The treatment of post-stroke dysarthria with a combination of different acupuncture types and language rehabilitation training: a systematic review and network meta-analysis

Xinming Yang[1,2#], Lei Shi[1,2#], Dawei Ran[1,2], Menghan Li[1,2], Chenyang Qin[1,2], Zimeng An[1,2]

[1]Clinical Department of Acupuncture and Moxibustion, First Teaching Hospital of Tianjin University of Traditional Chinese Medicine, Tianjin, China; [2]National Clinical Research Center for Chinese Medicine Acupuncture and Moxibustion, Tianjin, China

Contributions: (I) Conception and design: X Yang, L Shi; (II) Administrative support: X Yang, L Shi, D Ran; (III) Provision of study materials or patients: D Ran, M Li, C Qin; (IV) Collection and assembly of data: X Yang, L Shi; (V) Data analysis and interpretation: X Yang, L Shi, Z An; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Lei Shi. First Teaching Hospital of Tianjin University of Traditional Chinese Medicine, Tianjin, China; National Clinical Research Center for Chinese Medicine Acupuncture and Moxibustion, Tianjin, China. Email: shilei1978ster@gmail.com.

Background: This study used a network meta-analysis to evaluate the efficacy of various different acupuncture types and language rehabilitation training on post-stroke dysarthria (PSD), and examined the possible mechanisms involved. There are often clinical studies comparing the effects of different acupuncture methods on dysarthria after stroke. The efficacy of these methods can be ranked by network meta-analysis. This is necessary for clinical acupoints selection. The results of this study illustrated the comparison of the therapeutic effects of 6 different acupuncture types, which can provide some reference for clinical acupoints selection and research.

Methods: A comprehensive search for clinical studies related to the use of acupuncture to treat PSD was conducted in eight English and Chinese databases. Patients were divided into six groups based on the acupoints selected, namely, tongue, neck, scalp, body, combination, and traditional acupuncture. The recovery of neurological function in the patients was assessed based on the curative impact and the National Institutes of Health Stroke Scale (NIHSS) score. The quality of the included studies was evaluated using the Cochrane risk bias assessment tool and the STandards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA) criteria. A network meta-analysis was performed using the network-meta package of Stata 15.1 software based on frequency. The heterogeneity test, consistency test, head-to-head mixed comparison, efficacy ranking, and publication bias study were all performed.

Results: A total of 47 studies were finally included. There was a total of 4,197 patients in the eligible studies. The model for network meta-analysis proved robust, with minimal heterogeneity and high consistency. Combined acupuncture combined with language rehabilitation training was the most effective in treating dysarthria symptoms, followed by tongue acupuncture (TA) and nape acupuncture (NA). In addition, the combined effect of acupuncture and language training was superior to that of acupuncture alone. In terms of recovery of nerve function, traditional acupuncture and body acupuncture were more effective. To facilitate the recovery of nerve function, increasing the frequency of acupoints is necessary.

Conclusions: Combined acupuncture may have the most beneficial healing effect on PSD, followed by acupuncture of the tongue and the nape of the neck. In terms of recovery of nerve function, traditional acupuncture and body acupuncture may have more effective.

Keywords: Post-stroke dysarthria (PSD); acupuncture; different acupuncture types; language rehabilitation training; network meta-analysis

Submitted Oct 26, 2022. Accepted for publication Dec 07, 2022.

doi: 10.21037/atm-22-5583

View this article at: https://dx.doi.org/10.21037/atm-22-5583

Introduction

Dysarthria is a neuromotor language disorder. Thirty years ago, clinical observations led Darley *et al.* to propose a hypothesis of injury localization. Based on the diagnosis of potential nerve matrix damage and auditory-perceptual characteristics, neurological dysarthria can be classified into seven main types, namely, flaccid, spastic, ataxic, hypokinetic, hyperkinetic, unilateral upper motor neuron, and mixed, which includes bulbar palsy (lower motor neuron lesion), pseudobulbar palsy (upper motor neuron lesion), amyotrophic lateral sclerosis (lesions to both upper and lower motor neurons), cerebellar disorders (lesions to the cerebellum), parkinsonism (extrapyramidal lesion), dystonia (extrapyramidal lesion), and chorea (extrapyramidal lesion) (1,2). Dysarthria is characterized by muscular weakness of the tongue, chin, lips, and throat, as well as uncoordinated respiratory control, dysphonia, resonance disorders, and disorders of speech fluency (3,4). Of these characteristics, dysphonia can occur in all types of dysarthria, manifested as atypical excessive changes in sound quality, pitch, and volume (1,5). These characteristics may be associated with atypical involuntary movement and caused by disorders of basal ganglia or cerebellar control circuits (6). Current treatments for dysarthria include speech training, Lee Silverman Voice Treatment (LSVTLOUD), oral-motor therapy, proprioceptive neuromuscular facilitation (PNF) therapy, hyperbaric oxygen (HPO) therapy, phonation myoelectric stimulation, music therapy, psychotherapy, and traditional medicinal therapy. Dysarthria can be caused by a variety of factors, including degenerative diseases, congenital dysarthria, trauma, inflammation, and stroke.

Stroke is associated with high incidence, mortality, disability, and recurrence. Dysarthria, as one of the main symptoms caused by medulla oblongata paralysis after stroke, can occur in 41% of stroke patients (7). More precisely, both flaccid dysarthria and spasmodic dysarthria can develop following brainstem strokes; repeated strokes can result in bilateral upper motor neuron damage and spastic dysarthria; and ataxia dysarthria can arise from cerebellar circuit disruption. Vascular lesions that cause dysarthria usually involve the superior cerebellar artery, posterior-inferior cerebellar artery, or anterior-inferior cerebellar artery. Additionally, stroke in the basal ganglion circuit can result in dyskinesia and hyperactive dysarthria. Stroke is by far the most prevalent cause of unilateral superior motor neuron dysarthria, which can result from obstruction of the left or right carotid artery and the middle cerebral artery. In addition, mixed dysarthria is also common. Motor neuron disease (MND) patients can experience mixed dysarthria induced by bulbar spasms and relaxation (8-10). Post-stroke dysarthria (PSD) symptoms are easily overlooked, causing patients to fail to seek help from medical and rehabilitation facilities in a timely manner. This failure may lead to significant negative impacts on the patient's social life (11). Rehabilitation training is helpful in restoring a patient's autonomous eating ability and language ability, thereby empowering patients to live a more active life (12). However, there have been limited studies on the clinical effects of various cognitive rehabilitation and therapy options for aphasia and dysarthria (4). New therapies, such as stem cell therapy, repetitive transcranial magnetic stimulation, transcranial direct current stimulation, motor imagery, virtual reality, and new robotic therapies, have also been introduced in recent years (13-18). Furthermore, the National Institute for Health and Care Excellence (NICE) guideline on MND evaluation and management published in February 2019 recommends scheduling language therapists (SLT) and Augmentative and alternative communication (AAC) services. Combining SLT with neurology intervention allows patients to be evaluated and treated with SLT at diagnosis (19,20).

In recent years, the coronavirus disease caused by the SARS-CoV-2 virus, COVID-19, has been spreading

Highlight box

Key findings

- Combined acupuncture, tongue acupuncture, and nape acupuncture may be superior to other types of acupuncture in the recovery of language function in patients with post-stroke dysarthria.

What is known and what is new?

- Tongue acupuncture is more effective than traditional acupuncture for post-stroke dysarthria.
- Combined acupuncture, tongue acupuncture, and nape acupuncture may be more effective than body acupuncture and scalp acupuncture for the recovery of language function in patients with post-stroke dysarthria. And acupuncture combined with language training is more conducive to recovery than simple language training.

What is the implication, and what should change now?

- This means that for patients with post-stroke dysarthria, the effect of acupuncture near the articulation structure is better than that of acupuncture at the head and other parts of the body. It has very important significance for clinical acupoints selection.

worldwide. COVID-19 can infiltrate the nervous system, causing central and peripheral nervous system injuries, such as loss of sense of smell, confusion, encephalopathy, seizures of Guillain-Barre syndrome, and stroke. Many of these neurological manifestations can also lead to dysphagia, dysphonia, and dysarthria (21-23). A study has shown that predictors of dysphagia, dysphonia, and dysarthria are a combination of previous diseases, neurological manifestations, and history of intubation (24).

There is an urgent need to treat language disorders, dysphonia, and the consequences of dysarthria caused by various factors, but there is little evidence in the available literature. Acupuncture is a treatment modality from traditional Chinese medicine. At present, there is a lot of randomized controlled trials (RCTs) of acupuncture treatments for PSD reported in medical journals. Studies (25-28) have shown that tongue acupuncture (TA) and nape acupuncture (NA) are effective in the treatment of PSD, and clinical trials have been performed to verify that TA combined with NA and articulation training is effective in the treatment of PSD. Other studies have also reported the comparison of curative effects between different acupuncture methods, such as research on NA versus TA and scalp acupuncture (SA) (29,30), scalp needle versus body acupuncture (31), body acupuncture versus traditional acupuncture (32), combined acupuncture versus other acupuncture methods (33-35), etc. This reflects that there are many acupuncture methods to treat PSD in clinic, and it is necessary to explore the method with the better effect. However, it is difficult to design a randomized trial that includes control groups of all acupuncture types in clinical research. This current study used econometric analysis to determine the difference in therapeutic effects of different acupuncture types combined with language training for the treatment of dysarthria based on available clinical research data. Acupuncture treatments for dysarthria were divided into six groups based on the selected acupoints, including TA, neck acupuncture, SA, body acupuncture, traditional acupuncture, and compound acupuncture. A network meta-analysis was undertaken to investigate the efficacy of the six acupuncture modalities described above. In addition, the mechanisms of action of acupuncture in the treatment of PSD were summarized and inferred based on existing research. This investigation will provide a reference for the selection of clinical treatment acupoints and further the understanding of the mechanisms involved in acupuncture. We present the following article in accordance with the PRISMA-NMA reporting checklist (available at https://atm.amegroups.com/article/view/10.21037/atm-22-5583/rc).

Methods

The methodology in the present study was developed in reference to traditional meta-analysis and network meta-analysis in the PRISMA statement (36-38), as well as the system review in the Cochrane Handbook (39). The study was registered in PROSPERO with the registration number CRD42022322100 (25), and the research progress was updated in real-time during the implementation process.

Literature search strategies

Eight English and Chinese databases, including PubMed, Embase, Cochrane Library, Web of Science, CNKI, Wanfang database, Chongqing VIP database, and China Biology Medicine disc (CBMdisc), were searched for literatures related to dysarthria and acupuncture. The search words in PubMed included the following: “Dysarthrias”, “Flaccid Dysarthria”, “Hypokinetic Dysarthria”, “Scanning Dysarthria”, “Spastic Dysarthria”, “Hyperkinetic Dysarthria”, “Guttural Dysarthria”, “Mixed Dysarthria”, “stroke”, “Cerebrovascular Accident”, “CVA”, “Cerebrovascular Apoplexy”, “Brain Vascular Accident”, “Cerebrovascular Stroke”, “Apoplexy”, “Cerebral Stroke”, “Acute Stroke”, “Acute Cerebrovascular Accident”, “Acupuncture”, “electroacupuncture”, “electro-acupuncture”, and “electric acupuncture”. Literatures published from the inception of the database to March 2022 were included, with no restrictions on the language. The literature search process was conducted by two researchers and the results were discussed and summarized. The PubMed retrieval strategy is shown in *Table 1*.

Inclusion and exclusion criteria

Participants

Participants were patients with PSD, and there were no restrictions on the type of stroke, patient gender, age, nor course of the disease. Patients with dysarthria not caused by stroke, or complete aphasia, were excluded.

Interventions

The intervention group underwent acupuncture treatment for PSD, which could be combined or not combined with language training. The acupuncture types the studies used should be included in the six acupuncture types of

Table 1 The PubMed literature retrieval strategy

Number	Query
#1	dysarthrias(MeSH Terms)
#2	((((((Dysarthrias(Title/Abstract)] OR (Flaccid Dysarthria(Title/Abstract)]) OR (Hypokinetic Dysarthria(Title/Abstract)]) OR (Scanning Dysarthria(Title/Abstract)]) OR (Spastic Dysarthria(Title/Abstract)]) OR (Hyperkinetic Dysarthria(Title/Abstract)]) OR (Guttural Dysarthria(Title/Abstract)]) OR (Guttural Dysarthria(Title/Abstract)]
#3	#1 or #2
#4	(Stroke(MeSH Terms)] OR (strokes(MeSH Terms)]
#5	(((((((((((stroke(Title/Abstract)] OR (strokes(Title/Abstract)]) OR (Cerebrovascular Accident(Title/Abstract)]) OR (Cerebrovascular Accidents(Title/Abstract)]) OR (CVA(Title/Abstract)]) OR (CVAs(Title/Abstract)]) OR (Cerebrovascular Apoplexy(Title/Abstract)]) OR (Brain Vascular Accident(Title/Abstract)]) OR (Cerebrovascular Stroke(Title/Abstract)]) OR (Apoplexy(Title/Abstract)]) OR (Cerebral Stroke(Title/Abstract)]) OR (Acute Stroke(Title/Abstract)]) OR (Acute Cerebrovascular Accident(Title/Abstract)]
#6	#4 or #5
#7	(acupuncture(MeSH Terms)] OR (electroacupuncture(MeSH Terms)]
#8	((acupuncture(Title/Abstract)] OR (electroacupuncture(Title/Abstract)]) OR (electric acupuncture(Title/Abstract)]
#9	#7 or #8
#10	#3 and #6 and #9

this research. Otherwise, it will be excluded. Language training should include pronunciation training, speech discrimination, intonation, rhythm, speed training, which are training methods for articulation. In addition, any research on a third intervention measure was excluded, such as combined massage, combined electrical stimulation, or combined moxibustion.

Controls

In order to ensure the consistency of the network meta-analysis, the control group should be the one in the six acupuncture types, which could be combined or not combined with language training. And the simple language training. Controls other than acupuncture and language training were excluded.

Outcome

The primary outcome index of this study was the curative effect, with the Frenchay dysarthria assessment scale score or other language function rating scales used as evaluation indicators. If the evaluation grade improved, the results were valid; otherwise, they were invalid. The National Institutes of Health Stroke Scale (NIHSS) was used as a secondary outcome indicator to evaluate the recovery of neurological function.

Study

The included studies were clinical randomized controlled trials of acupuncture for the treatment of PSD. Non-randomized controlled trials, semi-randomized controlled trials, animal experiments, medical record reports, systematic evaluation or review, qualitative studies, conference reports, and graduation theses were all excluded.

Study selection and data extraction

An information extraction table was created to collate the necessary data, including basic patient information, eligibility, characteristics, risk bias evaluation of the research methodology, and patient outcomes. According to the inclusion and exclusion criteria, 47 trials were included in the current investigation. To avoid subjective bias, two researchers independently screened the studies and extracted the information, and any disagreements were resolved through discussion. The main contents of the included studies are shown in the information summary table.

Risk of bias assessment

The quality evaluation was performed using the Cochrane bias risk assessment tool (26), which involved selection bias, performance bias, attrition bias, reporting bias, and other biases. Bias was graded into three categories, namely, "low risk", "high risk", and "unclear." Risk assessment was independently conducted by two researchers and any disputes were resolved through discussion.

Report quality assessment of included RCTs

The STandards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA) criteria (40) was used to evaluate the design quality of acupuncture clinical trials. There are six categories in the STRICTA criteria, and each category includes some subcategories, with 17 entries, and 6 scores in total. If the score is less than 2, the report quality is "poor". If the score is between 2-4, the report quality is "medium". If the score is more than 4, the report quality is "good". These items were used to evaluate acupuncture rationale, details of needling, treatment regimen, other components of treatment, practitioner background, and control or comparator interventions. The scoring table by two researchers independently after the training. If the research meets the classification criteria, 1 point will be given; otherwise, 0 point will be given. The categories with subcategories were divided equally to score, with one as the denominator and the number of subcategories as the numerator. The scoring criteria were consistent with the similar study published previously (41). Cohen's κ- statistic was used to evaluate the consistency of the results. SPSS software version 26.0 was used for statistic. The STRICTA scores were summarized by median and interquartile ranges.

Grouping according to the six acupuncture types

According to the different therapeutic acupoints, patients were divided into the following six groups: SA, tongue acupuncture (TA), neck acupuncture (NA), body acupuncture (BA), combined acupuncture (CA), and traditional acupuncture (TDA). The TDA group underwent treatment acupoints recommended in the teaching materials, consensus, or guidelines on PSD, including GB20 (fengchi), SJ17 (yifeng), DU15 (yamen), PC6 (neiguan), HT5 (tongli), DU26 (shuigou), SP6 (sanyinjiao), ST36 (zusanli), REN23 (lianquan), Jinjin, and Yuye. The SA group used the scalp acupoints as the experimental acupoints or increased the number of scalp acupoints based on TDA. The TA group used the tongue acupoints as the experimental acupoints or increased the number of tongue acupoints and stimulation based on TDA. The NA group used neck acupoints as the experimental acupoints or increased the number of neck acupoints based on TDA. The BA group used body acupoints as the experimental acupoints or increased the number of body acupoints and manipulation based on TDA. The CA group selected and combined more than two methods from SA, TA, NA, and BA as the experimental group.

Statistical analysis

The network meta-analysis of this study was performed using the frequency framework under the PRISMA network meta-analysis guideline (36,42). Throughout the data analysis process, the network-meta software package in Stata 15.1 was used to create network evidence plots, comparison-adjusted plots, inconsistency test plots, prediction interval plots, and Sucra probability plots. A random-effects model was used for network meta-analysis.

Efficacy was presented as a binary variable, using the odds ratio (OR) with 95% confidence interval (CI) as the effect size. The NIHSS score was presented as continuous variables, using mean difference (MD) with 95% CI as the effect size. Used P value as the statistical effect value. If P value >0.05, the difference is not statistically significant. If P value ≤0.05, the difference is statistically significant. The index, I^2, was used to represent the heterogeneity of direct comparison among studies (43). When $I^2 \leq 50\%$, the heterogeneity was considered to be low; when $I^2 > 50\%$, the heterogeneity was considered to be high.

The consistency of the main outcome indicators was tested with three methods. First, as a method of checking loop consistency, the inconsistency factor (IF) test was used to compare the variable to zero, and if the result contained zero, the consistency was favorable. Second, the node-splitting method was used to verify whether the results of the direct comparison are consistent with that of the indirect comparison (44). Third, a prediction interval chart was drawn to reflect the consistency between mixed comparison and prediction value. The secondary outcome indicators were tested using the IF test and node splitting method.

A chart was created to represent the head-to-head mixed comparison of network meta-analysis. The Sucra cumulative probability was used to rate the efficacy of interventions, and the comparison-adjusted plot was used to investigate publication bias for more than ten comparison items (45).

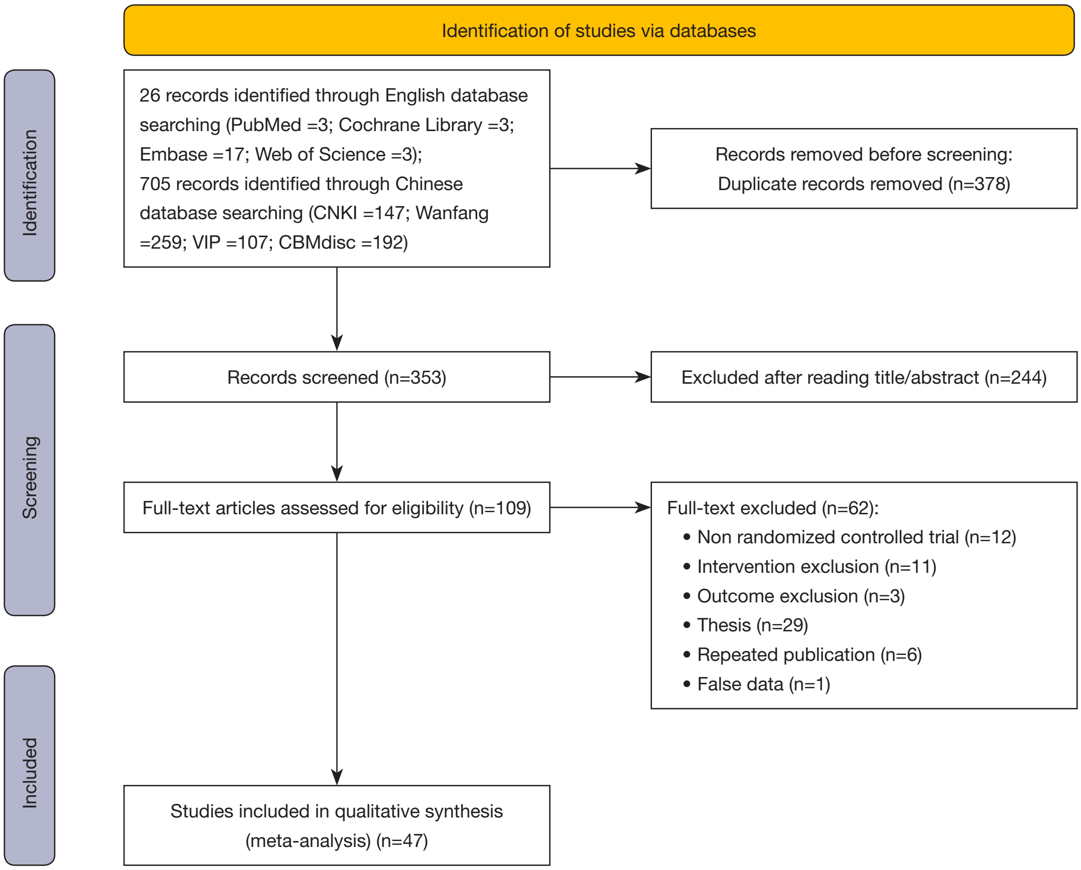

Figure 1 The literature selection and inclusion process.

Results

Research selection and inclusion

A total of 731 articles related to acupuncture treatment of PSD were obtained from 8 Chinese and English databases, with 378 duplicates removed. After reading the titles and abstracts, 244 irrelevant articles were deleted. Screening of the full text of the remaining 109 literature resulted in the removal of 12 non-randomized controlled trials, 11 studies with ineligible treatments, 3 studies with unrelated primary and secondary outcomes, 29 theses, 6 repeated reports, and 1 study with obvious data errors. Finally, a total of 47 clinical studies related to acupuncture in the treatment of PSD were included in the network meta-analysis (*Figure 1*).

Basic characteristics of the included study

This meta-analysis included 47 studies, including 3 trials retrieved from English databases and 44 literatures from Chinese databases. There was a total of 4,197 patients in the eligible studies, with an average age of 50–60 years. There were more patients with cerebral infarction compared to patients with cerebral hemorrhage. Both the course of disease and treatment period were 1–2 months. The basic information on the included literatures are shown in the supplementary materials (Table S1).

Of the 47 reports, 36 were 2-arm studies, 10 were 3-arm studies, and 1 was a 4-arm study. These studies involved 13 types of intervention measures, comprising nape acupuncture combined language rehabilitation training (NA&LRT), TA combined with language rehabilitation training (TA&LRT), scalp acupuncture combined with rehabilitation language training (SA&LRT), body acupuncture combined with language rehabilitation training (BA&LRT), combined acupuncture and language rehabilitation training (CA&LRT), traditional acupuncture combined with rehabilitation language training (TDA&LRT), language rehabilitation training (LRT), blank control (BC), nape acupuncture (NA), TA, scalp acupuncture (SA), body acupuncture (BA), and traditional acupuncture (TDA) (*Table 2*).

Table 2 A summary of basic information of the 47 included studies

Study, year	Sample size (n) (EG/CG)	Experimental group	Control group	Course of treatment	Outcome
Guan ZM 2016 (27)	120 (60/60)	SA (GB20, Gongxue, Yiming, Naokong): posterior head; 20 min/session	BC	20 days	①
Shi SF 2012 (28)	57 (30/27)	SA & LRT (DU21, SJ17, Sishencong): top head and posterior head; 30 min/session	LRT	0.5 month	①
Bi Y 2012 (29)	60 (30/30)	NA (Nei daying): pharyngeal itching; 30 min/session	TA (Jinjin, Yuye): prick bloodletting	1 month	①
Jin Z 2015 (30)	60 (30/30)	NA & LRT (REN23, REN22, ST9): around the larynx; 30 min/session	SA & LRT (DU20, DU16, DU15, SJ17): posterior head; 40 min/session	2 months	①②
Cao WJ 2012 (31)	80 (40/40)	SA & LRT (DU15, DU20, DU16, Sishencong): top head and posterior head; 30 min/session	BA & LRT (ST4, ST6, ST36, ST40, SP3, LIV3, SP9): face and lower limbs; 30 min/session	2 months	①
Gong XQ 2013 (32)	70 (30/20/20)	BA (Lingu, Dabai): upper limb; 30 min/session	A: TDA: 30 min/session; B: BC	–	①
Zhang LY 2019 (33)	120 (40/40/40)	CA & LRT (SA & TDA): lateral head and posterior head; sublingual; upper limb; 30 min/session	A: SA & LRT (Lateral head); B: TDA & LRT: 30 min/session	1 month	①
Sun N 2018 (34)	62 (31/31)	CA & LRT (TDA & TA & SA & NA): lateral head and posterior head; sublingual; upper limb; around the larynx; 30 min/session	TDA & LRT: 30 min/session	1.5 months	①
Zhao FG 2018 (35)	80 (40/40)	CA & LRT (TA & SA & NA)	NA & LRT (Zhiqiang, Tunyan, Fayin, Waijinjin, Waiyuye): pharynx; 30 min/session	0.5 month	①
Jian JY 2019 (46)	80 (40/40)	NA & LRT (Tunyan, Zhiqiang, Fayin, REN23, Waijinjin, Wai Yuye): around the larynx; operating 15s	BC	2 months	①
Han J 2014 (47)	60 (30/30)	NA & LRT (Gongxue, Zhiqiang, Tunyan, Fayin, REN23): around the larynx; 30 min/session;	LRT	40 days	①
Xu Y 2017 (48)	60 (30/30)	NA & LRT (four pharynx points): around the larynx; 20–30 min/session	LRT	1 month	②
Zhao J 2015 (49)	160 (80/80)	NA & LRT (Waijinjin, Waiyuye, REN23, Laryngeal acupoints): around the larynx; 30 min/session	LRT	0.5 month	②
Xue JQ 2017 (50)	60 (30/30)	NA & LRT (cervical acupoints): around the larynx; 30 min/session	LRT	0.5 month	①
Li G 2019 (51)	120 (30/30/30/30)	NA & LRT (Aqiang): 20 min/session	A: LTR B: NA (Aqiang) C: BC	3 months	②
Dong BJ 2011 (52)	60 (30/30)	SA & LRT (DU20, DU16, GB14, Sishencong): top head and forehead; 30 min/session	LRT	1 month	①
Zhao YY 2013 (53)	32 (16/16)	SA & LRT (DU15, DU16, GB20, Pinghengqu): posterior head; 30–40 min/session	LRT	1 month	①

Table 2 (*continued*)

Table 2 (*continued*)

Study, year	Sample size (n) (EG/CG)	Experimental group	Control group	Course of treatment	Outcome
Yang L 2017 (54)	120 (40/40/40)	SA & LRT (Niesanzhen): lateral head; 30 min/session	A: SA (Niesanzhen): Lateral head; 30 min/session; B: LRT	1 month	①
Zou HH 2017 (55)	97 (48/49)	BA & LRT (DU26, PC6, HT5, LI14): face; upper limb; 30 min/session	BA (DU26, PC6, HT5, LI14): face; upper limb; 30 min/session	1 month	①
Zhao YF 2015 (56)	60 (30/30)	BA & LRT (DU14, PC9, UB23, HT4, KID3, UB52): front and rear torso; lower limbs	TDA & LRT	1 month	①②
Ge HW 2021 (57)	72 (36/36)	BA & LRT (REN24, REN22, REN17, REN12, REN10, REN6, REN4): anterior trunk; 30 min/session	TDA & LRT: 30 min/session	2 months	①②
Chen YY 2021 (58)	58 (29/29)	TA & LRT (Shengen): sublingual; 20 min/session	BA & LRT (LU7, KID6, HT5, PC6, ST40, SP6, LI4, LIV3, GB20): upper and lower limbs; 20 min/session	1.5 months	①
He H 2019 (59)	70 (35/35)	TA & LRT (Shengen, Zuoliang, Zhimai): sublingual; lingual surface; penetrating needling; prick bleeding	TDA & LRT: 30 min/session	1 month	①
Yu XM 2007 (60)	82 (44/38)	TA & LRT (Xinxue, Pixue, REN23): sublingual; lingual surface; 20 min/session	TDA & LRT: 20 min/session	1 month	①
Yuan YL 2020 (61)	30 (15/15)	TA & LRT (Juhou): lingual surface; penetrating needling	TDA & LRT: 30 min/session	0.5 month	①
Hao PF 2018 (62)	120 (60/60)	TA & LRT (Jinjin, Yuye): sublingual; prick bleeding	LRT	1 month	①
Jia L 2016 (63)	60 (30/30)	TA & LRT (lingual surface): penetrating needling; prick bleeding	LRT	1 month	①
Luo KT 2012 (64)	60 (32/28)	CA & LRT (TA & SA & NA): 40 min/session	LRT	1 month	①
Zeng XQ 2005 (65)	60 (30/30)	TDA & LRT	LRT	1 month	①
Gao HY 2019 (66)	90 (45/45)	TDA & LRT: 30 min/session	LRT	2 months	①②
Liu H 2020 (67)	80 (40/40)	TDA & LRT: 30 min/session	LRT	1 month	①
Qi HM 2009 (68)	64 (32/32)	TDA & LRT: 30 min/session	LRT	20 days	①
Liu SD 2012 (69)	90 (30/30/30)	TDA & LRT: 30 min/session	A: TDA; B: LRT: 30 min/session	3 months	①
Zhang BD 2018 (70)	150 (50/50/50)	TDA & LRT: 30 min/session	A: TDA; B: LRT: 30 min/session	3 months	①
Hao P 2018 (71)	92 (46/46)	TDA & LRT: 30 min/session	LRT	1 month	①②
Chen LZ 2011 (72)	90 (30/30/30)	TDA & LRT: 30 min/session	A: LRT; B: BC	2 months	①
Liu XM 2020 (73)	114 (57/57)	TDA & LRT: 30 min/session	LRT	1 month	①
Shi JL 2021 (74)	65 (35/30)	TDA & LRT	TDA	3 months	①
Wu LL 2021 (75)	80 (40/40)	TDA & LRT	LRT	1 month	①
Xu JM 2010 (76)	61 (30/31)	TDA & LRT: 30 min/session	LRT	2 months	①
He M 2018 (77)	80 (40/40)	TDA & LRT: 30 min/session	BC	0.5 month	①

Table 2 (*continued*)

Table 2 (*continued*)

Study, year	Sample size (n) (EG/CG)	Experimental group	Control group	Course of treatment	Outcome
Kang K 2017 (78)	88 (44/44)	TDA & LRT: 30 min/session	LRT	1 month	①
Liang J 2014 (79)	193 (65/63/65)	TDA & LRT: 30 min/session	A: TDA; B: LRT	2 months	①
Wang GN 2016 (80)	180 (60/60/60)	TDA & LRT: 30 min/session	A: TDA; B: LRT	1 month	①
Wu ZJ 2014 (81)	270 (90/90/90)	TDA & LRT: 30 min/session	A: TDA; B: LRT	1 month	①
Yu JH 2017 (82)	120 (40/40/40)	TDA & LRT: 30 min/session	A: TDA; B: LRT	1 month	①
Hao PF 2017 (83)	60 (30/30)	TDA: 30 min/session	BA: 30 min/time	1 month	①

①: curative effect; ②: NIHSS score; REN24: Chengjiang; REN23: Lianquan; REN22: Tiantu; REN17: Danzhong; REN12: Zhongwan; REN10: Xiawan; REN6: Qihai; REN4: Guanyuan; ST9: Renying; DU26: Shuigou; DU21: Qianding; DU20: Baihui; DU16: Fengfu; DU15: Yamen; DU14: Dazhui; SJ17: Yifeng; ST4: Dicang; ST6: Jiache; ST36: Zusanli; ST40: Fenglong; SP3: Taibai; SP6: Sanyinjiao; SP9: Yinlingquan; LIV3: Taichong; GB20: Fengchi; PC6: Neiguan; HT5: Tongli; PC9: Lingdao; LI4: Hegu; UB23: Zhongchong; HT4: Shenshu; KID3: Taixi; UB52: Zhishi; LU7: Lieque; KID6: Zhaohai; HT5: Tongli; PC6: Neiguan; ST40: Fenglong. EG, experience group; CG, control group; SA, scalp acupuncture; BC, blank control; LRT, language rehabilitation training; NA, nape acupuncture; TA, tongue acupuncture; TDA, traditional acupuncture; BA, body acupuncture; CA, combined acupuncture.

Risk of bias in individual trials

Of the 47 eligible studies, 5 studies (29,47,49,73,77) were rated as high-risk for inappropriate random number generation and distribution concealment, namely, using the enrollment order as the random grouping. Furthermore, 2 (57,81) studies that clearly defined their blinding procedures were classified as "low risk," whereas other studies that did not provide such a description were classified as "unclear." One study (58) informed patients of its research proposal, hence it was classified as "high risk." All studies lacked complete outcome data and reported their results selectively. Furthermore, 1 study (58) designed different retention times of needles between the experimental group and the control group, which might have an impact on the curative effect, consequently it was rated as "high risk" in other biases. The detailed risk of bias summary and graph of all studies are shown in *Figure 2*.

Report quality of included RCTs

The STRICTA criteria indicated that 47 studies received an average score of 3.92 (3.53–4.37). The quality of research report was above average. Most of the included studies clearly reported acupuncture types (47/47, 100%) and historical background and origin of treatment (39/47, 83%). And can also describe the basic parameters of acupuncture in detail (46/47, 97.9%). The report on the control groups were also detailed (46/47, 97.9%). However, the deficiency was that all the researches did not tell the qualification of acupuncturists (0/47, 0%). Cohen's κ-statistics were ranged from 0.66–1.00, which interpreted the good evaluation consistency. The evaluation details are in Table S2.

Results of network meta-analysis

Curative effect

The network meta-analysis included 3,857 patients, 13 interventions, 27 direct comparisons, and 28 indirect comparisons from 44 of the 47 eligible studies that used curative impact as an outcome. The network evidence plot is shown in *Figure 3*. A meta-analysis was performed based on the 27 direct comparison results. As shown in *Table 3*, only 2 of the 27 direct comparisons were heterogeneous (CA&LRT *vs.* TDA&LRT, I^2=68.2%; NA&LRT *vs.* LRT, I^2=63.3%), suggesting that the heterogeneity of these studies was low and they could be combined for analysis.

In terms of the consistency test, the node splitting showed no statistical difference between direct comparison and indirect comparison (P>0.05 in 23 comparisons). The IF test (*Figure 4A*) showed that only 2 of the 25 loops did not contain zero, indicating good overall consistency. The predictive interval plot (*Figure 4B*) revealed that the 55 mixed comparison results were consistent with the prediction results. All these results demonstrated that not only was the network prediction model reliable, but the

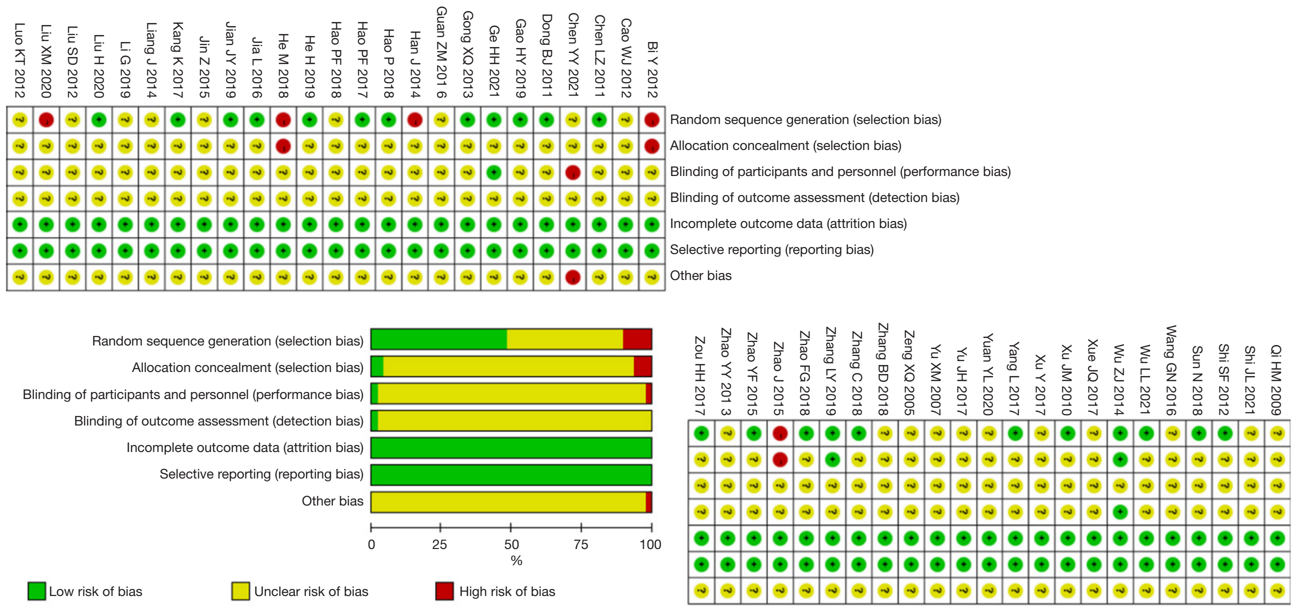

Figure 2 Risk of bias summary and graph.

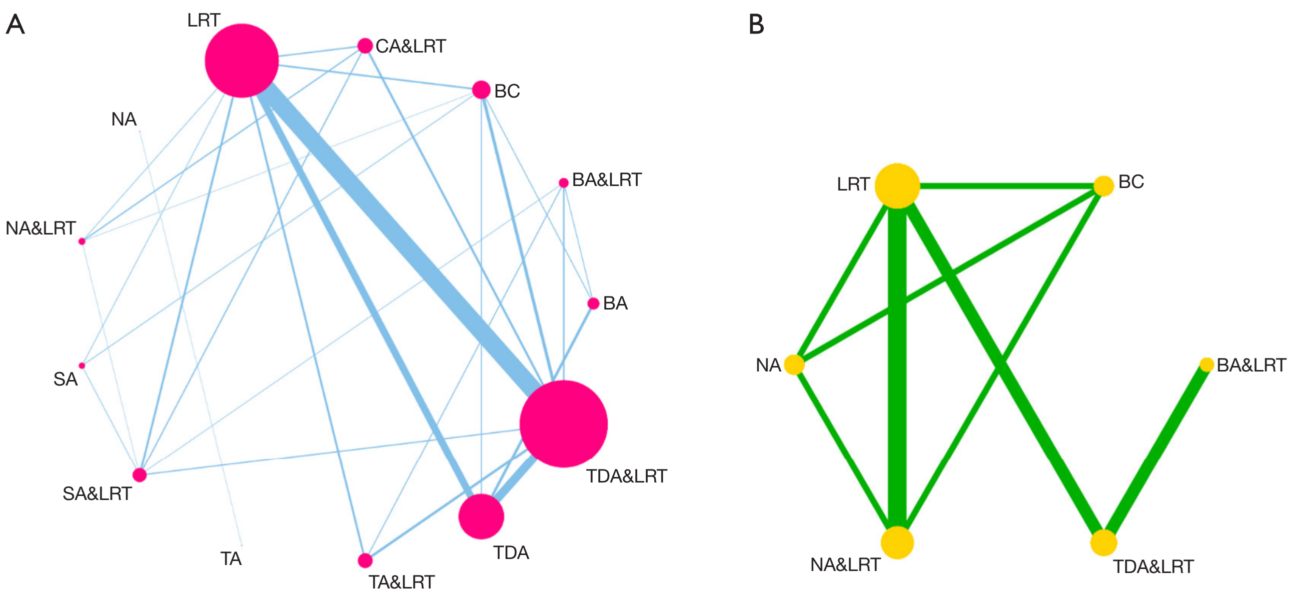

Figure 3 The network evidence plot. (A) Network diagram of curative effect. (B) Network diagram of NIHSS. NA, nape acupuncture; TA, tongue acupuncture; SA, scalp acupuncture; BA, body acupuncture; CA, combined acupuncture; TDA, traditional acupuncture; LRT, language rehabilitation training; BC, blank control; NIHSS, National Institutes of Health Stroke Scale.

consistency model used to analyze the data was also reliable.

According to the results of head-to-head mixed comparison (*Figures 4B* and *Figure 5*), BC showed a poorer curative effect than 7 other groups (P<0.05), including BA&LRT [OR =8.77, 95% CI: (3.38, 22.74)], CA&LRT [OR =24.33, 95% CI: (8.92, 66.35)], NA&LRT [OR =9.71, 95% CI: (3.98, 23.69)], SA&LRT [OR =6.97, 95% CI: (3.04, 16.0)], TA&LRT [OR =14.98, 95% CI: (6.10, 36.76)], TDA [OR =2.26, 95% CI: (1.12, 4.56)], and TDA&LRT [OR =7.97, 95% CI: (4.07, 15.60)]. In contrast, there was

Table 3 A direct comparison of the curative effect and NIHSS score

Comparison	Number of studies	OR	95% CI	P	I^2
Curative effect					
BA&LRT *vs.* BA	1	3.57	(1.06, 12.00)	0.04	–
BA&LRT *vs.* TA&LRT	1	0.42	(0.11, 1.59)	0.202	–
BA&LRT *vs.* TDA&LRT	2	3.03	(1.00, 9.13)	0.049	0.0%
BA *vs.* BC	1	2.79	(0.67, 11.55)	0.158	–
BA *vs.* TDA	2	3.15	(1.16, 8.55)	0.024	18.2%
CA&LRT *vs.* LRT	1	5.00	(0.94, 26.49)	0.059	–
CA&LRT *vs.* NA&LRT	1	2.73	(0.92, 8.13)	0.071	–
CA&LRT *vs.* SA&LRT	1	19.00	(2.34, 154.26)	0.006	–
CA&LRT *vs.* TDA&LRT	2	6.23	(2.05, 18.96)	0.001	68.2%
NA&LRT *vs.* BC	1	3.08	(0.75, 12.61)	0.12	–
NA&LRT *vs.* LRT	2	10.19	(2.97, 35.01)	<0.001	63.3%
NA&LRT *vs.* SA&LRT	1	4.26	(0.81, 22.53)	0.088	–
NA *vs.* TA	1	3.27	(0.77, 13.83)	0.107	–
SA&LRT *vs.* BA&LRT	1	2.11	(0.36,12.24)	0.405	–
SA&LRT *vs.* TDA&LRT	1	1.12	(0.44, 2.85)	0.812	–
SA&LRT *vs.* LRT	4	4.41	(2.05, 9.48)	<0.001	0.0%
SA&LRT *vs.* SA	1	10.23	(2.14, 48.85)	0.004	–
SA *vs.* LRT	1	1.11	(0.45, 2.77)	0.816	–
SA *vs.* BC	1	3.5	(1.06, 11.57)	0.04	–
TA&LRT *vs.* LRT	2	4.73	(2.10, 10.66)	<0.001	0.0%
TA&LRT *vs.* TDA&LRT	3	4.63	(1.54, 13.96)	0.007	0.0%
TDA&LRT *vs.* BC	2	7.22	(2.33, 22.41)	0.001	0.0%
TDA&LRT *vs.* LRT	16	6.49	(4.59, 9.17)	<0.001	0.0%
TDA&LRT *vs.* TDA	7	5.56	(3.36, 9.20)	<0.001	0.0%
TDA *vs.* LRT	6	1.45	(1.02, 2.06)	0.037	10.9%
TDA *vs.* BC	1	1.71	(0.4, 7.34)	0.468	–
LRT *vs.* BC	1	2.51	(0.83, 7.64)	0.105	–
NIHSS		MD			
BA&LRT *vs.* TDA&LRT	2	−0.17	(−2.8, 2.47)	0.9	89.4%
NA&LRT *vs.* BC	1	1.06	(−0.68, 2.80)	0.23	–
NA&LRT *vs.* LRT	3	1.01	(0.60, 1.44)	<0.001	0.0%
NA&LRT *vs.* NA	1	0.03	(−1.69, 1.75)	0.973	–
NA *vs.* BC	1	1.03	(−0.68, 2.74)	0.237	–
LRT *vs.* BC	1	1.16	(−0.55, 2.87)	0.183	–
LRT *vs.* NA	1	0.13	(−1.56, 1.82)	0.88	–
TDA&LRT *vs.* LRT	2	1.61	(0.98, 2.25)	<0.001	0.0%

NIHSS, National Institutes of Health Stroke Scale; OR, odds ratio; CI, confidence interval; BA, body acupuncture; LRT, language rehabilitation training; TA, tongue acupuncture; TDA, traditional acupuncture; BC, blank control; CA, combined acupuncture; NA, nape acupuncture; SA, scalp acupuncture; MD, mean difference.

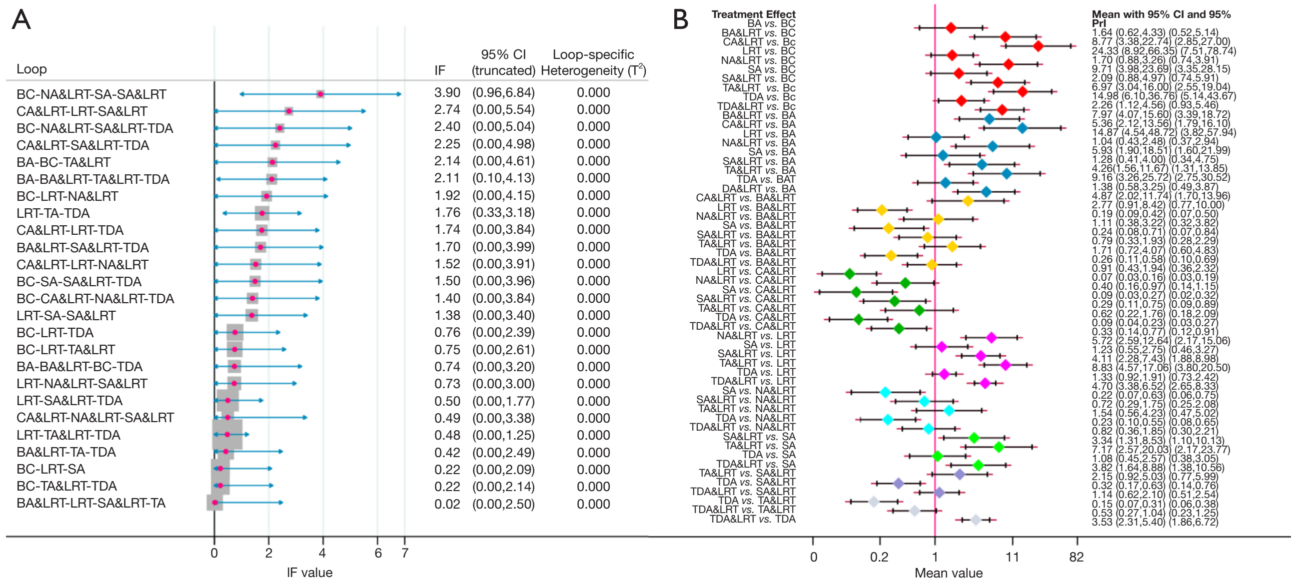

Figure 4 The curative effect IF test and predictive interval plot. (A) The result of IF test; (B) predictive interval plot. IF, inconsistency factor; NA, nape acupuncture; TA, tongue acupuncture; SA, scalp acupuncture; BA, body acupuncture; CA, combined acupuncture; TDA, traditional acupuncture; LRT, language rehabilitation training; BC, blank control; PrI: prediction intervals.

TDA&LRT				0.25 (0.02,3.08)	0.42 (0.07,2.39)	0.18 (0.05,0.69)		0.78(0.18,3.30)		0.09 (0.01,1.11)
3.53 (2.31,5.40)	TDA									
0.53 (0.27,1.04)	0.15 (0.07,0.31)	TA&LRT		NA	1.66 (0.20,13.89)	0.72 (0.09,5.97)		3.09 (0.17,56.08)		0.36 (0.03,3.80)
1.14 (0.62,2.10)	0.32 (0.17,0.63)	2.15 (0.92,5.03)	SA&LRT							
3.82 (1.64,8.88)	1.08 (0.45,2.57)	7.17 (2.57,20.03)	3.34 (1.31,8.53)	SA						
0.82 (0.36,1.85)	0.23 (0.10,0.55)	1.54 (0.56,4.23)	0.72 (0.29,1.75)	0.22 (0.07,0.63)	NA&LRT	0.43 (0.14,1.32)		1.86 (0.19,18.19)		0.22 (0.03,1.81)
4.70 (3.38,6.52)	1.33 (0.92,1.91)	8.83 (4.57,17.06)	4.11 (2.28,7.43)	1.23 (0.55,2.75)	5.72 (2.59,12.64)	LRT		4.30 (0.60,30.88)		0.50 (0.06,4.17)
0.33 (0.14,0.77)	0.09 (0.04,0.23)	0.62 (0.22,1.76)	0.29 (0.11,0.75)	0.09 (0.03,0.27)	0.40 (0.16,0.97)	0.07 (0.03,0.16)	CA&LRT			
0.91 (0.43,1.94)	0.26 (0.11,0.58)	1.71 (0.72,4.07)	0.79 (0.33,1.93)	0.24 (0.08,0.71)	1.11 (0.38,3.22)	0.19 (0.09,0.42)	2.77 (0.91,8.42)	BA&LRT		0.12 (0.01,2.11)
4.87 (2.02,11.74)	1.38 (0.58,3.25)	9.16 (3.26,25.72)	4.26 (1.56,11.67)	1.28 (0.41,4.00)	5.93 (1.90,18.51)	1.04 (0.43,2.48)	14.87 (4.54,48.72)	5.36 (2.12,13.56)	BA	
7.97 (4.07,15.60)	2.26 (1.12,4.56)	14.98 (6.10,36.76)	6.97 (3.04,16.00)	2.09 (0.88,4.97)	9.71 (3.98,23.69)	1.70 (0.88,3.26)	24.33 (8.92,66.35)	8.77 (3.38,22.74)	1.64 (0.62,4.33)	BC

Intervention	Curative effect	NIHSS score

Figure 5 Head-to-head mixed comparison. TDA, traditional acupuncture; LRT, language rehabilitation training; TA, tongue acupuncture; SA, scalp acupuncture; NA, nape acupuncture; CA, combined acupuncture; BA, body acupuncture; BC, blank control.

no significant difference between BC and LRT, BA, nor SA (P>0.05). The curative effect of CA&LRT was better than that of BC, BA [OR =14.87, 95% CI: (4.54, 48.72)], LRT [OR =14.34, 95% CI: (6.12, 33.58)], NA&LRT [OR =2.51, 95% CI: (1.04, 6.06)], SA [OR =11.65, 95% CI: (3.73, 36.45)], SA&LRT [OR =3.49, 95% CI: (1.34, 9.11)], TDA [OR =10.78, 95% CI: (4.34, 26.79)], and TDA&LRT [OR =3.05, 95% CI: (1.30, 7.17)] (P<0.05). By comparison, there was no significant difference between CA&LRT and BA&LRT [OR =2.77, 95% CI: (0.91, 8.42)] nor TA&LRT [OR =1.62, 95% CI: (0.57, 4.64)] (P>0.05). The comparison between other interventions is shown in *Figure 4B* and *Figure 5*.

The curative effect of 11 interventions that could be transmitted was ranked by Sucra probability (*Figure 6*). As shown in *Figure 6A*, the efficacy of the 11 interventions was ranked as follows: CA&LRT > TA&LRT > NA&LRT > BA&LRT > TDA&LRT > SA&LRT > TDA > SA > BA≈LRT > BC.

The comparison-adjusted plot was used to test the publication bias of the model. The results showed that the funnel chart was symmetrical, indicating a low possibility of publication bias (*Figure 7*).

NIHSS score

A total of 7 studies reported NIHSS scores, involving 6 interventions (BA&LRT, BC, LRT, NA, NA&LRT, and

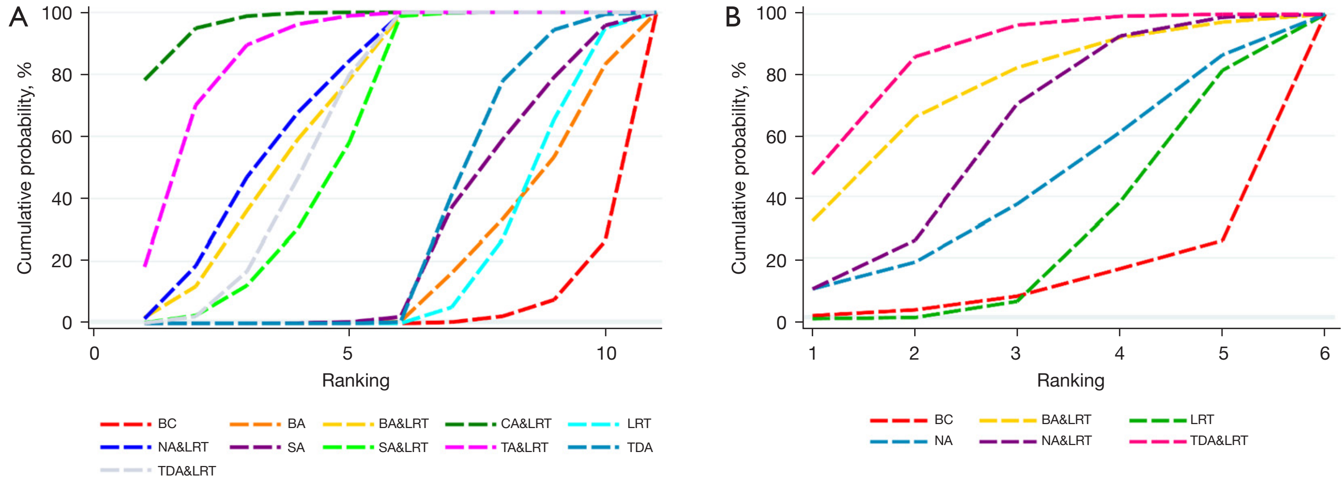

Figure 6 Sucra cumulative probability. (A) Ranking of curative effect, and (B) ranking of NIHSS score. NIHSS, National Institutes of Health Stroke Scale; BC, blank control; BA, body acupuncture; LRT, language rehabilitation training; CA, combined acupuncture; NA, nape acupuncture; SA, scalp acupuncture; TA, tongue acupuncture; TDA, traditional acupuncture.

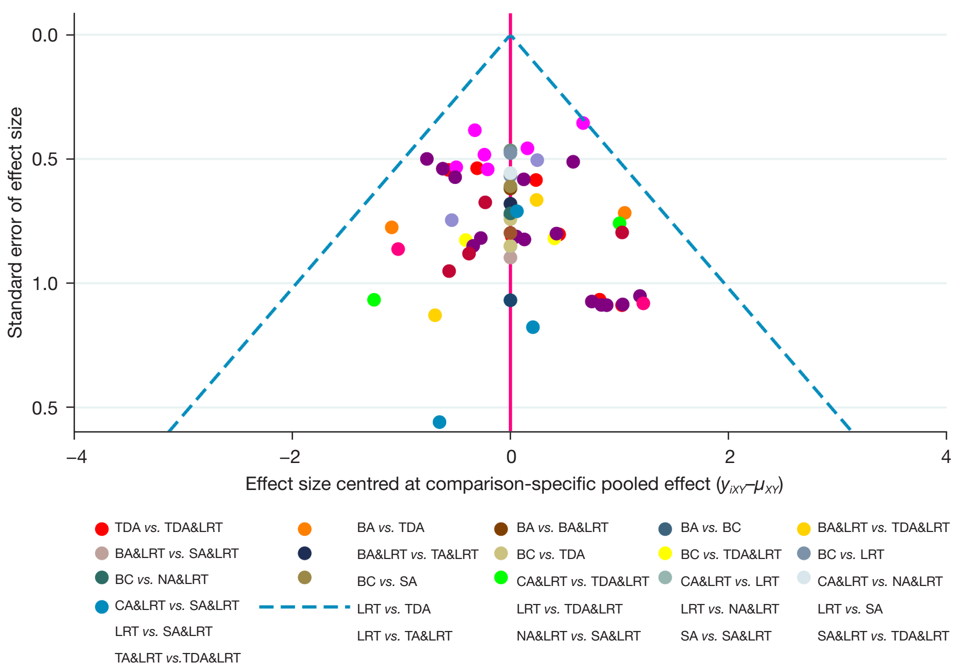

Figure 7 A comparison-adjusted plot for curative effect. TDA, traditional acupuncture; LRT, language rehabilitation training; BC, blank control; BA, body acupuncture; CA, combined acupuncture; NA, nape acupuncture; SA, scalp acupuncture; TA: tongue acupuncture.

TDA&LRT). There were 8 direct comparisons, as indicated in the network evidence plot (*Figure 3*). A heterogeneity test conducted for direct comparison suggested that the heterogeneity of the model was low (*Table 3*).

The results of the consistency test showed that the IF with 95% CI of the two detected loops (BC-LRT-NA&LRT and LRT-NA-NA&LRT) by NIHSS score contained zero [IF =1.19, 95% CI: (0.00, 3.66); IF =1.19, 95% CI: (0.00, 3.64)]. The node splitting showed good consistency between the direct comparisons and indirect comparisons of NIHSS score (P>0.05 in all comparisons). To summarize, the NIHSS score network analysis produced reliable results.

A consistency model was used to analyze the data, and the results of the head-to-head mixed comparison are shown in *Figure 5*. The NIHSS score indicated that the efficacy of TDA & LRT was better than that of LRT [mean =5.52, 95% CI: (1.45, 20.98), P<0.05], whereas other comparisons were not statistically significant (P>0.05). The efficacy of the 6 interventions in terms of NIHSS score was ranked as follows: TDA&LRT > BA&LRT > NA&LRT > NA > LRT > BC (*Figure 6B*).

Discussion

The results of network meta-analysis

The curative effect reflects the recovery of language function in patients with PSD by using the improvement in the Frenchay dysarthria assessment scale or other language function assessment scales as the judgment standard. The results of the consistency test for the curative effect model of 11 intervention measures show good consistency and reliable analysis results. The curative effect of the 11 interventions were ranked by network meta-analysis as follows: CA&LRT > TA&LRT > NA&LRT > BA&LRT > TDA&LRT > SA&LRT > TDA > SA > BA≈LRT > BC. CA&LRT, as the best intervention, combined more than two kinds of acupuncture methods, namely, TA, NA, SA, and BA. This suggested that combining more than two types of acupuncture interventions produces better results than a single acupuncture intervention. TA&LRT was the second most effective intervention. Tongue acupoints can be found on both the lingual and sublingual surface, and acupuncture techniques include pricking and bleeding at the tongue acupoints, deeply stabbing into the root of the tongue, and twisting after stabbing. The meta-analysis of TA in the treatment of PSD previously conducted by the research team showed that the curative effect of acupuncture at sublingual acupoints was better than that at lingual surface acupoints, and combining multiple techniques had a better performance than a single one treatment modality (84). NA&LRT ranked third most curative. Neck acupoints are mainly distributed around the thyroid cartilage and hyoid bone. The acupuncture direction is mostly towards the posterior pharyngeal wall, which makes the pharynx itchy. Strong stimulation manipulation is unsuitable for neck acupuncture due to the dense distribution of cervical arteries. Selecting acupoints away from pronunciation organs (BA&LRT, SA&LRT) or without targeted treatment (TDA&LRT) had poor effects. Acupuncture combined with LRT had better therapeutic effects than simple acupuncture, which suggested that combined LRT can improve the curative effect of acupuncture. The curative effect of both acupuncture methods (whether paired with LRT or not) was higher than that of simple LRT and BC, confirming the effectiveness of acupuncture in rehabilitation treatment.

The NIHSS score reflects the recovery of neurological function in stroke patients, and only 7 of the 47 eligible studies reported this index, involving 6 intervention measures. Network meta-analysis showed good consistency and high reliability. The curative effect was ranked as follows: TDA&LRT > BA&LRT > NA&LRT > NA > LRT > BC. TDA&LRT had the best impact on neurological function recovery among the 6 involved interventions, followed by BA&LRT and NA&LRT. The results showed that TDA (GB20, SJ17, DU15, PC6, HT5, DU26, SP6, ST36, REN23, Jinjin, Yuye, etc.) was not only effective in the treatment of dysarthria but also beneficial to the recovery of neurological function (85-87). Therefore, although CA&LRT, TA&LRT, and NA&LRT have better effects on the recovery of language function (88,89), acupoints at other parts of the body should also be increased in the treatment of stroke patients to help the recovery of neurological function.

Evaluation of the safety of acupuncture therapy

Most of the experiments included in this study did not evaluate safety events. A small part of the studies mentioned that no serious adverse events occurred during the study, which suggests that acupuncture treatment may be safe. At the same time, it also potentially indicates that such researches were insufficient for safety evaluation, and this important issue needs to be considered in later research. Clinical studies on acupuncture need to evaluate possible adverse events such as pain, hematoma, dizziness, nausea, etc.

Mechanisms of acupuncture treatment

Dysarthria, a clinical manifestation of post-stroke pseudobulbar palsy, is mainly caused by central spastic paralysis of related articulatory muscles (tongue, soft palate, throat, etc.). Pseudobulbar palsy is characterized by an upper motor lesion induced by bilateral disturbance of the corticobulbar tracts (90). Damage to the bilateral cortical medullary pathway can result in pseudobulbar paralysis, with stroke being one of the most common causes. The incidence rate of post-stroke pseudobulbar palsy is about 51% (91). In recent years, an increasing number of clinical studies have shown the effectiveness of acupuncture in the treatment of pseudobulbar paralysis (92-97). Chinese scientists have made great efforts to validate the curative impact of acupuncture on PSD, resulting in several clinical achievements (98). Acupuncture treatment can significantly enhance the speech function of patients with dysarthria (35,76,99). Despite its clinical effectiveness, the mechanisms of acupuncture in the treatment of dysarthria remain to be fully elucidated. Therefore, we investigated the mechanisms linking acupuncture to the nervous system, vascular reconstruction, and muscular function recovery.

There were a large number of studies linking acupuncture to the recovery of nerve and muscle function. Furthermore, existing reports have confirmed that acupuncture has neuroprotective and nerve regeneration effects (100-103). A study showed that acupuncture may activate cannabinoid type-1 receptors in astrocytes to increase the level of the endogenous cannabinoid, thus protecting neurons during cerebral ischemia (104). In addition, acupuncture can reduce post-stroke brain edema and promote the proliferation, migration, and differentiation of neural stem cells (86), and promote the generation of neurotrophic factors, to protect nerves (105). Acupuncture can also activate the inherent antioxidant enzyme system by regulating the oxidative stress mechanism. The excessive formation of reactive oxygen species was prevented in this regulation to reduce the excessive oxidative stress response in the brain during the onset of cerebral infarction (106). Furthermore, it can regulate cerebral blood flow and activate cerebral angiogenesis after ischemic cerebral infarction (107). A recent study reported the electrophysiological mechanism of electroacupuncture (108). Electroacupuncture may play a therapeutic role by regulating electroencephalogram frequency. In addition, the changes in the magnetic resonance images of the brain after acupuncture may provide potential evidence for the improvement of brain function after acupuncture (109,110).

Acupuncture has also been shown to promote the recovery of peripheral nerves and muscles. A study demonstrated that acupuncture can promote the recovery of rats with median nerve rupture and restore the functions of nerve-innervated muscles (111). Moreover, it can assist in the functional recovery of nerves and muscles in patients suffering from upper limb nerve injury (112). The mechanism of acupuncture promoting nerve regeneration has also been confirmed. Acupuncture may promote facial nerve regeneration by upregulation of Glial Cell-derived eurotrophic factor (GDNF) and N-cadherin mRNA in facial neurons, demonstrating the nerve regeneration-promoting function of acupuncture (113). In addition, another report confirmed that electroacupuncture can promote Schwann cell proliferation and elevate nerve growth factors (114). Electroacupuncture with appropriate frequency can promote muscle protein synthesis by regulating the PI3K/Akt pathway and its downstream molecular mTOR target, expression of FoXO and F-box; and downregulate the expression of downstream FoXO and F-box protein 32 (Atrogin-1) to reduce protein degradation (115). Dry acupuncture at the Ashi acupoint can promote gene expression in muscle tissues and accelerate the process of muscle regeneration (116). Electroacupuncture can also increase the level of glutathione in muscle tissues and prevent muscle fatigue (117). Furthermore, electroacupuncture has been shown in a study on healthy college students to increase muscle content, skin temperature, and skin blood flow (118).

Many studies have demonstrated that the dysphonia caused by primary increased muscle tone can be significantly improved by symptomatic speech therapy. Many sound therapies, such as yawning sighs, resonance sound therapy, visual and EMG biofeedback, progressive relaxation, and perilaryngeal massage, can help relieve or rebalance laryngeal muscle hyperfunction and symptoms (119-121). Perilaryngeal treatment can improve the dysphonia caused by increased muscle tone (122). Acupuncture at neck acupoints can shorten the distance between hyoid bone and thyroid cartilage (123), alleviating neck muscular tension and spasm. This also provides evidence of curative effect for the treatment of dysarthria with TA and NA (both acupuncture sites involve areas around the throat).

The above analysis demonstrated that acupuncture plays a part in the treatment of PSD through the central system-efferent nerve-pronunciation muscle pathway (*Figure 8*). Acupuncture in different areas has various therapeutic effects. SA, for example, can promote the recovery of the cerebral central nervous system after stroke and facilitate the connection of the bilateral cortex medulla oblongata pathway. TA, NA, BA, and other acupuncture can come into play by stimulating the recovery of peripheral nerves and balancing vocal muscle spasms. Our analysis revealed that combined acupuncture was more effective for disease treatment. However, this is merely a speculation based on

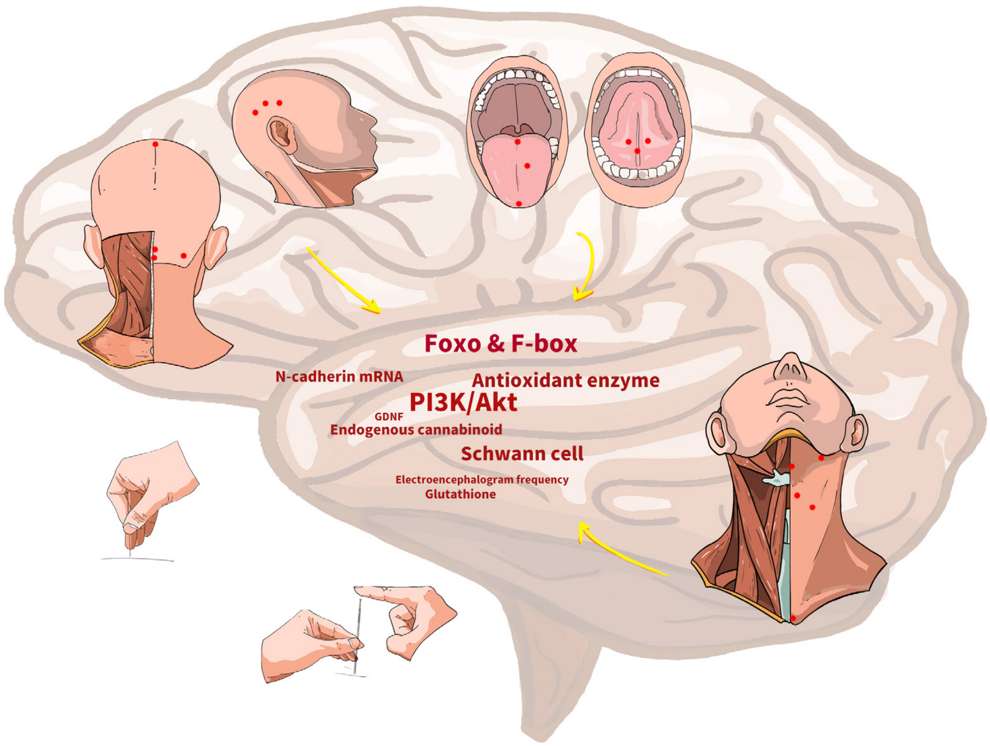

Figure 8 Potential mechanisms of acupuncture in the treatment of post-stroke dysarthria.

existing evidence. How acupuncture works in the treatment of PSD remains to be elucidated by clinical and animal experimental research.

Risk bias assessment and research quality evaluation analysis

The results of the risk bias assessment suggested that there may be a greater risk of bias. It was probably due to the lack of methodology in acupuncture clinical research. We used the STRICTA criteria to evaluate the quality of acupuncture clinical research reports and got 3.92 points (the full score is 6 points). This was actually a good score, which means that the quality of the included research reports was medium above. Otherwise, there was less heterogeneity in the direct comparison results of the meta-analysis. The consistency of mixed comparison results was relatively good. The funnel graph was symmetrical, and the possibility of publication bias was small. To sum up, the results of this study should be viewed dialectically. Although there may be bias risk, the overall model was relatively stable. This suggests that more scientific research methods are needed in the later clinical research of acupuncture. The results of this network meta-analysis can provide a possible reference for later clinical research.

Conclusions

Acupuncture has a good therapeutic effect on PSD. Among the six types of different acupuncture regimens studied, CA, TA, and NA may have the best impact on language function recovery. Acupuncture combined with LRT has superior effect compared to simple acupuncture alone. Acupuncture can promote the recovery of neurological function in patients with stroke. Therefore, treatment of patients with PSD should focus on the recovery of neurological function and increase the number of acupoints at other parts of the body, such as the head and limbs, in addition to tongue acupoints and neck acupoints. We believe that acupuncture may have a role in the treatment of PSD through the central nerve-efferent nerve-pronunciation muscle pathway based on previous studies on the therapeutic mechanism of acupuncture. The network meta-analysis data and the inference of acupuncture mechanisms are based on existing research. The results of this study have clinical relevance and provide guidance for the clinical treatment of dysarthria, as well as research into the superior curative effects of acupuncture and related mechanisms. Clinical and animal research with larger sample size is required to further validate these results.

Acknowledgments

The authors thank all researchers and participants for sharing these data.
Funding: This study was funded by the evidence-based capacity building project of traditional Chinese medicine of National Administration of Traditional Chinese Medicine: evidence-based research on acupuncture and moxibustion in the treatment of advantageous diseases (No. 2019XZZX-ZJ013).

Footnote

Reporting Checklist: The authors have completed the PRISMA-NMA reporting checklist. Available at https://atm.amegroups.com/article/view/10.21037/atm-22-5583/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://atm.amegroups.com/article/view/10.21037/atm-22-5583/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Darley FL, Aronson AE, Brown JR. Differential diagnostic patterns of dysarthria. J Speech Hear Res 1969;12:246-69.
2. Kent RD, Duffy JR, Slama A, et al. Clinicoanatomic studies in dysarthria: review, critique, and directions for research. J Speech Lang Hear Res 2001;44:535-51.
3. Mackenzie C. Dysarthria in stroke: a narrative review of its description and the outcome of intervention. Int J Speech Lang Pathol 2011;13:125-36.
4. Mahler LA, Ramig LO. Intensive treatment of dysarthria secondary to stroke. Clin Linguist Phon 2012;26:681-94.
5. Darley FL, Aronson AE, Brown JR. Clusters of deviant speech dimensions in the dysarthrias. J Speech Hear Res 1969;12:462-96.
6. Lester-Smith RA, Miller CH, Cherney LR. Behavioral Therapy for Tremor or Dystonia Affecting Voice in Speakers with Hyperkinetic Dysarthria: A Systematic Review. J Voice 2021. [Epub ahead of print]. doi: 10.1016/j.jvoice.2021.03.026.
7. Lawrence ES, Coshall C, Dundas R, et al. Estimates of the prevalence of acute stroke impairments and disability in a multiethnic population. Stroke 2001;32:1279-84.
8. Brownlee A, Bruening LM. Methods of communication at end of life for the person with amyotrophic lateral sclerosis. Topics in Language Disorders 2012;32:168-85.
9. Hecht M, Hillemacher T, Gräsel E, et al. Subjective experience and coping in ALS. Amyotroph Lateral Scler Other Motor Neuron Disord 2002;3:225-31.
10. Spencer KA, Brown KA. Dysarthria following Stroke. Semin Speech Lang 2018;39:15-24.
11. Mackenzie C, Kelly S, Paton G, et al. The Living with Dysarthria group for post-stroke dysarthria: the participant voice. Int J Lang Commun Disord 2013;48:402-20.
12. Chiaramonte R, Pavone P, Vecchio M. Speech rehabilitation in dysarthria after stroke: a systematic review of the studies. Eur J Phys Rehabil Med 2020;56:547-62.
13. Boncoraglio GB, Bersano A, Candelise L, et al. Stem cell transplantation for ischemic stroke. Cochrane Database Syst Rev 2010;(9):CD007231.
14. Henderson A, Korner-Bitensky N, Levin M. Virtual reality in stroke rehabilitation: a systematic review of its effectiveness for upper limb motor recovery. Top Stroke Rehabil 2007;14:52-61.
15. Richards LG, Stewart KC, Woodbury ML, et al. Movement-dependent stroke recovery: a systematic review and meta-analysis of TMS and fMRI evidence. Neuropsychologia 2008;46:3-11.
16. Zimmermann-Schlatter A, Schuster C, Puhan MA, et al. Efficacy of motor imagery in post-stroke rehabilitation: a systematic review. J Neuroeng Rehabil 2008;5:8.
17. Martinsson L, Hårdemark H, Eksborg S. Amphetamines for improving recovery after stroke. Cochrane Database Syst Rev 2007;(1):CD002090.

18. Coupar F, Pollock A, van Wijck F, et al. Simultaneous bilateral training for improving arm function after stroke. Cochrane Database Syst Rev 2010;(4):CD006432.
19. National Institute for Health and Care Excellence: Guidelines, in Motor neurone disease: assessment and management. 2019, National Institute for Health and Care Excellence (NICE) Copyright © NICE 2020: London.
20. Elliott E, Newton J, Rewaj P, et al. An epidemiological profile of dysarthria incidence and assistive technology use in the living population of people with MND in Scotland. Amyotroph Lateral Scler Frontotemporal Degener 2020;21:116-22.
21. Dziewas R, Warnecke T, Zürcher P, et al. Dysphagia in COVID-19 -multilevel damage to the swallowing network? Eur J Neurol 2020;27:e46-7.
22. Mao L, Jin H, Wang M, et al. Neurologic Manifestations of Hospitalized Patients With Coronavirus Disease 2019 in Wuhan, China. JAMA Neurol 2020;77:683-90.
23. Qureshi AI, Baskett WI, Huang W, et al. Acute Ischemic Stroke and COVID-19: An Analysis of 27 676 Patients. Stroke 2021;52:905-12.
24. Regan J, Walshe M, Lavan S, et al. Dysphagia, Dysphonia, and Dysarthria Outcomes Among Adults Hospitalized With COVID-19 Across Ireland. Laryngoscope 2022;132:1251-9.
25. Research, N.I.f.H. PROSPERO International prospective register of systematic reviews. Available online: https://www.crd.york.ac.uk/prospero/
26. Higgins JP, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.
27. Guan ZM. Acupuncture acupoints in the cervical region for the treatment of spasmodic dysarthria in 60 cases. Henan Chinese Medicine 2016;36.
28. Shi SF, Wu GH, Zhang YJ. Effect of head acupuncture combined with tongue acupuncture on dysarthria in stroke patients. Clinical Journal of Acupuncture and Moxibustion 2012;28:17-9.
29. Bi Y, Li L, Shao X, et al. Observation on the curative effect of acupuncture at Neidaying point in the treatment of dysarthria after stroke. China Traditional Chinese Medicine Science and Technology 2012;19:2.
30. Jin Z, Cao XT. Efficacy of neck electrical acupuncture on 30 cases of post-stroke spastic dysarthria. Journal of Clinical Acupuncture and Moxibustion 2015;31:26-8.
31. Cao WJ. Acupuncture combined with traditional Chinese medicine for the treatment of dysarthria after stroke in 40 cases. Chinese Traditional Chinese Medicine Acute Care 2012;21.
32. Gong XQ, Ren Y, Li Z, et al. Clinical study on dysarthria due to post-stroke pseudobulbar palsy treated with inverted horse acupuncture. Journal of Chinese Medicine 2013;28.
33. Zhang LY, Xu F, Ye XM, et al. Efficacy of scalp acupuncture combined with somatic acupuncture for post-stroke dysarthria. Chinese Journal of Rehabilitation Medicine 2019;34:334-6.
34. Sun N, Zhang LT, Xie BD. Clinical study of compound acupuncture combined with speech training for the treatment of post-stroke dysarthria. Massage and Rehabilitation Medicine 2018;9:14-6.
35. Zhao FG. Effect of combined tongue acupuncture and Xiang acupuncture group dysarthria rehabilitation training on the speech function of patients with dysarthria after stroke. Chinese Acupuncture 2018;38.
36. Hutton B, Salanti G, Caldwell DM, et al. The PRISMA extension statement for reporting of systematic reviews incorporating network meta-analyses of health care interventions: checklist and explanations. Ann Intern Med 2015;162:777-84.
37. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.
38. Shamseer L, Moher D, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ 2015;350:g7647.
39. Cochrane Handbook for Systematic Reviews of Interventions. Available online: https://trainingcochraneorg/handbook/current
40. MacPherson H, Altman DG, Hammerschlag R, et al. Revised STandards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA): Extending the CONSORT statement. J Evid Based Med 2010;3:140-55.
41. Yang X, Qin C, Li M, et al. How about the RCTs' quality of acupuncture treatment for female urinary incontinence in recent 20 years? A report quality assessment. World J Urol 2022. doi: 10.1007/s00345-022-04213-x.
42. White IR. Network meta-analysis. The Stata Journal 2015;15:951-85.
43. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. BMJ 2003;327:557-60.
44. Rücker G, Schwarzer G. Ranking treatments in frequentist network meta-analysis works without resampling methods. BMC Med Res Methodol 2015;15:58.
45. Trinquart L, Chatellier G, Ravaud P. Adjustment for

reporting bias in network meta-analysis of antidepressant trials. BMC Med Res Methodol 2012;12:150.
46. Jian JY, Li G, Ma JY. Clinical observation of acupuncture combined with ice stick stimulation for post-stroke dysarthria. Chinese Folk Therapy 2019;27.
47. Han J, Wu Y. A randomized parallel controlled study on the treatment of post-stroke dysarthria by combined speech rehabilitation training with neck acupuncture and tongue acupuncture. Journal of Practical Chinese Medicine and Internal Medicine 2014.
48. Xu Y, Luo ZR, Jin R. Clinical observation on the treatment of spastic dysarthria after stroke by acupuncture "pharyngeal four points" combined with dysarthria training. 2017;8:27-9.
49. Zhao J, Li KJ, Li MR. Clinical observation of low-frequency electrical pulse stimulation combined with acupuncture treatment on spastic dysarthria after acute cerebral infarction. Journal of Tropical Medicine 2015;15.
50. Xue JQ. Efficacy observation of neuromuscular electrical stimulation combined with acupuncture in the treatment of dysarthria after stroke. The Great Physician 2017;2:59-60.
51. Li G, Zhang JF, Meng HB. Clinical efficacy of general acupuncture combined with ice stick stimulation for post-stroke dysarthria. World Abstract of the Latest Medical Information 2019.
52. Dong BJ. Efficacy of waking the brain and Tongluo method in treating 60 cases of post-stroke spastic dysarthria. Beijing Chinese Medicine 2011;30.
53. Zhao YY. Efficacy of acupuncture with speech training in the treatment of post-stroke dysarthria dysarthria. 2013. Available online: https://www.nstl.gov.cn/paper_detail.html?id=2a1e8f4d08ec278f3bff6515cf881480
54. Yang L. Efficacy of speech training with "temporal three needles" in the treatment of post-stroke dysarthria. World Chinese Medicine 2017;12.
55. Zou HH, Lin L, Chen M, et al. 50 cases of dysarthria in stroke treated with oral-facial exercises and acupuncture. Modern Distance Education in Chinese Traditional Medicine 2017;15.
56. Zhao YF, Wang XY. Clinical efficacy of spasmolytic acupuncture in the treatment of post-stroke spastic dysarthria. Heilongjiang TCM 2015.
57. Ge HW, Zhu CF, Gui L, et al. Clinical study on the treatment of motor dysarthria after stroke by combining speech training with toning and reverberation acupuncture. Journal of Clinical Acupuncture and Moxibustion 2021;37:5-9.
58. Chen YY, Fan HL, Ke BX, et al. Clinical observation of different acupuncture methods in the treatment of motor dysarthria in stroke Guangming Journal of Chinese Medicine 2021;36:442-4.
59. He H, Luo ZC, Wang X, et al. Clinical application of tongue acupuncture in the speech rehabilitation of patients with post-stroke dysarthria. Clinical Research 2019;27:99-101.
60. Yu XM. Tongue-acupuncture-based treatment with rehabilitation training for post-stroke dysarthria. Chinese Journal of Traditional Chinese Medicine 2007;25.
61. Yuan YL. Clinical study on the treatment of dysarthria during the recovery period of stroke by acupuncture at Ju Hou acupuncture point with speech training. Available online: https://www.nstl.gov.cn/paper_detail.html?id=60b5a00abc91a58c4667e7bb9a3a608a.
62. Hao PF, Dong Y, Sun SB, et al. Observation on the efficacy of puncturing Jinjin and Yuyi with speech training for post-stroke dysarthria. Journal of Anhui University of Chinese Medicine 2018;37:46-9.
63. Jia L, Bai J, Liu D, et al. 30 cases of motor dysarthria after stroke treated with multi-needle puncture on the tongue body with speech training. Chinese Medicine Modern Distance Education of China 2016;14:44-6.
64. Luo KT, Qian LF, Yan YQ, et al. Analysis of the efficacy of acupuncture and speech rehabilitation training in the treatment of post-stroke dysarthria. Chinese Traditional Medicine Science and Technology 2012.
65. Zeng XQ, Teng DS, Yang T, et al. 30 cases of dysarthria after cerebral infarction treated with acupuncture and rehabilitation training. Clinical Journal of Acupuncture and Moxibustion 2005;21.
66. Gao HY, Zhu J, Huang GH, et al. Clinical study on spasmodic dysarthria after stroke treated with tongue three acupuncture combined with mouth muscle training. Clinical Journal of Acupuncture and Moxibustion 2019;35:8-12.
67. Liu H, Yao YL, Feng W, et al. Clinical observation of acupuncture combined with language rehabilitation training in the treatment of dysarthria after qi deficiency and blood stasis type of stroke. Hebei Journal of Traditional Chinese Medicine 2020;42:1568-70,74.
68. Qi HM. Clinical observation of dysarthria treated with acupuncture and rehabilitation training. Chinese Medicine 2009;4.
69. Liu SD. Clinical study of speech training combined with acupuncture in the treatment of dysarthria in stroke. Internal Medicine of China 2012;7:336-8.

70. Zhang BD. Clinical efficacy of acupuncture combined with speech training in the treatment of dysarthria in spastic stroke. Yin Shi Bao Jian 2018;5:20.
71. Hao P, Wang YM, Chen DP, et al. Exploration of the effect of acupuncture with language rehabilitation training for patients with dysarthria in stroke. Journal of Medical Forum 2018;39.
72. Chen LZ, Wang LJ. Acupuncture combined with speech training for the treatment of spastic dysarthria in stroke patients. Journal of Clinical Acupuncture and Moxibustion 2011;27:24-6.
73. Liu XM, Wang J, Li SM, et al. Clinical effects of acupuncture with speech training in the treatment of patients with dysarthria after stroke. World TCM 2020;15.
74. Shi JL, Dong SH. Clinical efficacy of acupuncture combined with lemonade and tongue exercises in the treatment of post-stroke patients with dysarthria. Shenzhen Journal of Integrated Chinese and Western Medicine 2021;31:74-6.
75. Wu LL. Effect of acupuncture combined with speech rehabilitation therapy on acoustic index and speech function in patients with motor dysarthria. Guangming TCM 2021;36.
76. Xu JM, Li HL, Lu HY, et al. Effect of acupuncture on speech and acoustic levels in patients with dysarthria. World Journal of Acupuncture - English version 2011;21.
77. He M. Effect of speech rehabilitation care combined with acupuncture therapy on patients with spastic dysarthria in stroke. Guangming TCM 2018;33:276-7.
78. Kang K. Clinical effects of acupuncture combined with speech rehabilitation training in the treatment of post-stroke dysarthria. Chinese Primary Medicine 2017;24.
79. Liang J. Acupuncture combined with speech training for the treatment of post-stroke dysarthria. Journal of Changchun University of Traditional Chinese Medicine 2014.
80. Wang GN. Clinical efficacy of acupuncture combined with speech rehabilitation in the treatment of post-stroke patients with dysarthria. World Abstract of the Latest Medical Information 2016;16:179-80.
81. Wu ZJ, Hu KM, Guo YG, et al. Acupuncture combined with speech rehabilitation training for post-stroke spasmodic dysarthria: a multicenter randomized controlled study. World Journal of Acupuncture and Moxibustion - English Edition 2014.
82. Yu JH. Clinical efficacy of acupuncture combined with speech rehabilitation in the treatment of patients with post-stroke dysarthria. World Abstract of the Latest Medical Information 2017;17:104.
83. Hao PF, Xu QL. Clinical study on the treatment of dysarthria in stroke with point-pricking as the main treatment and tongue three acupuncture. Journal of Clinical Chinese Medicine 2017;29:919-22.
84. Yang XM, Shi L, Ran D, et al. Comparison of Tongue Acupuncture and Traditional Acupuncture in the Treatment of Poststroke Dysarthria: A Meta-Analysis and Tongue Acupuncture System Classification Evaluation, Evid-based Compl Alt, 2022.
85. Chavez LM, Huang SS, MacDonald I, et al. Mechanisms of Acupuncture Therapy in Ischemic Stroke Rehabilitation: A Literature Review of Basic Studies. Int J Mol Sci 2017;18:2270.
86. Lu L, Zhang XG, Zhong LL, et al. Acupuncture for neurogenesis in experimental ischemic stroke: a systematic review and meta-analysis. Sci Rep 2016;6:19521.
87. Zhang J, Lu C, Wu X, et al. Neuroplasticity of Acupuncture for Stroke: An Evidence-Based Review of MRI. Neural Plast 2021;2021:2662585.
88. Harrison AM, Hilmi OJ. Isolated partial, transient hypoglossal nerve injury following acupuncture. J Surg Case Rep 2014;2014:rju055.
89. Xie Q, Chen X, Xiao J, et al. Acupuncture combined with speech rehabilitation training for post-stroke dysarthria: A systematic review and meta-analysis of randomized controlled trials. Integr Med Res 2020;9:100431.
90. Saleem F, Munakomi S. Pseudobulbar Palsy, in StatPearls. 2022, StatPearls Publishing Copyright ©. Treasure Island (FL): StatPearls Publishing LLC., 2022.
91. Martino R, Foley N, Bhogal S, et al. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. Stroke 2005;36:2756-63.
92. Chen XH, Lai XS, Chen ZZ. Observation on clinical therapeutic effect of acupuncture on apoplectic pseudobulbar palsy. Zhongguo Zhen Jiu 2005;25:161-3.
93. Du L, Wang P. Clinical observation of 38 cases of pseudobulbar palsy treated with acupuncture. Chinese Journal of Traditional Chinese Medicine 2002;17:568-70.
94. Liu Y. Treatment of pseudobulbar paralysis by scalp acupuncture and sublingual needling. J Tradit Chin Med 2004;24:26-7.
95. Qu H, Ren L, Guo Y. Combined application of scalp and body acupuncture in the treatment of pseudobulbar paralysis. J Tradit Chin Med 1991;11:170-3.
96. Shi X, Yang J. A clinical and mechanistic study of 325 cases of pseudobulbar palsy treated with acupuncture. Chinese Acupuncture 1999;19:2.

97. Wang J. Clinical study on acupuncture treatment of pseudobulbar paralysis. J Tradit Chin Med 2004;24:131-2.
98. Chen MY, Tan J, Zhang H, et al. Systematic evaluation of acupuncture in the treatment of motor dysarthria. Chinese Acupuncture 2019:7.
99. Mitchell C, Bowen A, Tyson S, et al. Interventions for dysarthria due to stroke and other adult-acquired, non-progressive brain injury. Cochrane Database Syst Rev 2017;1:CD002088.
100. Chang QY, Lin YW, Hsieh CL. Acupuncture and neuroregeneration in ischemic stroke. Neural Regen Res 2018;13:573-83.
101. Chen A, Lin Z, Lan L, et al. Electroacupuncture at the Quchi and Zusanli acupoints exerts neuroprotective role in cerebral ischemia-reperfusion injured rats via activation of the PI3K/Akt pathway. Int J Mol Med 2012;30:791-6.
102. Liu L, Zhang Q, Li M, et al. Early Post-Stroke Electroacupuncture Promotes Motor Function Recovery in Post-Ischemic Rats by Increasing the Blood and Brain Irisin. Neuropsychiatr Dis Treat 2021;17:695-702.
103. Wang MM, Zhang M, Feng YS, et al. Electroacupuncture Inhibits Neuronal Autophagy and Apoptosis via the PI3K/AKT Pathway Following Ischemic Stroke. Front Cell Neurosci 2020;14:134.
104. Yang C, Liu J, Wang J, et al. Activation of astroglial CB1R mediates cerebral ischemic tolerance induced by electroacupuncture. J Cereb Blood Flow Metab 2021;41:2295-310.
105. Shin HK, Lee SW, Choi BT. Modulation of neurogenesis via neurotrophic factors in acupuncture treatments for neurological diseases. Biochem Pharmacol 2017;141:132-42.
106. Su XT, Wang L, Ma SM, et al. Mechanisms of Acupuncture in the Regulation of Oxidative Stress in Treating Ischemic Stroke. Oxid Med Cell Longev 2020;2020:7875396.
107. Vallon M, Chang J, Zhang H, et al. Developmental and pathological angiogenesis in the central nervous system. Cell Mol Life Sci 2014;71:3489-506.
108. Zou F, Lin YF, Chen SG, et al. The Impact of Electroacupuncture at Hegu, Shousanli, and Quchi Based on the Theory "Treating Flaccid Paralysis by Yangming Alone" on Stroke Patients' EEG: A Pilot Study. Evid Based Complement Alternat Med 2020;2020:8839491.
109. Han X, Jin H, Li K, et al. Acupuncture Modulates Disrupted Whole-Brain Network after Ischemic Stroke: Evidence Based on Graph Theory Analysis. Neural Plast 2020;2020:8838498.
110. Li Z, Yang M, Lin Y, et al. Electroacupuncture promotes motor function and functional connectivity in rats with ischemic stroke: an animal resting-state functional magnetic resonance imaging study. Acupunct Med 2021;39:146-55.
111. Ho CY, Yao CH, Chen WC, et al. Electroacupuncture and Acupuncture Promote the Rat's Transected Median Nerve Regeneration. Evid Based Complement Alternat Med 2013;2013:514610.
112. Li H, Yu L, Ye D, et al. Rehabilitation Training Combined with Jiaji Electroacupuncture Can Promote the Recovery of Muscle Group Function and Improve the Quality of Life in Patients with Upper Limb Peripheral Nerve Injury. J Healthc Eng 2021;2021:3621568.
113. Fei J, Gao L, Li HH, et al. Electroacupuncture promotes peripheral nerve regeneration after facial nerve crush injury and upregulates the expression of glial cell-derived neurotrophic factor. Neural Regen Res 2019;14:673-82.
114. Hu LN, Tian JX, Gao W, et al. Electroacupuncture and moxibustion promote regeneration of injured sciatic nerve through Schwann cell proliferation and nerve growth factor secretion. Neural Regen Res 2018;13:477-83.
115. Huang XQ, Xu JS, Ye XR, et al. Wide Pulse Width Electroacupuncture Ameliorates Denervation-Induced Skeletal Muscle Atrophy in Rats via IGF-1/PI3K/Akt Pathway. Chin J Integr Med 2021;27:446-54.
116. Chen J, Li W, Huang Y, et al. Needling on trigger point promotes muscle regeneration after bupivacaine injection induced injury. Neurosci Lett 2020;739:135436.
117. Toda S. Investigation of electroacupuncture and manual acupuncture on carnitine and glutathione in muscle. Evid Based Complement Alternat Med 2011;2011:297130.
118. Kubota T, Mori H, Morisawa T, et al. Influence of electroacupuncture stimulation on skin temperature, skin blood flow, muscle blood volume and pupil diameter. Acupunct Med 2020;38:86-92.
119. Andersson K, Schalén L. Etiology and treatment of psychogenic voice disorder: results of a follow-up study of thirty patients. J Voice 1998;12:96-106.
120. Carding PN, Horsley IA, Docherty GJ. A study of the effectiveness of voice therapy in the treatment of 45 patients with nonorganic dysphonia. J Voice 1999;13:72-104.
121. Pedersen M, Beranova A, Møller S. Dysphonia: medical treatment and a medical voice hygiene advice approach. A prospective randomised pilot study. Eur Arch Otorhinolaryngol 2004;261:312-5.
122. Dromey C, Nissen SL, Roy N, et al. Articulatory changes following treatment of muscle tension dysphonia:

preliminary acoustic evidence. J Speech Lang Hear Res 2008;51:196-208.
123. Chen D, Guo H. Therapeutic effects of acupuncture combined with rehabilitation training on dysphagia in post-stroke pseudobulbar palsy. Zhongguo Zhen Jiu 2018;38:364-8.

Cite this article as: Yang X, Shi L, Ran D, Li M, Qin C, An Z. The treatment of post-stroke dysarthria with a combination of different acupuncture types and language rehabilitation training: a systematic review and network meta-analysis. Ann Transl Med 2022;10(23):1281. doi: 10.21037/atm-22-5583

