The *P-value* was 0.78, indicating no significant publication bias in this *meta*-analysis.

4. Discussion

The objective of this *meta*-analysis was to investigate the effects of EART on hypertension. The results showed that EART could significantly

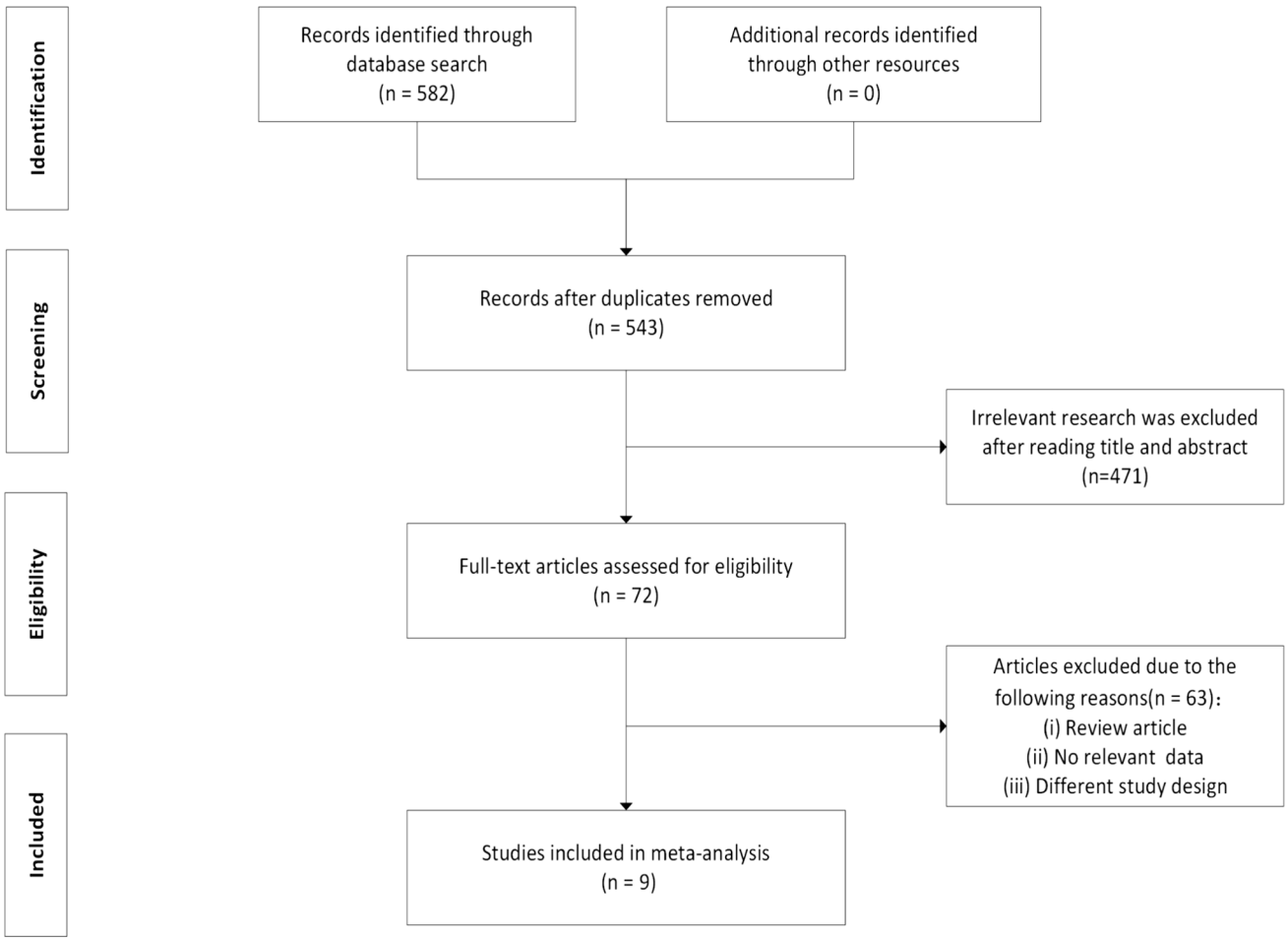

Fig. 1. Flowchart of the results of the literature search.

Table 1
Characteristics of studies included in the systematic review and *meta*-analysis.

Study	Study design	No. patients		Age		Years of onset	Country
		EART	CRT				
He et al. [2018]	RCT	60	60	36.4 ± 9.3	37.2 ± 10.1	January 2015 to December 2016	China
Jung et al. [2020]	RCT	150	150	31.32 ± 13.07	32.51 ± 13.14	January 2018 to October 2019	Korea
Li et al. [2019]	RCT	30	23	40.5 ± 13.6	32.2 ± 11.5	March 2017 to December 2018	China
Tan et al. [2016]	RCT	20	20	37.70 ± 11.33	37.10 ± 9.67	February 2012 to August 2013	China
Tanaka et al. [2018]	RCT	49	50	29.5 ± 1.7	29.1 ± 1.5	January 2017 to January 2018	Brazil
Wan et al. [2009]	RCT	39	38	41 ± 5	40 ± 5	April 2003 to September 2007	China
Wang et al. [2018]	RCT	50	50	42.97 ± 5.54	42.85 ± 5.76	March 2016 to March 2018	China
Zheng et al. [2001]	RCT	21	23	35.9 ± 13.6	31.5 ± 11.0	January 2000 to August 2001	China
Zhang et al. [2019]	RCT	149	149	46 ± 6	47 ± 5	January 2018 to October 2019	China

EART = electroacupuncture combined with rehabilitation training; CRT = conventional rehabilitation training; RCT = randomized controlled trial.

control blood pressure. When EART was compared with CRT, there was a significant lower in systolic blood pressure after treatment (MD = -16.62, 95 %CI = -21.84 to −11.39; P < 0.00001), lower diastolic blood pressure after treatment (MD = -16.03, 95 % CI = -21.55 to −10.50; P < 0.00001) and higher effective rate (MD = 1.22, 95 % CI = 1.13 to 1.32; P < 0.00001). To our knowledge, this was the first *meta*-analysis focused on the effectiveness of EART on hypertension. EART was found to help decreasing hypertension. The finding was that EART was beneficial for the treatment of hypertension.

In clinical practice, the application of EART in patients with hypertension was not rare [30–32]. In Li's study, EA was used to treat hypertension and compared with usual medicine, EA took effects quickly and keep efficacy for a long time [33]. Wang et al. used EA to treat essential hypertension. Compared with the control group, the effective rate of EA was higher [34]. Yin et al. used EA combined with fumigation and Chinese medicine to improve hypertension, effectively avoiding the occurrence of complications and significantly improving blood pressure [35].

Drug was the most common measure to control hypertension [36,37]. At this time, medicine was easy to increase the other complications [38,39]. Acupuncture had a history of more than 2000 years in China. Chronic disease is one of the main indications of acupuncture treatment [40,41]. EART was an improvement of traditional acupuncture. It had definite analgesic effect by stimulating acupoints [42,43]. Compared with conventional rehabilitation, EART can improve the compliance of functional exercise. While improving patients' symptoms,

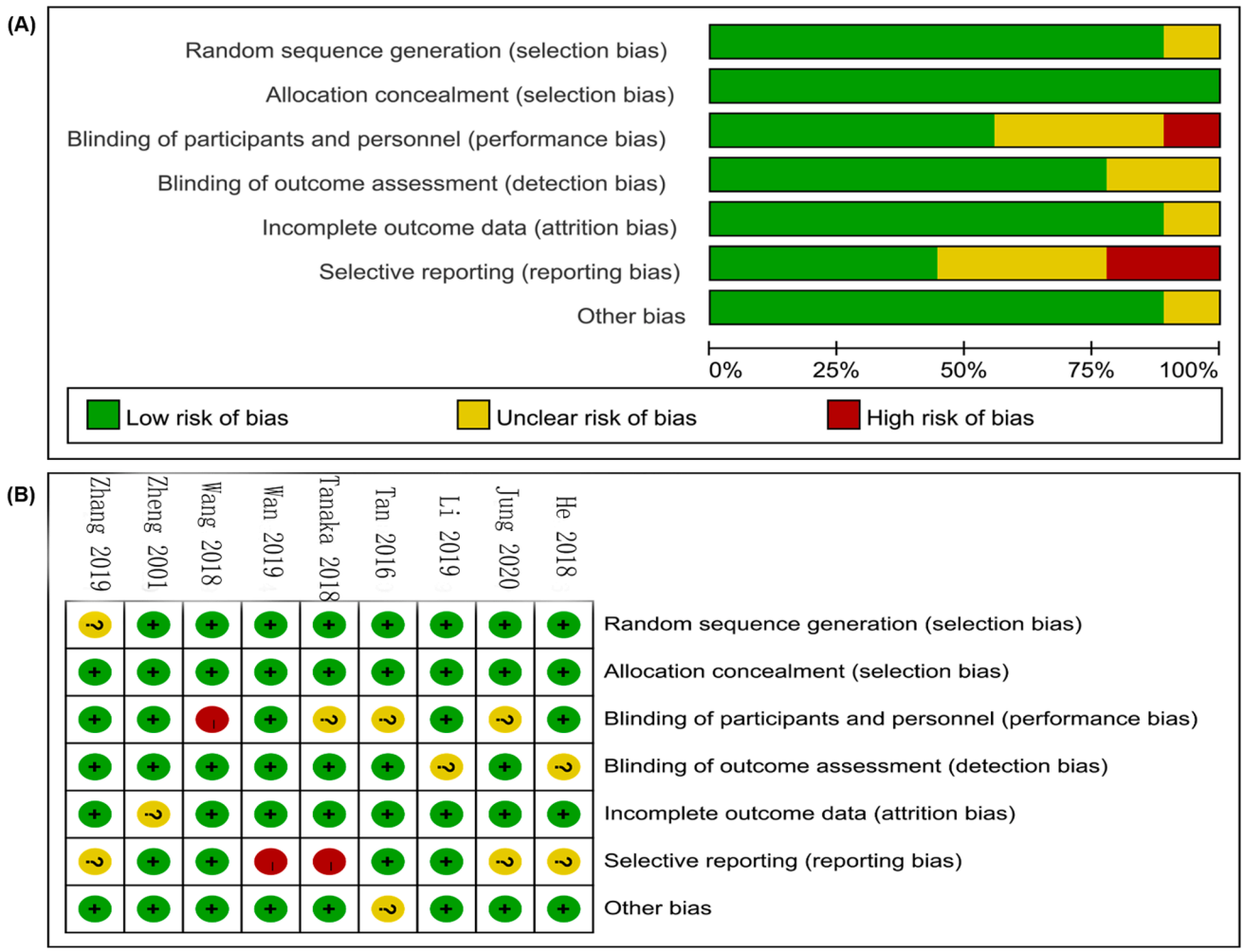

Fig. 2. Overall risk of bias using the Cochrane risk of bias tool: low (green hexagons), unclear (yellow hexagons), and high (red hexagons). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

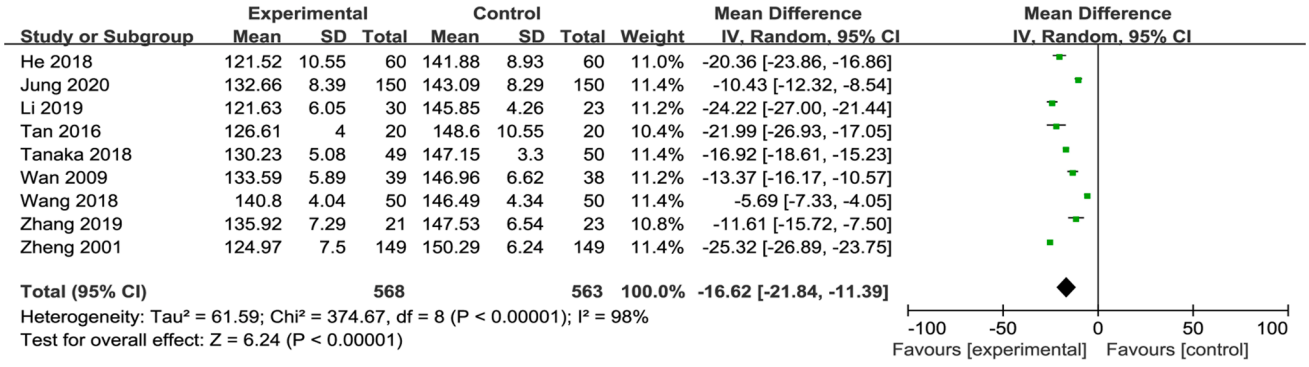

Fig. 3. Results from the pooled analysis of systolic blood pressure after treatment.

it did not increase the economic burden of patients [44,45].

This systematic review had several obvious limitations. First, it was mainly conducted in China, so more high-quality clinical trials were needed to confirm the efficacy of EART. Secondly, although we found that the conclusion was stable through sensitivity analysis, we can not ignore the significant heterogeneity in the studies' primary outcomes. In addition, there was no description of the economic benefit-cost ratio in all included studies.

5. Conclusion

This *meta*-analysis suggested that EART was better than CRT on hypertension. We believe that EART would play a more and greater role in hypertension with the development and in-depth study of acupuncture. Given the limitations of this study, many RCTs with high quality, large sample size, multi-centre and relatively uniform evaluation criteria were still needed to further verify the results to provide strong evidence for the superiority of EART in the treatment of hypertension.

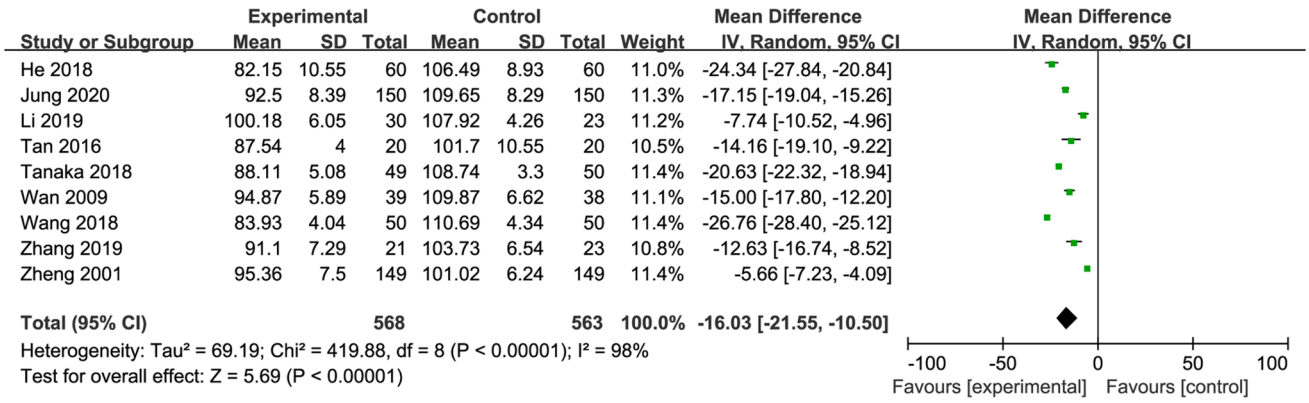

Fig. 4. Results from the pooled analysis of diastolic blood pressure after treatment.

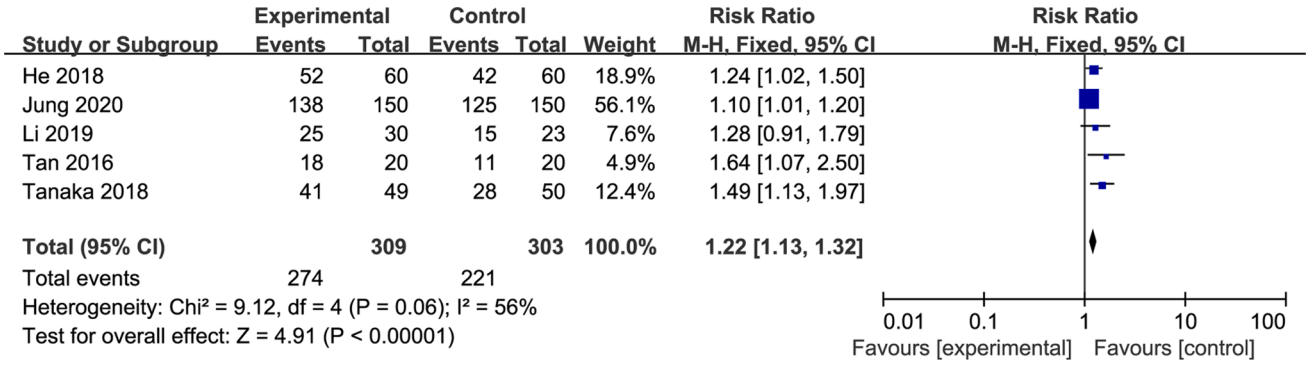

Fig. 5. Results from the pooled analysis of effective rate.

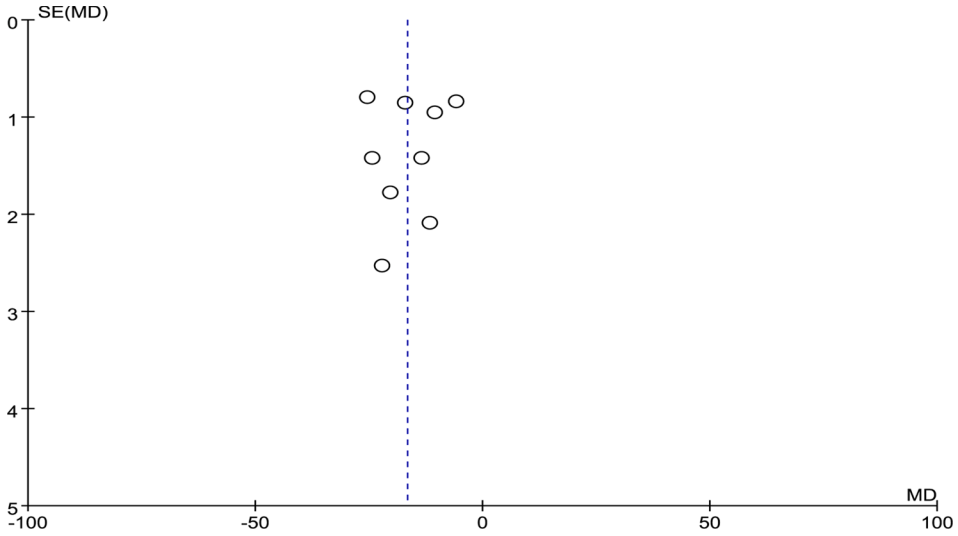

Fig. 6. Funnel plot showing publication bias.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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