



Review Article

Acupuncture combined with speech rehabilitation training for post-stroke dysarthria: A systematic review and meta-analysis of randomized controlled trials

Qianwen Xie ^a, Xueyin Chen ^a, Jingmin Xiao ^a, Shaonan Liu ^b, Lihong Yang ^b, Jing Chen ^b, Jiaqi Lai ^b, Rui Lan ^a, Yi Chen ^b, Haifang Yang ^b, Xinfeng Guo ^{b,*}

^a The Second Clinical College of Guangzhou University of Chinese Medicine, Guangzhou, China

^b Guangdong Provincial Hospital of Chinese Medicine, Guangzhou, China

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ABSTRACT

Background: The evidence of Acupuncture combined with speech rehabilitation training for post-stroke dysarthria is insufficient and there is no consensus on its efficacy.

Methods: We searched seven Chinese and English medicine databases for randomized controlled trials (RCTs) from their inception to November 2019. The primary outcome measure was the clinical response rate, assessed with the Frenchay Dysarthria Assessment (FDA) tool. We assessed risk of bias using the Cochrane risk-of-bias tool. We used GRADE to assess the certainty of evidence (CoE).

Results: Thirty studies were included in this systematic review, 23 of which were pooled in meta-analysis. Acupuncture combined with speech rehabilitation training is likely beneficial for was response rate ($n = 1685$; RR = 1.37; 95% CI [1.29, 1.46], $P < 0.01$, $I^2 = 34%$; 17 studies, low CoE) compared to speech rehabilitation treatment alone.

Conclusion: The combination of acupuncture and speech rehabilitation training may improve total response rate of stroke patients with dysarthria. However, more RCTs with rigorous study design and validated outcome measures are needed to confirm the evidence.

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1. Introduction

Globally, stroke is the second most common cause of mortality and the third most common cause of disability.¹ As a consequence of stroke, approximately 25% of patients experience damage to their motor neurons or cerebellum, thus losing their ability to normally articulate words; this is known as dysarthria.² Post-stroke dysarthria (PSD) is a motor speech disorder with various signs and symptoms, and is characterized by slurred, slow, weak, nasal, raspy, strained, imprecise, or uncoordinated speech, or an abnormal speech rhythm.³ With dysarthria, one or more of the speech sub-systems may be affected, resulting in poor intelligibility, audibility, naturalness, and efficiency of speech.⁴ Dysarthria affects more than merely physiological function; it may also lead to poor self-identity, social and emotional disruptions (depression, isolation, and difficulty returning to work), and feelings of stigmatization.⁵

As the conventional treatment for PSD, speech rehabilitation training is commonly employed by speech and language

therapists.^{6–8} To increase the efficacy of the above, acupuncture has received increasing attention as a complementary therapy for the treatment of nervous system diseases.⁹ Accumulating evidence indicates that acupuncture may improve motor function, sensation, speech, and other neurological functions in patients that experienced stroke.^{10–13} However, it remains uncertain whether acupuncture should be recommended as a routine adjunct therapy for PSD. The similar meta-analyses and systematic reviews have not been performed. The aim of this systematic review and meta-analysis was to determine the effectiveness of acupuncture combined with speech rehabilitation training (ACWSRT) for PSD.

2. Methods

This meta-analysis was registered in the International Prospective Register of Systematic Reviews (PROSPERO) on November 2018 (CRD42018117216).

2.1. Search strategy

A systematic literature review was undertaken by searching seven electronic databases, including PubMed, Embase, the

* Corresponding author at: Guangdong Provincial Hospital of Chinese Medicine, Guangzhou, China.

E-mail address: guoxinfeng@gzucm.edu.cn (X. Guo).

Cochrane Library, the China National Knowledge Infrastructure, the Chinese Biomedical Literature Database, VIP Database for Chinese Technical Periodicals, and WANFANG Data, for records from their inception up to and including Nov 2019. The search terms used were derived from the Medical Subject Headings thesaurus produced by the National Library of Medicine. Three terms were searched in conjunction: “acupuncture,” “stroke,” and “dysarthria,” according to each database language (Appendix). We also screened the reference lists of initially retrieved articles to identify any other eligible published studies. We included all English and Chinese language articles of randomized controlled trials (RCTs) investigating the effectiveness of ACWSRT for PSD.

2.2. Eligibility criteria

2.2.1. Study type

RCTs with parallel-group or crossover designs were included. All non-RCT studies were excluded.

2.2.2. Participants

Participants in eligible studies were adults who suffered dysarthria following stroke, regardless of sex, age, or duration of the disease. Individuals diagnosed with dysarthria resulting from other conditions (e.g., Parkinson’s disease or brain tumors), or from aphasia, were excluded.

2.2.3. Intervention

The intervention group received ACWSRT, regardless of frequency, intensity, or duration of the interventions. We included patients receiving either manual acupuncture or electroacupuncture, using conventional acupoints. We also included acupuncture therapies that focused on specific parts of the body, such as nape, scalp, or tongue acupuncture. RCTs that combined ACWSRT with herbal medicine, moxibustion, tuina, auricular therapy, or other alternative complementary treatments, were excluded.

2.2.4. Comparator

The comparator was speech rehabilitation training alone (SRTA), i.e., conventional speech and language therapies including articulation, voice, prosody, and respiratory training.

2.2.5. Outcome measure

The primary outcome measure was the clinical response rate measured with the Frenchay Dysarthria Assessment (FDA) tool. Clinical response was defined as sufficient improvement of speech and language function, and the clinical response rate was calculated as the portion of the patients exhibiting a clinical response among the analyzed populations. Clinical response was evaluated using the following scale: (1) cured, (2) markedly effective, (3) effective, and (4) ineffective.

The secondary outcomes were speech intelligibility and quality of life (measured using a validated questionnaire). Adverse events and serious adverse events were also summarized.

2.3. Study selection

We screened and excluded duplicate studies using EndNote X7 (Clarivate Analytics, Philadelphia, PA, USA). Second, three researchers (QX, XC, and JX) independently selected studies based on the eligibility criteria listed in Section 2.2. The first two researchers excluded ineligible studies through screening the title, abstract, and full text of each, and noted the reason for exclusion. If there were disagreements, the two selectors tried to reach a consensus. If no consensus could be reached, the third researcher

would make the final decision. Incomplete data or queries were followed up with the original authors via email.

2.4. Data extraction

Two reviewers (QX and XC) independently collated the data using a standard data extraction form containing pre-specified outcome data categories. Extracted information included authors, publication year, diagnostic method, sample size, mean age, duration of disease, interventions, duration of treatment, outcomes, and adverse events.

2.5. Assessment of risk of bias

The risk of bias of the included RCTs was assessed with Cochrane risk-of-bias tool (Cochrane, London, UK).¹⁴ This instrument consists of six domains where bias may arise: (1) inadequate random sequence generation and treatment allocation blinding; (2) deviation from intended interventions, such as inadequate blinding of participants and personnel; (3) inadequate blinding of outcome assessment; (4) incomplete outcome data; (5) selective reporting; and (6) others. Three authors (QX, XC, and RL) independently performed this assessment. A fourth reviewer (SL) was consulted, or a consensus reached if there were different opinions.

2.6. Certainty of evidence

Two authors (QX and XC) used GRADEpro GDT (McMaster University and Evidence Prime Inc., Hamilton, Ontario, Canada), the Guideline Development Tool of the Grading of Recommendations Assessment, Development and Evaluation working group, to assess the quality of the meta-analysis. The following factors were considered: (1) risk of bias due to study limitations; (2) indirectness of evidence due to e.g. differences in patient populations or the use of surrogate outcome measures; (3) inconsistency, i.e. unexplained heterogeneity; (4) imprecision, i.e., a wide confidence interval (CI) around the effect estimate; and (5) publication bias, where entire studies remain unpublished.¹⁴ We graded overall certainty of evidence (CoE) for each outcome as “high,” “moderate,” “low,” or “very low.”

2.7. Data synthesis

The meta-analysis was performed using RevMan 5.3 (Cochrane). For dichotomous outcomes, risk ratios (RRs) with 95% CIs were calculated. Mean differences (MDs) with 95% CIs were adopted for continuous outcomes. Study heterogeneity was tested using a standard I^2 statistic. If I^2 was lower than 50%, heterogeneity was considered low. The entire meta-analysis was conducted using a random effects model, as a certain level of clinical heterogeneity is inevitable. If there were available data, we would carry out a necessary subgroup analysis divided by different acupuncture point selection. Potential publication bias was detected using a funnel plot constructed in RevMan 5.3, or Egger’s funnel plot constructed in Stata 13.1 (StataCorp LLC, College Station, TX, USA).

3. Results

3.1. Characteristic of included studies

We identified 827 potentially relevant publications, of which 30 met the eligibility criteria. Ultimately, 23 studies were included in the meta-analysis (Fig. 1).

The characteristics of included studies are described in Table 1. The 30 eligible studies were all performed in China and published

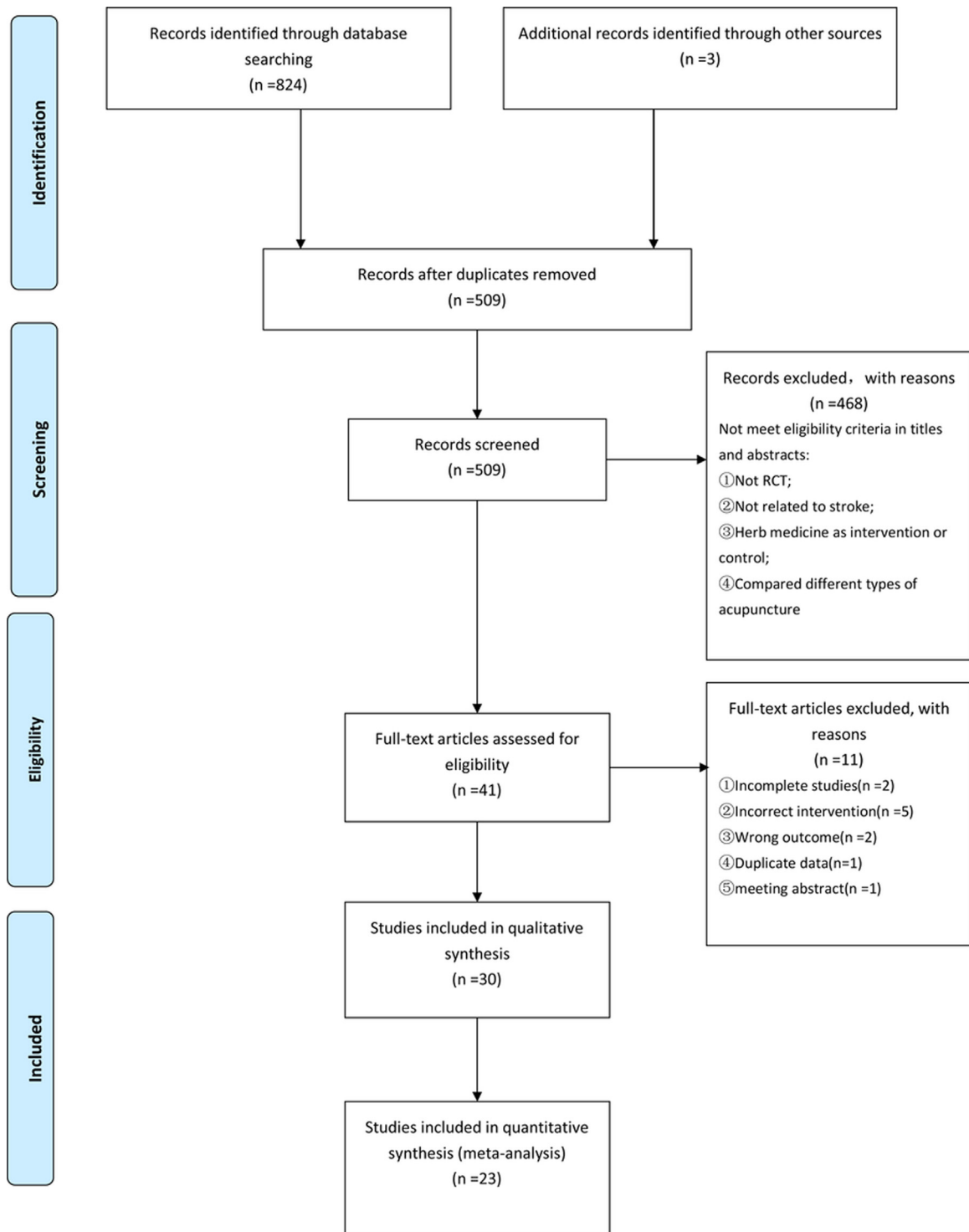


Fig. 1. Flowchart of the literature search and publication selection process.

from 2005 to 2019; 10 were three-arm trials, and 20 were two-arm trials.

3.1.1. Participants

There were 1298 participants in the treatment group and 1291 participants in the control group. In each of the groups, the minimum sample size was 16 and the maximum was 90. The mean age of patients (49.7–64.5 years) was reported in all but five studies.^{17,20,27,33,35} The duration of disease ranged from 3.5 days to 4.6 months.

3.1.2. Intervention

Treatment time ranged from 19 days to 3 months. Patients in treatment groups received manual acupuncture in 9 studies,^{15,18,26,29,30,35,37,39,43} electroacupuncture in 2 studies,^{16,17} tongue acupuncture in 4 studies,^{21,32,36,40} and a combination of manual and tongue acupuncture in 11 studies.^{20,22–25,27,33,34,38,41,42} The frequency and duration of acupuncture sessions in most studies was 20 or 30 minutes, once a day.

Overall, 34 distinct traditional acupoints (24 acupoints with international standard code in Table 1) were used for the treatment

Table 1
Characteristics of the Included Studies

Author(year)ref	Sample size Duration of disease Age (years)	Acupuncture (regimen) Acupuncture points	Comparators	Outcomes	Results	Adverse events
Zeng (2005) ¹⁵	60 NR 60.5/62.7	MA (<i>n</i> = 30) 1 time daily, 5 times weekly for 4 weeks PC6, GV26, SP6, GB20, GB12, TE17, EX-HN12, EX-HN13	ResT,TT, AT (<i>n</i> = 30) NR	CRR (FDA)	RR 1.45 [1.12, 1.88]	NR
Cui (2016) ¹⁶	66 42.2d/42.1d 56.1/56.3	EA (<i>n</i> = 33) 20 min, 1 time daily for 4 weeks EX-HN12, EX-HN13	ResT,TT, AT, ProT, SNT (<i>n</i> = 33) 20 min, 1 time daily for 5 times weekly, 4 weeks	CRR	NR, <i>P</i> < 0.05	NR
Dong (2011) ¹⁷	60 NR NR	EA (<i>n</i> = 30) 30 min, 1time daily, 5 times weekly for 4 weeks DU20, EX-HN1, GB14, ST2, DU16, ST6,ST4,RN24, RN23	ResT,TT,AT, ProT,SNT (<i>n</i> = 30) 30 min, 2 times daily, 5 times weekly, 4weeks	CRR (FDA)	RR 1.12 [0.93, 1.35]	NR
Ge (2011) ¹⁸	60 70.2d/71.4d 57.1/58.1	MA (<i>n</i> = 30) NR RN23, TE17, GB20, EX-HN12, EX-HN13	ResT, TT, AT (<i>n</i> = 30) 20 min, 1 time daily	CRR	NR, <i>P</i> < 0.05	NR
Wu(2014) ¹⁹	60 28.0 d/29.0 d 58.2/56.42	NA and TA (<i>n</i> = 30) 30 min, 1 time daily for 40 days GB20, EX-HN14, EX-HN10, EX-HN12, EX-HN13	ResT, TT, AT (<i>n</i> = 30) 30 min, 1 time daily for 40 days	(1) CRR (FDA) (2) Recovered dimensions of FDA	(1) RR 2.07 [1.40, 3.05] (2) MD 4.40 [1.36, 7.44]	NR
Hu (2011) ²⁰	180 NR NR	MA and TA (<i>n</i> = 60) 30 min, 1 time daily, 5 times weekly for 2 months DU20, EX-HN12, EX-HN13	ResT, TT, AT, ProT, SNT (<i>n</i> = 60) 1 time daily, 5 times weekly, 2 months	CRR (FDA)	RR 1.55 [1.27, 1.88]	Needle sickness (NR)
Jia (2016) ²¹	60 NR 62.3/62.37	TA(local areas of tongue) (<i>n</i> = 30) 1 time daily, 6 times weekly for 4 weeks NR	ResT, TT, AT, ProT, SNT (<i>n</i> = 30) 1 time daily, 6 times weekly for 4 weeks	CRR (FDA)	RR 1.17 [0.93, 1.48]	NR
Kang (2017) ²²	88 5.5d/5.0d 53.56/53.9	MA and TA (<i>n</i> = 44) 30 min, 1 time daily, 5 times weekly for 4 weeks DU20, EX-HN12, EX-HN13	ResT, TT, AT (<i>n</i> = 44) 20 min, 1 time daily, 5 times weekly, 4 weeks	(1) CRR (FDA) (2) Recovered dimensions of FDA	(1) RR 1.26 [1.07, 1.49] (2) MD 8.93 [6.37, 10.53]	Needle sickness (3 cases)
Lai (2011) ²³	210 3.8 m/3.5 m 61.8/59.9	MA and TA (<i>n</i> = 70) 30 min, 1 time daily, 5 times weekly for 2 months DU20, EX-HN12, EX-HN13	ResT, TT, AT, ProT, SNT (<i>n</i> = 70) 1 time daily, 5 times weekly, 2 months	CRR (FDA)	RR 1.34 [1.13, 1.60]	NR
Lao (2013) ²⁴	65 42.9d/29.8d 60.47/62.77	MA and TA(local areas of tongue) (<i>n</i> = 30) 30 min, 1 time daily RN23, EX-HN12, EX-HN13, GB20, TE17, GB12	ResT, TT, AT, ProT, SNT (<i>n</i> = 30) 1 time daily	(1) FDA (2) SI	(1) NS (2) MD 7.23 [-5.68, 20.14]	Needle sickness (NR)
Hu (2015) ²⁵	265 3.9d/3.5d 60.34/60.48	MA and TA (<i>n</i> = 89) 30 min, 1 time daily, 5 times weekly for 4 weeks DU20, EX-HN12, EX-HN13	ResT, TT, AT, ReIT, ProT, SNT, etc. (<i>n</i> = 88) 1 time daily, 5 times weekly, 4 weeks	(1) CRR (FDA) (2) Recovered dimensions of FDA	(1) RR 1.54 [1.29, 1.84] (2) MD 8.35 [6.17, 10.53]	Needle sickness (NR)
Chen (2014) ²⁶	60 121.2d/112.4d 62.18/52.2	MA (<i>n</i> = 30) 30 min, 5 times weekly for 19 days EX-HN12, EX-HN13, RN23, GB20, TE17, GB12	ResT, TT, AT, ReIT,ProT, SNT, etc. (<i>n</i> = 30) 30 min, 1 time daily, 5 times weekly, 19 days	SI	MD 5.18 [-8.29, 18.65]	NR

Table 1 (Continued)

Author(year)ref	Sample size Duration of disease Age (years)	Acupuncture (regimen) Acupuncture points	Comparators	Outcomes	Results	Adverse events
Liang (2014) ²⁷	193 NR NR	MA and TA (n = 65) 30 min, 1 time daily, 5 times weekly for 4 weeks DU20, EX-HN12, EX-HN13	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 63) 1 time daily, 5 times weekly, 4 weeks	CRR (FDA)	RR 1.34 [1.13, 1.60]	Needle sickness (NR)
Liu (2012) ²⁸	90 71.2 d/72.0 d 56.02/58.21	NA, SA and TA (n = 30) 30 min, 1 time daily, 5 times weekly for 3 months GV26, PC6, HT05, LI04, GB20, DU15, EX-HN20, EX-HN12, EX-HN13	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 30) 30 min, 1–2 times daily, 3 months	(1) CRR, (2) FDA, (3) QoL (WHOQOL-100)	(1) NR, P = 0.002 < 0.05 (2) NR, P = 0.003 < 0.05 (3) NR, P < 0.05	NR
Qian (2012) ²⁹	60 72.1d/71.3d 56.21/57.43	MA (n = 32) 40 min, 1 time daily for 30 days EX-HN20, GB20, DU15, GB12, BL10	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 28) 1 time daily, 30 days	CRR	NR, P < 0.05	Needle sickness (1 case)
Hu (2014) ³⁰	270 3.9 m/3.5 m 60/60	MA (n = 90) 30 min, 1 time daily, 5 times weekly for 1 month DU20, EX-HN12, EX-HN13, EX-HN20	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 90) 1 time daily, 5 times weekly, 1 month	CRR (FDA)	RR 1.54 [1.29, 1.84]	NR
Luo (2017) ³¹	60 73.4d/74.2d 60.16/59.2	MA and NA (local areas surrounded throat) (n = 30) NR NR	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 30) 20 min, 1 time daily, 5 times weekly	FDA	NR, P < 0.01	NR
Guo (2017) ³²	120 72.5d/72.9d 57.68/56.97	TA (n = 40) 30 min, 1 time daily, 5 times weekly for 4 weeks NR	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 40) NR	(1) CRR, (2) FDA, (3) QoL (WHOQOL-BREF)	(1) NR, P < 0.01, (2) NR, P = 0.002 < 0.05 (3) NR, P < 0.001	NR
Yu (2017) ³³	120 NR NR	MA and TA (n = 40) 30 min, 1 time daily for 1 month DU20, EX-HN12, EX-HN13	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 40) 5 times weekly	CRR (FDA)	RR 1.41 [1.12, 1.77]	Needle sickness (NR)
Zhang (2018) ³⁴	150 2.0 m/2.0 m 54/56	MA and TA (n = 50) 1 time daily for 3 months GV26, PC6, LI04, GB20, DU15, EX-HN12, EX-HN13	ResT, TT, AT (n = 50) 1 time daily, 3 months	(1) CRR, (2) FDA, (3) QoL (Unclear scale)	(1)–(3) NR, P < 0.05	NR
Zhang (2018) ³⁵	36 NR NR	MA (n = 18) 20 min, 1 time daily, 5 times weekly for 2 weeks EX-HN20, EX-HN10, EX-HN12, EX-HN13	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 18) 1 time daily, 5 times weekly, 2 weeks	FDA	NR, P < 0.05	NR
Zhao (2018) ³⁶	86 4.4 m/4.6 m 57.21/58.31	TA (local areas of tongue) (n = 43) 5 times weekly for 4 weeks EX-HN12, EX-HN13	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 43) NR	CRR (FDA)	RR 1.21 [1.02, 1.43]	NR
Bai (2013) ³⁷	32 NR 55.1/52.29	MA (n = 16) 30 min, 1 time daily, 6 times weekly for 1 month DU16, DU15, RN23, GB20	ResT, TT, AT, RelT, ProT, SNT, etc. (n = 16) 30–40 min, 1 time daily, 6 times weekly, 1 month	CRR (FDA)	RR 1.17 [0.83, 1.64]	NR
Zhong (2013) ³⁸	270 3.9 m/3.5 m 60.34/60.48	MA and TA (n = 90) 30 min, 1 time daily, 5 times weekly for 1 month EX-HN12, EX-HN13, DU20	RelT, SNT, ResT, AT, etc. (n = 90) 20 min, 1 time daily, 5 times weekly, 1 month	CRR (FDA)	RR 1.54 [1.29, 1.84]	needle sickness (6 cases)

Table 1 (Continued)

Author(year)ref	Sample size Duration of disease Age (years)	Acupuncture (regimen) Acupuncture points	Comparators	Outcomes	Results	Adverse events
Xu (2010) ³⁹	61 2.8 m/2.5 m 52.6/52.2	MA (n = 30) 30 min, 1 time daily, 5 times weekly for 9 weeks RN23, EX-HN12, EX-HN13, GB20, TE17, GB12	ResT, AT, SNT (n = 31) 30 min, 5 times weekly, 9 weeks	(1) CRR, (2) SI	(1) NR, P < 0.01 (2) MD 3.58 [-3.93, 11.09]	NR
Gao (2019) ⁴⁰	90 12.0 w/12.0 w 50.1/49.7	TA (n = 45) 30 min, 1 time daily, 5 times weekly for 2 months EX-HN20, EX-HN12, EX-HN13, DU20	ResT, TT, AT, etc. (n = 45) 30 min, 1 time daily, 3 times weekly, 2 months	CRR (FDA)	RR 1.29 [1.03, 1.61]	NR
Han (2019) ⁴¹	61 NR 53.09/53.65	MA and TA (n = 31) 30 min, 1 time daily for 1 month EX-HN12, EX-HN13, DU20	ResT, TT, AT, ReIT, ProT, SNT, etc. (n = 30) 5 times weekly, 1 month	(1) CRR (FDA) (2) Recovered dimensions of FDA	(1) RR 1.28 [1.01, 1.61] (2) MD 6.01 [5.11, 6.91]	NR
Hao (2018) ⁴²	92 NR 57.51/59.27	MA and TA (n = 46) 4 weeks EX-HN12, EX-HN13, DU20, EX-HN10	ResT, TT, AT, ReIT, ProT, SNT, etc. (n = 46) NR	(1) CRR, (2) FDA, (3) QoL (SS-QoL)	(1) NR, P = 0.027 < 0.05 (2) NR, P < 0.05 (3) NR, P = 0.000 < 0.05	NR
Hao (2018) ⁴³	120 1.0 m/1.0 m 59.3/59.6	MA (n = 60) 1 time every two days for 4 weeks EX-HN12, EX-HN13, DU20, EX-HN10	ResT, TT, AT, ReIT, ProT, SNT, etc. (n = 60) 30 min, 1 time daily, 4 weeks	(1) CRR (FDA) (2) Recovered dimensions of FDA	(1) RR 1.50 [1.20, 1.88] (2) MD 5.64 [3.09, 8.19]	NR
Sun (2014) ⁴⁴	72 13.3d/14.4d 62.23/64.53	NA (n = 36) 1 time daily for 2 months GB20, GB12	ResT, TT, AT, etc. (n = 36) 20 min, 1 time daily, 2 months	(1) CRR, (2) Recovered dimensions of FDA	(1) NR, P = 0.036 < 0.05 (2) MD 2.02 [0.80, 3.24]	NR

Note: d: days; w: weeks; m: months; min: minutes; CRR: the Clinical Response Rate; FDA: The Frenchay Dysarthria Assessment; SI: Speech Intelligibility; QoL: Quality of Life; NR: not reported; NS: No Significant differences; MA: manual acupuncture; EA: electroacupuncture; NA: nape acupuncture; TA: tongue acupuncture; SA: scalp acupuncture; ResT: respiratory training; TT: tongue training; ReIT: relaxation training; AT: articulation training; ProT: prosody training; SNT: the training of surmounting nasalization.

of PSD. The five acupuncture points with the highest frequency were Jinjin (EX-HN12), Yuye (EX-HN13), Lianquan (RN23), Baihui (DU20), and Fengchi (GB20). The number of acupuncture points used in each study ranged from approximately 2 to 12. With regard to speech rehabilitation training, the included studies used respiratory, tongue, relaxation, articulation, prosody, and nasalization training. The frequency of speech rehabilitation training in most studies was 20 or 40 minutes, once or twice daily.

3.1.3. Outcomes

The clinical response rate was used as an outcome measure in 26 trials, 17 of which adopted FDA as the evaluation criterion. Six studies reported the number of FDA dimensions for which patients achieved recovery (normal task/movement/sound).^{19,22,25,41,43,44} Three RCTs reported the FDA score, calculated by assigning values to the 28 dimensions,^{24,35,42} although the algorithms employed differed between studies. Three studies used speech intelligibility as an outcome measure.^{24,26,39} In four trials, quality of life was assessed, although different scales were used between the trials (WHOQOL-100, WHOQOL-BREF, Stroke Specific Quality of Life Scale/SS-QoL, and unclear).^{28,32,34,42} Only eight publications reported adverse events, including subcutaneous hemorrhage and pain during needle penetration.^{20,22,24,25,27,29,33,38} All outcomes are listed in Table 1.

3.2. Risk of bias assessment

Details of risk of bias assessment for each study are presented in Fig. 2. The randomization procedure was described in 12 of 30 studies, for example, referring to a random number table, using a computer-generated random number sequence, or using

sealed envelopes.^{17,21–25,32,36,38–40,42} However, five trials used non-random methods, such as a sequence generated based on hospital or clinic numbering systems.^{16,19,26,33,35} As for allocation concealment, only one trial was assessed as low risk; all others were undetermined. In terms of blinding, only three studies were assessed as low risk, as in these, participants, personnel, and outcome assessors were blinded.^{23,24,38} As for incomplete outcome data, seven trials contained instances of participation withdrawal cases,^{20,23–25,30,38,44} only one of which employed intention-to-treat analysis.²⁴

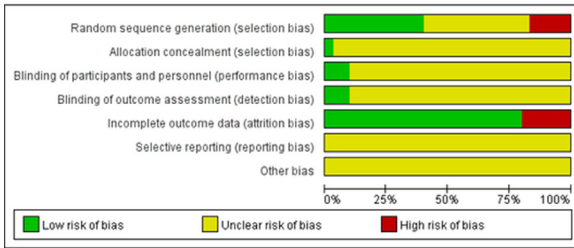
3.3. Meta-analysis Results

3.3.1. Clinical response rate based on the FDA

Clinical response rate based on the FDA was assessed in 17 studies, involving 1685 participants, to compare the effects of ACWSRT with those of SRTA. In these trials, patients receiving ACWSRT exhibited a statistically significant reduction in dysarthria after stroke, compared with that of patients receiving SRTA. In our meta-analysis, we calculated RR, with low amounts of heterogeneity observed, indicating that ACWSRT improved the clinical response rate for PSD better than did SRTA (RR = 1.37, 95% CI [1.29, 1.46], $P < 0.01$, $I^2 = 34%$) (Fig. 3).

Furthermore, in six studies, involving 563 PSD patients, the number of FDA dimensions for which patients achieved recovery was calculated. Upon meta-analysis, the ACWSRT treatment group exhibited a statistically significantly higher number of improved FDA dimensions (MD = 5.82, 95% CI [3.64, 7.99], $P < 0.01$, $I^2 = 89%$) than that of the SRTA group. This indicated a potential 5.82 times improvement of ACWSRT patients over that of SRTA patients for

(A) Risk of bias graph



(B) Risk of bias summary

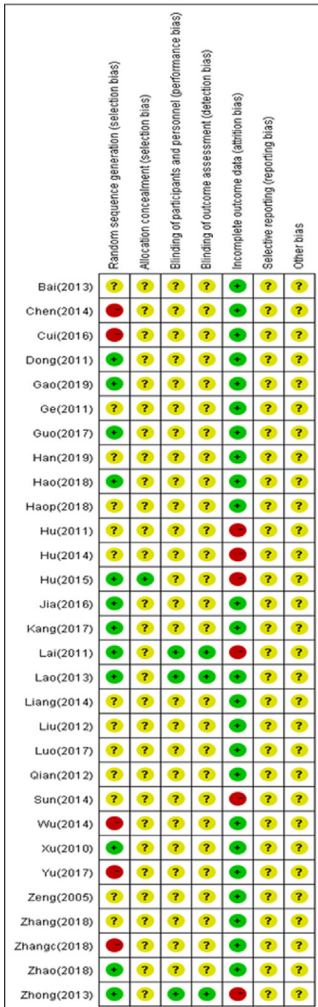


Fig. 2. (A) Risk of bias graph; (B) Risk of bias summary.

the 28 dimensions of FDA; however, these populations exhibited severe heterogeneity (Fig. 3).

3.3.2. Speech intelligibility

In the three studies where speech intelligibility was measured, meta-analysis revealed no statistically significant difference between the ACWSRT and SRTA groups (MD = 4.63, 95% CI [-1.22, 10.48], $P=0.12$, $I^2=0\%$) (Fig. 3).

3.3.3. Quality of life

In four trials, quality of life was assessed. Meta-analysis revealed that, in the two trials using World Health Organization Quality

of Life questionnaires, ACWSRT yielded statistically significantly better improvement than did the SRTA. This effect was observed in all four domains: physiological domain MD=29.47 (95% CI [25.16, 33.78], $P<0.01$, $I^2=0\%$), psychological domain MD=25.60 (95% CI [21.69, 29.51], $P<0.01$, $I^2=0\%$), social relationship domain MD=23.32 (95% CI [19.17, 27.48], $P<0.01$, $I^2=0\%$), and environmental domain MD=32.93 (95% CI [28.86, 37.00], $P<0.01$, $I^2=0\%$).

3.3.4. Safety evaluation

In 22 RCTs, adverse events were not discussed. Of the eight trials in which slight pain and subcutaneous hemorrhage during acupuncture treatment was reported, precise numbers were only reported in four. No serious or frequently occurring adverse events were reported in any of the studies. As reporting of these adverse effects was not standardized in most studies, we did not attempt to conduct quantitative analysis thereof.

3.4. Certainty of evidence

Although GRADE assessment revealed a high CoE for the RCT (Table 2), we downgraded their CoE because of the risk of bias and small sample size. We rated the meta-analysis CoE as low, or very low (as a summary of the findings of key outcomes). The CoE of the results of the meta-analysis of the 17 studies assessing clinical response rate based on the FDA was downgraded to low because of a high risk of bias ($n=1685$, RR=1.37 95% CI [1.29, 1.46]). All secondary outcomes were also downgraded. The CoE of meta-analysis of the trials that assessed FDA dimensions was very low and the CoE of meta-analysis of speech intelligibility was low.

3.5. Publication bias

Of 30 studies, 17 reported results for the primary outcome. Based on these trials, we produced a funnel plot to assess potential publication bias. The funnel plot was approximately symmetric, upon visual inspection. Egger's funnel plot also suggested no obvious publication bias ($P=0.398$) (Fig. 4 A and B).

4. Discussion

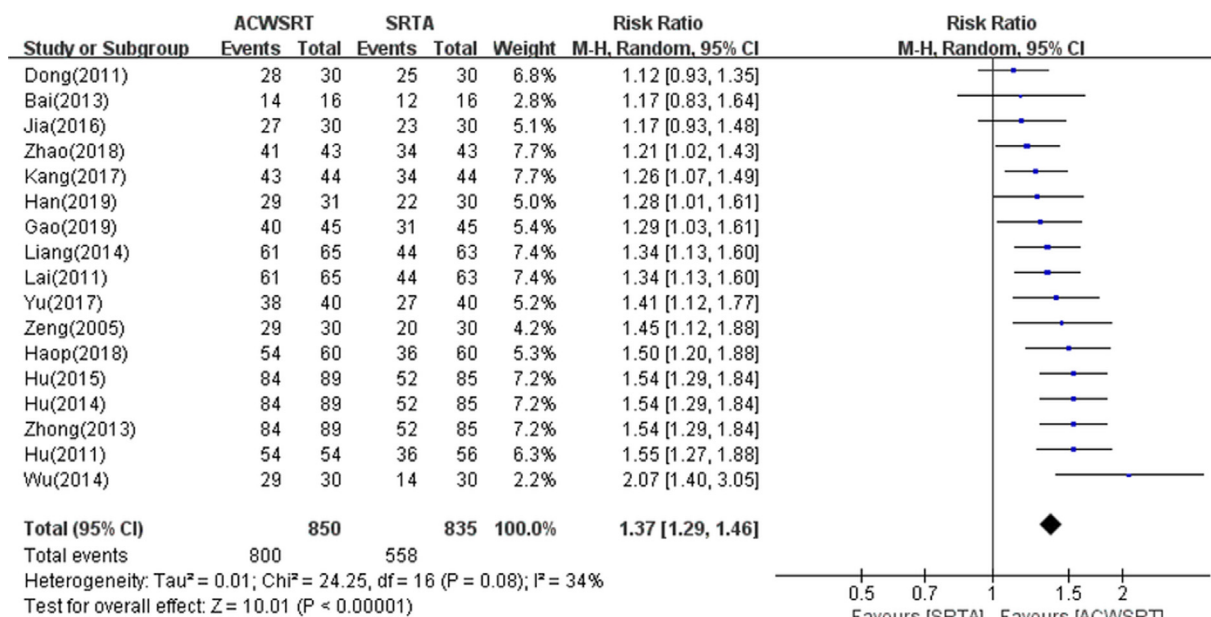
4.1. Summary of main results

Our study revealed that, compared with speech rehabilitation training alone, additional acupuncture has a beneficial effect on clinical response rate (when using FDA for evaluation), based on low-quality evidence. Furthermore, no serious adverse events were reported among the studies analyzed.

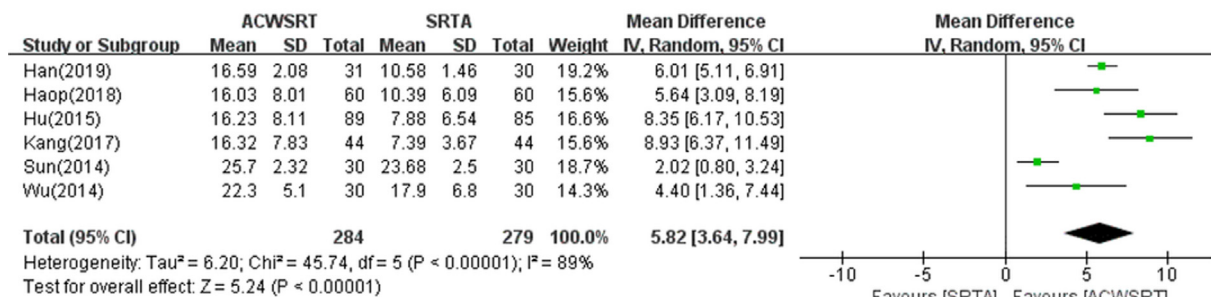
4.2. Overall completeness and applicability of evidence

In this systematic review and meta-analysis, 30 RCTs met our inclusion criteria, involving 2589 subjects with PSD. With regard to the generalizability of our findings, our inclusion criteria allowed for a wide range of patients, including adults of different ages and with different durations of disease. Among patients not represented in the study populations were those with dysarthria from causes other than stroke. Thus, our findings do not apply to patients who are at risk of developing dysarthria resulting from other conditions (e.g., Parkinson's or brain tumors), or to children with dysarthria. We also included patients treated with different acupoints, treatment duration, and frequency. In addition, inter-operator treatment techniques were not monitored for consistency in terms of acupuncture and speech rehabilitation training, thus affecting clinical practice. Moreover, we included studies where FDA was used to evaluate the clinical response rate. FDA is composed of 28 dimensions, grouped under the headings: reflex,

(A) Clinical response rate



(B) recovered dimensions of the FDA



(C) Speech Intelligibility

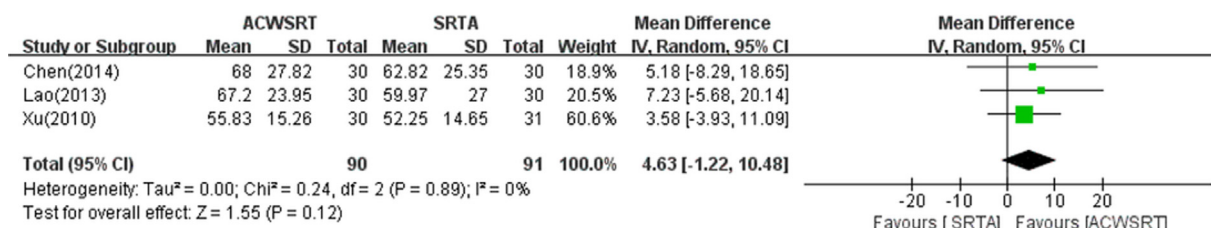





Fig. 3. Forest plot of the (A) clinical response rate; (B) recovered dimensions of the FDA; (C) Speech Intelligibility.

respiration, lips, jaw, palate, laryngeal, tongue, and intelligibility. Each dimension is rated from "a" ("normal task/movement/sound") to "e" ("unable to undertake task/movement/sound").⁴⁵ Although 26 studies were conducted with the use of the universally accepted FDA to measure the primary outcome, only 17 applied the standard algorithm; in 6 studies, non-standard criteria were used, and in 3 studies, self-made algorithms were used. Therefore, not all 26 could be pooled for synthesis. The original FDA data, such as the rate change of each dimension, were not acquired.

Most of the outcome assessment instruments for PSD are subjective and rely on patients' and therapists' feelings and expectations. We excluded clinical trials implementing different, less widely-accepted assessment instruments.

PSD can affect quality of life, for example, impairing communication and activities. However, few trials reported health-related quality of life and patient satisfaction. Finally, the number of trials reporting adverse events was inadequate.

Table 2
The Summary of Findings

Acupuncture combined with speech rehabilitation training compared with speech rehabilitation training alone for people with post-stroke dysarthria					
Patient or population: patients with post-stroke dysarthria					
Intervention: acupuncture combined with speech rehabilitation training					
Comparison: speech rehabilitation training alone					
Outcomes	No. of participants (studies) Follow-up	Certainty of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with SRTA	Risk difference with ACWSRT
Clinically response rate	1685 (17 RCTs)	 LOW ^a	RR 1.37 (1.29–1.46)	Study population	
				668 per 1000	247 more per 1000 (194 more to 307 more)
				Moderate	
				689 per 1000	255 more per 1000 (200 more to 317 more)
FDA	563 (6 RCTs)	 VERY LOW ^b	–	The mean the FDA rate was 0	MD 5.82 higher (3.64 higher to 7.99 higher)
Speech intelligibility	181 (3 RCTs)	 LOW ^c	–	The mean speech intelligibility was 0	MD 4.63 higher (1.22 lower to 10.48 higher)

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI). **CI:** confidence interval; **RR:** risk ratio; **MD:** mean difference

GRADE Working Group grades of evidence

High certainty: we are very confident that the true effect lies close to that of the estimate of the effect

Moderate certainty: we are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. There were 6 studies with high risk of bias due to incomplete outcome data and 2 studies with high risk of bias due to random and blinding. There were 10 studies with low risk of bias in random and blinding. The result should be downgraded because of high risk of bias.

b. 3 included studies have high risk of bias and the funnel plot illustrated in RevMan software showed that the left and right symmetry was not acceptable. There is a small sample in these studies. The inconsistency should also be downgraded because this outcome measurement has not been standardized and universally accepted.

c. 1 included study has high risk of bias and there is a small sample in these studies.

4.3. Quality of evidence

Analysis with the Cochrane risk-of-bias tool revealed a high risk of bias due to inadequate random sequence generation and incomplete outcome data, which failed methodological quality. Other potential limitations included uncertainty of blinding measures, which increases the risk of selection and performance bias. Publication bias assessment revealed a generally acceptable quality of reporting. Using GRADE assessment, we rated the CoE as low-very low.

4.4. Potential bias in the review process

This systematic review was conducted following Cochrane Collaboration guidelines. The selection process was based on PRISMA guidelines. We maximized the number of studies available for our review, by searching seven Chinese and English language databases. Study selection, risk-of-bias assessment, and data extraction were performed by two different reviewers, which reduced the risk of error. However, the possibility of missing data cannot be excluded.

4.5. Implications for practice

The data from the studies we reviewed are promising. The additional use of acupuncture appears to be an effective strategy for improving recovery of PSD patients. In

12 of the trials, Jin's three-needle tongue acupuncture was employed.^{20,22,23,25,27,28,30,33,38,40–42} For this technique, the first needle is placed 1 cun above Lianquan (RN23); the second and third needles are placed 0.8 cun on either side of Lianquan(RN23). There were two common acupoint groups: the first combined three-needle tongue acupuncture with Jinjin (EX-HN12), Yuye (EX-HN13), and Baihui (DU20)^{20,22,23,25,27,30,33,38,40–42}; the second placed needles at Jinjin (EX-HN12), Yuye (EX-HN13), Lianquan (RN23), and Fengchi (GB20).^{15,18,19,24,26,28,34,39}

4.6. Implications for research

First, our study emphasizes the need for standardization of acupuncture RCTs, including protocol design, needling technique, outcome assessment, and trial reporting. The latter can be achieved by following Consolidated Standards for Reporting of Trials (CONSORT) guidelines.

Second, we support the use of validated instruments and objective measures in clinical trials for PSD, as well as the detailed reporting of criteria and algorithms used to measure clinical response or clinical effectiveness.

In conclusion, our review suggests that ACWSRT is a promising option for improving speech and language function for PSD patients. Further RCTs are warranted, employing rigorous study designs, universally accepted outcome measures, and validated instruments. Furthermore, future studies should measure relia-

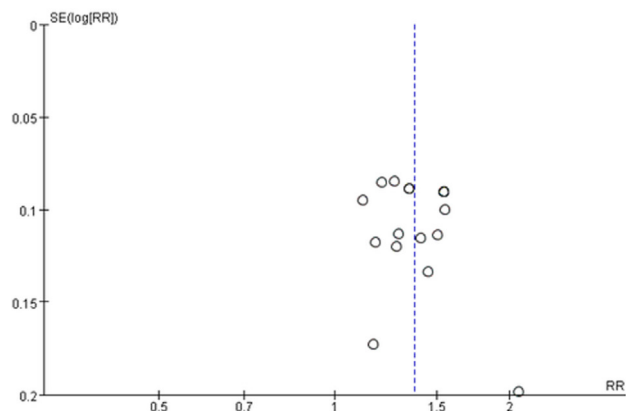
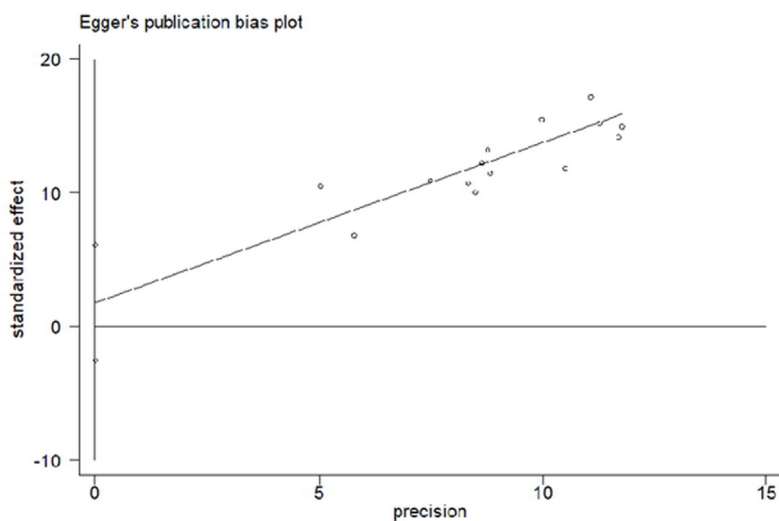
(A) The funnel plot**(B) Egger's test**

Fig. 4. (A) The funnel plot; (B) Egger's test.

bility, validity, responsiveness, and minimal clinical important difference of outcome measurement tools.

Author contributions

Conceptualization: QX; Data curation: QX, XC; Formal analysis: QX; Funding acquisition: XG; Investigation: QX, XC, JX, JL, RL; Project administration: XG; Supervision: XG, JC, LY, SL, HY; Validation: QX; Visualization: QX; Writing - Original Draft: QX; Writing - Review & Editing: QX, XG.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Ethical statement

No ethical approval was required for this manuscript because this study did not involve human subjects or laboratory animals.

Data availability

The authors confirm that the data supporting the findings of this study will be made available on request.

Supplementary material

Search strings and forest plot of QoL, can be found in the online version, at [doi:10.1016/j.imr.2020.100431](https://doi.org/10.1016/j.imr.2020.100431).

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