Electroacupuncture for Reflex Sympathetic Dystrophy after Stroke: A Meta-Analysis

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Background: Reflex sympathetic dystrophy (RSD) is the common complication among stroke and cerebral injury patients, which is lack of safe and effective treatment. Electroacupuncture (EA) may potentially be a reliably therapy, but the evidence is insufficiency. *Methods*: Cochrane Library, MEDLINE, Embase, Chinese National Knowledge Infrastructure, Wan Fang Data, the Chinese Biology Medicine disc, etc., were searched, until July 20, 2018. We included random control trials that contrast EA with conventional rehabilitation therapy for the treatment of RSD. Main outcomes were visual analog scale score and Fugl-Meyer upper limb motor function scoring scale, other outcomes such as Barthel index, and hand swelling score were also collected. Data in included studies were extracted into an excel and pooled by Stata/MP 14.1. *Results*: We incorporated 13 studies involving 1040 RSD patients and outcomes were from 2 to 6 weeks' follow-up. The analgesic effect between 2 groups had statistically significant difference (weighted mean difference [WMD] = −1.122, 95% confidence interval [CI] [−1.682 to −.562], $P = .000$], a statistical difference existed in improving dysfunction between 2 groups: (WMD = 6.039, 95% CI [2.231−.916], $P = .000$). EA groups had a better effect on improving activities of daily life abilities (WMD = 12.170, 95% CI [6.657−17.682], $P < .00011$] and better detumescence effect (WMD = −.800, 95% CI [−1.972 to −.212], $P = .000$] contrast to conventional rehabilitation therapy. *Conclusions*: This meta-analysis supports that EA has a positive effect on alleviating pain, improving limb dysfunction, and promoting activities of daily living. On account of moderate-quality random control trials and high heterogeneity, further high-quality studies are imperative to optimize the EA treatment program.

Key Words: Electroacupuncture—reflex sympathetic dystrophy—poststroke—meta-analysis—review

Introduction

Reflex sympathetic dystrophy (RSD), named shoulder-hand syndrome before, has been confirmed as the common complication among poststroke and cerebral injury patients.[1,2] Substantial morbidities of RSD are noticed by clinician accompanied with increasing stroke

Abbreviations: EA, electroacupuncture; RCTs, random control trials; RSD, reflex sympathetic dystrophy: VAS, visual analog scale score; FMA, Fugl-Meyer upper limb motor function scoring scale; BI, Barthel index; HSS, hand swelling score; PEDro, Physiotherapy Evidence Database scale; CRPS, Complex Regional Pain Syndrome

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Received November 10, 2018; accepted February 11, 2019.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest: All authors have no conflicts of interest.

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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2019.02.010

hemiparalysis sufferer.[3] RSD belongs to Type I of Complex Regional Pain Syndrome (CRPS),[4] clinically manifested with severe burning pain in the shoulder and arm, swelling of hand, hyperesthesia on the skin, vasomotor dystrophic changes in tissues and dysfunction of the affected extremity.[5-6] Therefore, the rehabilitation process of upper limb function has been greatly hindered, in some poststroke patients, prolonged course and pain may develop into permanent disability and psychological distress, which come to a huge disaster for patients and their families.[7] Obviously, the choice of effective intervention is crucial to RSD patients.[8,9]

The pathophysiology and etiology of RSD are gradually understood as multifactorial and complicated.[10-12] Additionally, insufficient evidence of therapeutic strategies can be extracted from extensive empirical experience and research.[13,14] Nonetheless, guidelines from different associations and nations recommend physical therapy and rehabilitation as a primary consideration.[15,16] It includes cold-hot water for immersion, microwave therapy, sympathetic block, spinal cord stimulation, and so on. Unfortunately, those conventional medical procedures are tested tentative efficacious, and the adverse reaction cannot be neglected.[17] Therefore, finding an effective and reliable treatment is needed urgently for treating RSD, maybe electroacupuncture (EA) is a good choice.

Currently, EA has become an important method of pain therapy,[18,19] what s'more, some literature had reported EA as a possible choice for RSD patients.[20,21] EA has been confirmed effective by both clinical and animal studies in persistence pain management.[22,23] Furthermore, mechanisms of EA analgesia are revealed in different dimensions.[24,25] However, evidence of EA for RSD is low convincing because of inadequate methodological quality and small sample size.

Unfortunately, the pooled data of EA therapy for RSD are rarely found in current reviews. Therefore, to explore receivable EA evidence and treatment strategy, meta-analysis methods were adopted. Randomized controlled trials that contrast EA with conventional rehabilitation therapy for the treatment of RSD were included. The main outcomes assessed were visual analog scale score (VAS) and Fugl-Meyer upper limb motor function scoring scale (FMA). Meanwhile, the pooled effect of EA was evaluated for poststroke patients with RSD.

Methods

We declare that all supporting data are available in the Supplementary Data. This meta-analysis was conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) regulations.[26] On the foundation of published and available data, approval from institutional review board was exempt from our study. There is no protocol and registration number available.

Data Sources and Database Searches

We searched the Cochrane Library, PubMed, Embase, Chinese National Knowledge Infrastructure, Wan Fang Data, the Chinese Biology Medicine disc from inception until July 20, 2018 (search date). We adopted the following mesh terms based on principles: RSD, poststroke, stroke, CRPS; EA, acupuncture, rehabilitation; randomized control trial (RCT). Furthermore, similar retrieval methods were applied in the Clinical Trials.gov and International Clinical Trials Registry Platform to obtain unpublished studies. The same terms in Chinese were conducted in Chinese databases. The studies were limited to clinical subjects, without considering their publication regions and language. In addition, the cross-reference lists of all involved literature were retrieved by the manual search to confirm that all relevant references were available. The search algorithm was available in the Supplementary Data.

Selection Criteria

RCTs incorporating EA treatment merely or combined with other conventional therapies:

1. The included poststroke patients had been confirmed definitely with RSD;
2. RCTs assessed the clinical efficacy of EA, compared with conventional rehabilitation therapy;
3. Participants are limited to consciousness, no cognitive impairment, no mental disorder, and no serious underlying comorbidities;
4. Primary outcomes included VAS, FMA, other outcomes such as Barthel index and hand swelling score were also collected.

Exclusion Criteria

1. Duplicated and repetitious studies;
2. No clear diagnostic criteria of RSD;
3. EA was conducted in both groups;
4. Quasi-RCT or no control group;
5. Without inadequate outcomes.

Deserve to be mentioned that the EA adopted in the EA group with no restriction of the needle size, acupoint selection, current stimulation frequency, retention time, and treatment course.

Data Extraction and Management

Respectively, 2 investigators retrieved qualified trails through titles and abstracts, then reviewed full article to extract the appropriate researches according to the inclusion criteria. The data extraction was implemented by the same 2 investigators independently. The tabulated data

were composed of design methodology, interventions strategy, outcomes measurement, and follow-up. When 2 investigators could not reach a consensus or had any potential doubts, the resolution was concluded by discussion and consensus.

Assessment of Quality and Risk of Bias

Methodological quality and reporting biases were evaluated by 2 reviewers independently, according to the Physiotherapy Evidence Database (PEDro) scale.[27] Studies with 9-10 PEDro scores were regarded to "excellent," with 6-8 scores were confirmed as "good," and studies with score 4 or 5 were considered to "fair" quality.[28] For this analysis, we evaluated a high-quality study with a score greater than or equal to 7 according to the PEDro scale and 5-6 as "fair."

For assessing study bias, we adopted Cochrane ROB (risk of bias)[29]: we operated judgment of "low risk of bias," "unclear risk of bias," or "high risk of bias" on the basis of the standard entries. Divergence would be conquered by the adjudication of the corresponding author.

Statistical Analysis

The meta-analysis adopted Stata/MP 14.1 (SataCorp. LP) for data processing. The heterogeneity test between the studies was performed according to chi-square and Higgins I^2, $P < .01$ was the assumed test level. Random effect model was applied if substantial heterogeneity was detected ($I^2 \geq 50\%$ was evaluated as moderate or significant heterogeneity). The fixed effect model was adopted if there was low statistical heterogeneity across the studies. Standardized mean difference was chose instead of weighted mean difference (WMD) by reason of the different scales encountered, when measuring pain and limb function. Inverse variance was applied to synthesize the individual effect size and 95% confidence interval (CI) was settled on the margin of error. When clinical or methodology heterogeneity was confirmed, subgroup analysis, forest plot, and Egger's test were conducted to probe the source of heterogeneity as far as possible.

Results

Study Selection and Study Characteristics

We selected 13 trials according to the established criteria from the 814 retrieved literature. Literature screening process and flow diagram can be found in Figure 1. Four trials[35,38,40,41] without peer review which belongs to academic dissertation were also incorporated according to the predefined inclusion criteria. Identified trials were single-center randomized controlled trials published in Chinese and English. A total of 530 poststroke patients affected RSD in the EA group and 510 participants in the control group were involved.

We checked the baseline carefully from different dimensions that we could obtain as far as possible, such as demographic information, intervention frequency, average course of RSD, and protopathy (more details in Table 1). Except for 1 trial,[35] the reported male/female ratio was 528/343. Almost all patients of RSD were secondary to a cerebrovascular accident; however, only 4 studies[34,35,38,41] described the specific protopathy, 156 hemiplegia patients involved, among them 91 cases of RSD caused by cerebral hemorrhage and 65 cases of RSD attributed to cerebral infarction. The fourth week was selected for observation end point by 9 RCTs, the shortest was 2 weeks[40] and the longest was 12 weeks.[42] Comparison of baseline showed great course difference between RCTs, the longest course was (6.48 ± 3.12) years and the shortest was (28 ± 6) days. The main course baseline concentrates on 1-2 months.

All included 13 RCTs reported VAS and FMA, 4 RCTs reported Barthel index, and 5 RCTs reported hand swell score. The interventions in the extracted trials consisted of EA or EA plus conventional rehabilitation therapy or EA plus massage or EA plus acupoint injection. Meanwhile, the control groups included were conventional rehabilitation therapy or warm acupuncture or acupuncture. Moreover, from Table 1, we might not difficult to summarize that the EA acupoints were distributed around the shoulder and elbow (LI 15, SJ 14, LI 4, LI 11, SJ 5, etc.). Most of the RCTs choose the dilatational wave, G6805 EA apparatus, as the basic elements. The intensity of the current was determined by the patient maximum tolerance threshold and local muscles twitch. No adverse events report was available from the included RCTs.

Publication Bias

Depended on the available data, we explored the publication bias of the pain control by means of a funnel plot and Egger's test ($P = .226$). As it demonstrates in Figure 2, the publication bias might be neglected.

Visual Analog Scales

All trials adopted the VAS except one[42] employed the numeric pain rating scale (NPRS) to estimate the variation of pain intensity. We assumed that the NPRS is equal to VAS in evaluating pain intensity. We choose WMD as the effect magnitude. Analysis of pooled data adopted a random effect model (WMD = −1.122, 95% CI [−1.682 to −.562], $P = .000$; Fig 3), the heterogeneity was high ($I^2 = 93.7\%$).

Fugl-Meyer Upper Limb Motor Function Scoring Scale

To standardize to a single dimension, we assumed that simplify Fugl-Meyer upper limb motor function scoring scale and FMA were equivalent. Therefore, the consolidated evaluation criterion to measure the improvement of poststroke limb function was established. We synthesized

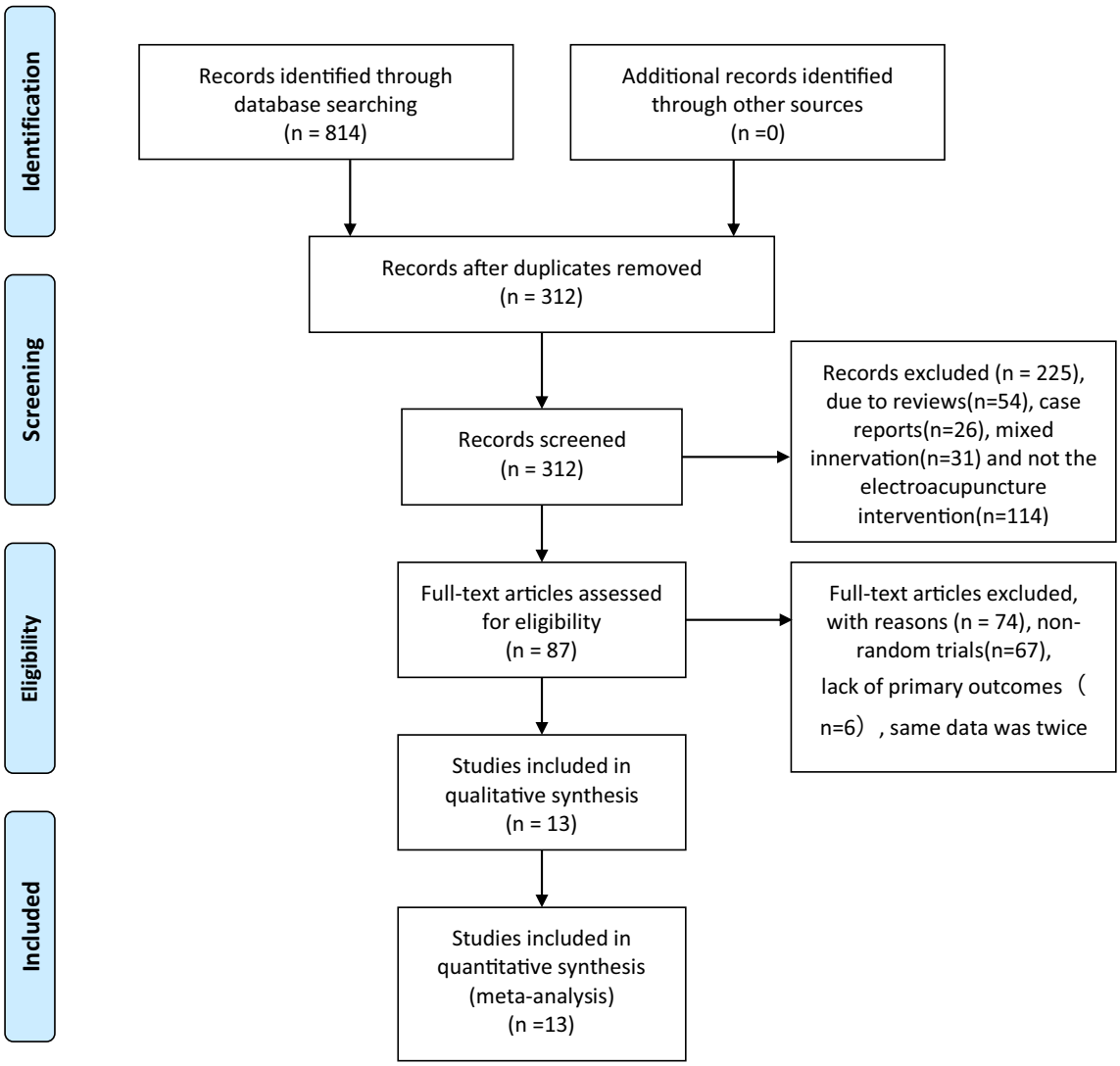

Figure 1. *Flow-chart diagram presenting the selection of eligible studies. From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.*

and analyzed the 13 group data via the random effect model (WMD = 6.039, 95% CI [2.231−.916], $P = .002$; Fig 4). Unfortunately, high heterogeneity $I^2 = 97.1\%$ was encountered.

Barthel Index

Four trials[34,37,38,40] identified to report the Barthel index, we synthesized and pooled data adopting a random effect model indicating high heterogeneity, which I^2 is 89.2%. The analysis revealed that statistic difference in Barthel index between the groups receiving EA and the control groups was significant (WMD = 12.170, 95% CI [6.657−17.682], $P < .0001$; Fig 5).

Hand Swelling Score

We planned to investigate the intervention therapies efficacy on swelling hand, one unanticipated condition impeded progress, the measurement difference was significant. The pooled data (WMD = −.800, 95% CI [−1.972 to −.212], $P = .000$; Fig 6) from 5 trials demonstrated high heterogeneity ($I^2 = 97.9\%$). On account of small sample size and clinical diversity, we even did not explore the difference source through sensitivity analysis and subgroup analysis.

Sensitive Analysis and Subgroup Analysis

To explore sources of heterogeneity, we employed subgroup analysis. Average duration less than 3 months or not, journal or dissertation, acupuncture in control group or no acupuncture in control group, EA alone or EA plus RT, etc. were as stratification factors (Supplemental Figs 1-10). Unfortunately, the exact sources of heterogeneity cannot be confirmed. When trials without peer review were removed, the pooled VAS and FMA outcomes unchanged (Supplemental Figs 11 and 12).

Table 1. *Characteristics of the 13 trails identified*

Study references	Randomization	Sample size	Age (y)	Intervention		Outcomes		Intervention frequency	Therapeutic course
	Method	Intervention/ control	Intervention/control	Intervention group	Control group	Primary	Secondary		
Gao 2017[30]	Random number table	30/30	60 ± 17/62 ± 14	EA + RT	Warm acupuncture + RT	VAS SFMA	HSS	7 times/W 30 min	4 W
Jia et al 2012[31]	Random number table	28/24	60 ± 17/62 ± 14	EA	RT	VAS FMA	N/A	5 times/W 30 min	4 W
Wang et al 2017[32]	Random number table	50/46	56.6 ± 7.2/58.6 ± 5.7	EA + acupoint injection	RT + modulated middle-frequency electrotherapy	VAS SFAM	BI,HSS	7 times/W 20 min	4 W
Xie et al 2016[33]	Random number table	40/40	50 ± 11/51 ± 10	EA + RT	RT	VAS FMA	N/A	3 times/W 30 min	4 W
You 2014[34]	Random number table	40/40	61.23 ± 10.92/60.87 ± 11.34	EA + RT	RT	VAS FMA	BI,HSS	6 times/W 30 min	4 W
Zhang 2012[35]	Random statistical software PEMS3.1	30/30	57.82 ± 8.60/56.83 ± 9.20	EA	RT	VAS FMA	N/A	5 times/W 30 min	3 W
Cui et al 2013[36]	Random statistical software PEMS	31/31	40-70	EA	RT	VAS FMA	N/A	5 times/W 30 min	4 W
Huang et al 2014[37]	Random number table	110/110	54.8 ± 3.69/53.9 ± 4.12	EA + RT	RT	VAS FMA	BI	7 times/W 30 min	4 W
Lai 2010[38]	Random number table	30/30	41-70	EA	Acupuncture	VAS FMA	BI	5 times/W 30 min	4 W
Lin 2017[39]	Random number table	15/15	62.31 ± 5.39/62.54 ± 5.47	EA + RT	Warm acupuncture + RT	VAS FMA	HSS	5 times/W 30 min	4 W
Xiong 2016[40]	Random number table	30/30	62.00 ± 7.54/59.77 ± 8.56	EA	RT + acupuncture	VAS SFMA	BI	7 times/W 30 min	2 W
Wang 2009[41]	Random System area group design	30/30	53.3 ± 8.60/54.83 ± 9.23	EA	Acupuncture	VAS FMA	HSS	6 times/W 30 min	3 W
Li et al 2012[42]	Random Computerized	60/60	62 ± 12/61 ± 13	EA + massage	RT	NPRS FMA	N/A	7 times/W 25 min	6 W, 12 W

Table 1 *(Continued).* *Baseline characteristics of the included patients*

Study references	Acupoint in EA group	Instrument Frequency/ waveform	Current Intensity	Gender M/F	Baseline VAS	Baseline FMA/SFMA	Course of the Disease	Literature Type	Pathogenesis CH/CI	Blinding Method
Gao 2017[30]	LI 15, LI 11, LI 10, LI 4, SJ 5	G6805-D 20Hz, Dilatational	Myoclonus	45/15	5.49 ± .99	13.29 ± 11.94	79.37 ± 10.03 d	Journal	N/A	N/A
Jia et al 2012[31]	LI 15, SJ 14, LI 1, LI 4, SJ 5	SDZ-□, 50-100Hz, Dilatational	Muscle tremor	31/21	5.53 ± 1.47	13.63 ± 11.96	28.5 ± 5.7 d	Journal	N/A	N/A
Wang et al 2017[32]	LI 15, SI 9, GB 21, SJ 14, GB20	N/A N/A, Discontinuous	Maximum tolerance	57/39	7.15 ± 1.45	34.76 ± 1.42	3.5 ± 7.6 m	Journal	96	N/A
Xie et al 2016[33]	SJ 13, LI 15, SJ 11, LI 4, LI 15, LI 11, LI 10, LI 5	HANS-200A N/A	Muscle tremor	49/31	5.85 ± 1.48	32.75 ± 4.03	14 d to 2 m	Journal	N/A	N/A
You 2014[34]	LI 15, SI 9, SJ 14, LI 14, SI 11 EX-UE9	G6805-2 N/A, Dilatational	Maximum tolerance	42/19	5.81 ± 1.33	19.9 ± 2.69	34.23 ± 16.25 d	Journal	32/29	N/A
Zhang 2012[35]	LI 15, LI 14, LI 4, LI 10, SJ 5	G6805-1 N/A, Discontinuous	Maximum tolerance	N/A	5.45 ± 1.98	14.83 ± 12.73	58.64 ± 12.89 d	Thesis	30/30	Envelope sealing
Cui et al 2013[36]	Shoulder tri-needles	N/A N/A, Dilatational	Maximum tolerance	38/24	3.62 ± .49	12.33 ± 3.94	N/A	Journal	N/A	N/A
Huang et al 2014[37]	LI 15, LI 4, SJ 5, LI 11, LU 5, TE 4	G6805-1 N/A, Dilatational	Maximum tolerance	114/106	6.31 ± 2.25	36.45 ± 8.97	6.48 ± 3.12 y	Journal	N/A	N/A
Lai 2010[38]	LI 15, SJ 14, HT 1, LU 5, PC 5, EX-UE9	G6805-2 2-4Hz, Dilatational	Myoclonus	38/22	5.6 ± 2.31	43.53 ± 7.85	>6 m	Thesis	47/13	Envelope sealing
Lin 2017[39]	LI 10, SJ 5, LI 11, LI 15, LI 4	N/A 20Hz, Dilatational	Muscle tremor	23/7	5.62 ± 1.36	13.65 ± 5.64	2.85 ± .32 m	Journal	N/A	N/A
Xiong 2016[40]	LI 15, LI 14, SJ 14, SI 11, SJ 3, LI 11, LI 10	N/A N/A, Dilatational	Maximum tolerance	32/28	6.07 ± 2.53	34.67 ± 2.28	73.23 ± 48.58 d	Thesis	N/A	N/A
Wang 2009[41]	Aponeurotic channel Shoulder and elbow	N/A N/A, Dilatational	Myoclonus	39/21	4.47 ± 1.36	19.9 ± 2.71	46.63 ± 25.43 d	Thesis	49/11	N/A
Li et al 2012[42]	LI 3, SI 3, SJ 3, SI 15, SJ 14, LI 15, LI 10, SJ 5, SI 11	HANS(LH202H) N/A, Dilatational	Maximum tolerance	81/39	8 ± 1.3	10.2 ± 3.9	28 ± 6 d	Journal	N/A	Envelope sealing

Abbreviations: BI, Barthel index; CI, cerebral infarction; CH, cerebral hemorrhage; EA, electroacupuncture; FMA, Fugl-Meyer upper limb motor function scoring scale; HSS, Hand swell score; N/A Not available; NPRS, the numeric pain rating scale; RT, rehabilitation therapy (The training of rehabilitation exercise, correct limb placement, Bobath shake hands, Passive exercise therapy, microwave treatment, air pressure pump, etc.); SFMA, simplify Fugl-Meyer upper limb motor function scoring scale; VAS, visual analog scale.

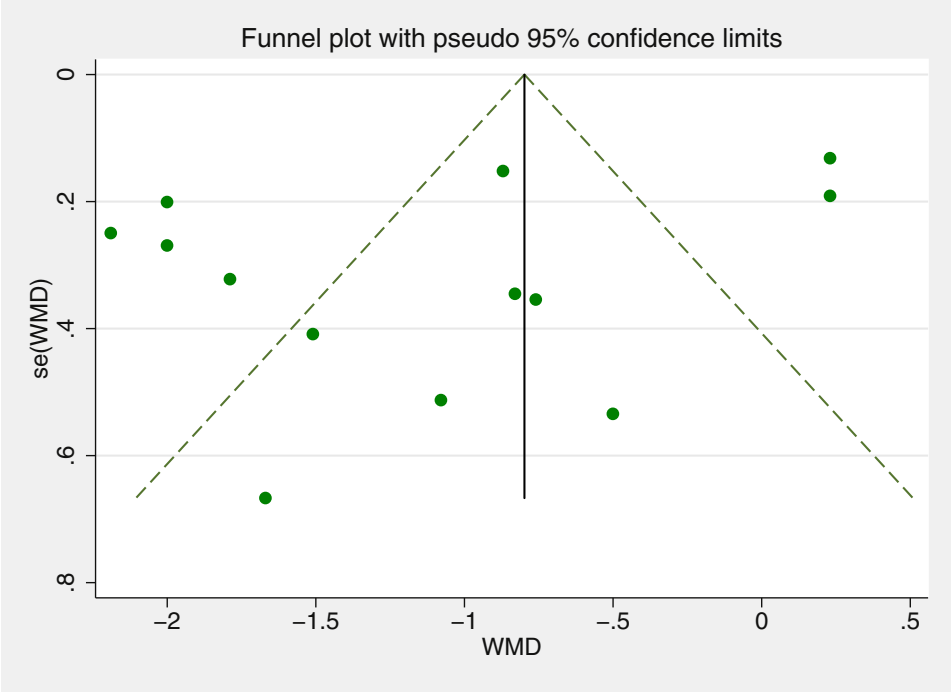

Figure 2. *Funnel plot of meta-analysis showing by VAS.*

Risk of Bias

The results in Cochrane risk of bias analysis were moderate, most of the trails were identified as secondary methodological quality accompanied by the risk of bias, only 2 trials were evaluated as low bias.[35,42] As is demonstrated in Table 2, the great mass of bias concentrated expression in performance bias and selection bias.

Quality Assessment

The results of an assessment by PEDro scale are available in Table 2. From the demonstration, we have no difficulty to capture that quality scores on PEDro scale fluctuated between 6 and 9, 8 studies were evaluated to "good" level, 5 studies were deemed to "fair" level. Therefore, the quality of the included RCTs was moderate.

Discussion

Based on included 13 RCTs, we conducted this meta-analysis primarily to explore evidence for the effectiveness of EA in the pain release and dysfunction improvement generated by RSD in poststroke patients. As demonstrated above, the meta-analysis suggested roughly that EA was more effective in alleviating RSD symptom than conventional rehabilitation therapies or acupuncture alone, particularly reflected in decreasing pain intensity, improving limb dysfunction, and enhancing activities of daily living. One thing we could not ignore that the conventional rehabilitation was regarded as an integral intervention when contrasted with EA. Therefore, the results obtained from the analysis should be interpreted with prudence.

Strengths and Weaknesses of Our Methodology

From this review, we can clearly know the present EA application condition among poststroke patients with RSD. Moderate evidence showed a positive effect on pain management and symptom control based on short-term observation (4W, $P < .05$). EA is likely to new hope for RSD with high safety. It needs to be emphasized that the methodological quality assessment of included trials was deemed to a moderate level, especially in blind method and allocation of concealment. Clinically, it is difficult to implement the blind method in EA manipulate because of invasive procedure. Therefore, only the evaluators were blind could accomplish, the stability of the analysis result should be downshifted. As illustrated in Table 2, the PEDro scale evaluated the design qualities of 13 RCTs from different dimensionality, which demonstrated the blinded subjects score almost zero.

Exploration of Sources of Heterogeneity

As we can see in the previous analysis, especially in the subgroup analysis, the results illustrated a mass of heterogeneity between studies. For the VAS score, the average duration less than 3 months, the publication year 2017, article type of journal, using RT in the intervention group, might be the source of heterogeneity (Supplemental Figs 1-5). It seems that dissertations had stricter methodological quality control than journals and the heterogeneity among them is low. The clinical diversity of rehabilitation forms in intervention groups might contribute to heterogeneity. More than 3 months' duration of RSD might lead

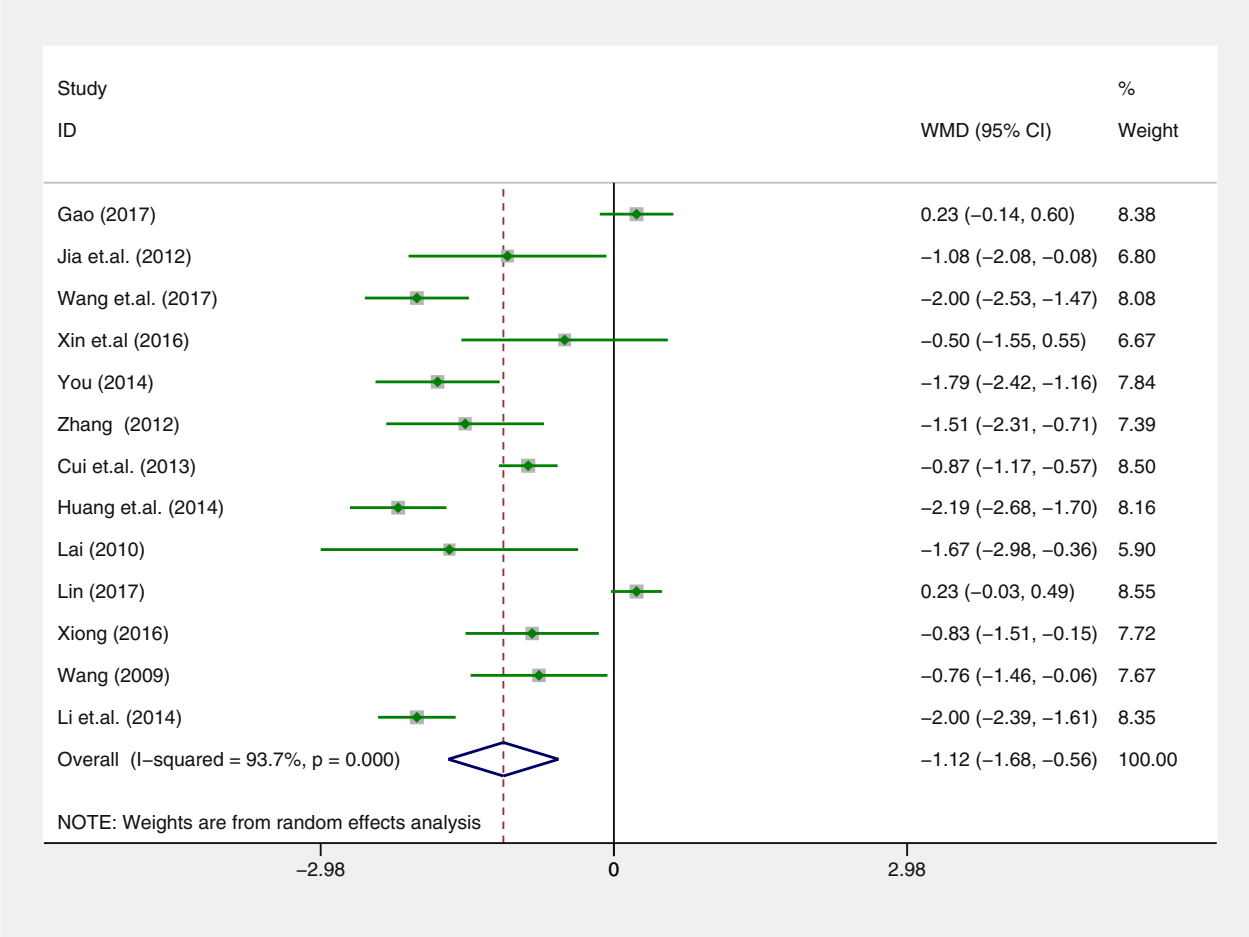

Figure 3. *Forest plot of VAS.*

to psychological disorder and generate more stable pain experience. Although NPRS and VAS were regarded as almost equivalent evaluation validity in most situation, the conversion between 2 different scales might generate a difference. For FMA score, except for article type of journal, using RT in the intervention group, we still could not explore other influence factors of heterogeneity (Supplemental Figs 5-10). To investigate this trouble ulteriorly, we would like to adopt meta-regression exploring the sources of heterogeneity from the perspective of clinical diversity and methodology difference. However, the limited sample size and clinical diversity stopped us from doing this. Different RSD patients in different stages may have a different sensibility to disparate rehabilitation measures, which are potential to generate a difference. Therefore, trials in the future should be organized scrupulously to decrease methodological limitations.

There were some confounding factors might not be ignored among included trials. First, a large difference existed among the treatments in the control groups. Warm acupuncture therapy adopted by 2 studies,[30,39] routine rehabilitation therapies employed by 7 studies[31,33–37,42] (cold-hot water for immersion, microwave therapy, sympathetic block, spinal cord stimulation, and so on), simple acupuncture adopted by 2 other trials[38,41] and the rest of trials united routine rehabilitation therapies and simple acupuncture. Therefore, inconformity therapies may contribute to unsteady clinical results. Second, other therapies presented in intervention groups, 6 trials[31,35,36,38,40,41] adopted EA alone, 5[30,33,34,37,39] studies combined EA with conventional rehabilitation therapies, and 2 studies[32,42] adopted massage or acupoint injection in addition to EA. We would like to make a subgroup analysis based on EA alone or not. Nonetheless, a small number of trials and inconsonant baseline held us back. Third, the difference of primary extremity function score and pain intensity score may contribute to heterogeneity. For instance, the farthest outlier was the study conducted by Li[42] that the baseline average VAS score was far higher than the others but the average FMA score was the lowest. This considerable difference is may be attributed to the shortest duration. We could suppose that longer EA treatment course might contribute to a better therapeutic effect for RSD. Therefore, the validity of the result needs to be enhanced by adequate, rigorous, stabilized, and long-term follow-up trials.

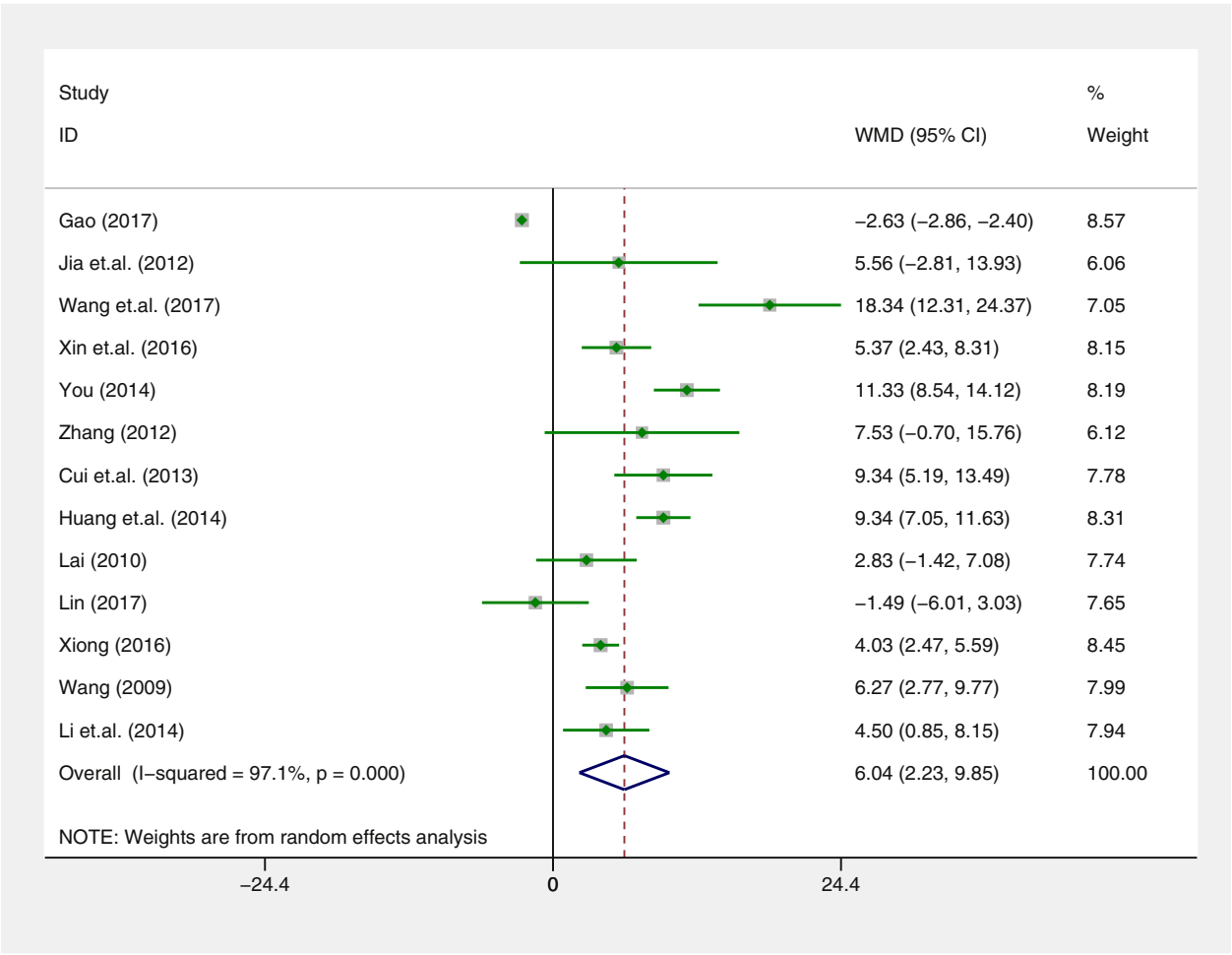

Figure 4. *Forest plot of FMA.*

Clinical Implications

Based on forest graphs, we could discover better detumescence effect trend in warm acupuncture groups than EA groups. For example, Gao[30] reported a superior detumescence effect according to hand swell score ($P < .05$), that is maybe due to warm acupuncture can regulate inflammatory cytokines,[43] regulate the immune system, and improve microcirculation.[44] One would hypothesize that warm acupuncture should be a good choice for poststroke patients with RSD. Therefore, our results may contribute to reducing scrupulosity of planning RCTs for warm acupuncture and EA in the treatment of RSD. Based on the analysis, we can infer that earlier intervention and longer treatment courses with EA will obtain a better benefit, although the parameters of EA were incomplete. However, special consideration required to concentrate upon the optimal intensity criterion of the current was determined by maximum tolerance threshold of the patient and local muscles twitch. All incorporated RCTs were from a single center and lack of long-term follow-up, thus, we did not deliver the grading of evidence quality and recommendation intensity. What is more, psychological and spiritual factors are essential to the evaluation of RSD. In the future, long-term EA efficacy observation is necessary to provide responsibly evidence of handling RSD patients, especially, in mental and spiritual factors.

Limitations

Although this meta-analysis may contribute to some positive consequence, the limitations of this review should not be ignored. The all included literature was reported in Chinese except 1 reported in English. Therefore, considerable attention should be paid to instability evidence when introduced to other race or country. In addition, our failure was to extract the operation forms of EA, such as needling depth and angle, parameters of needles, and so on. Unfortunately, adverse reactions or events could not be confirmed, as a result, that we cannot confidently declare absolute security for EA as one optimal choice of RSD.

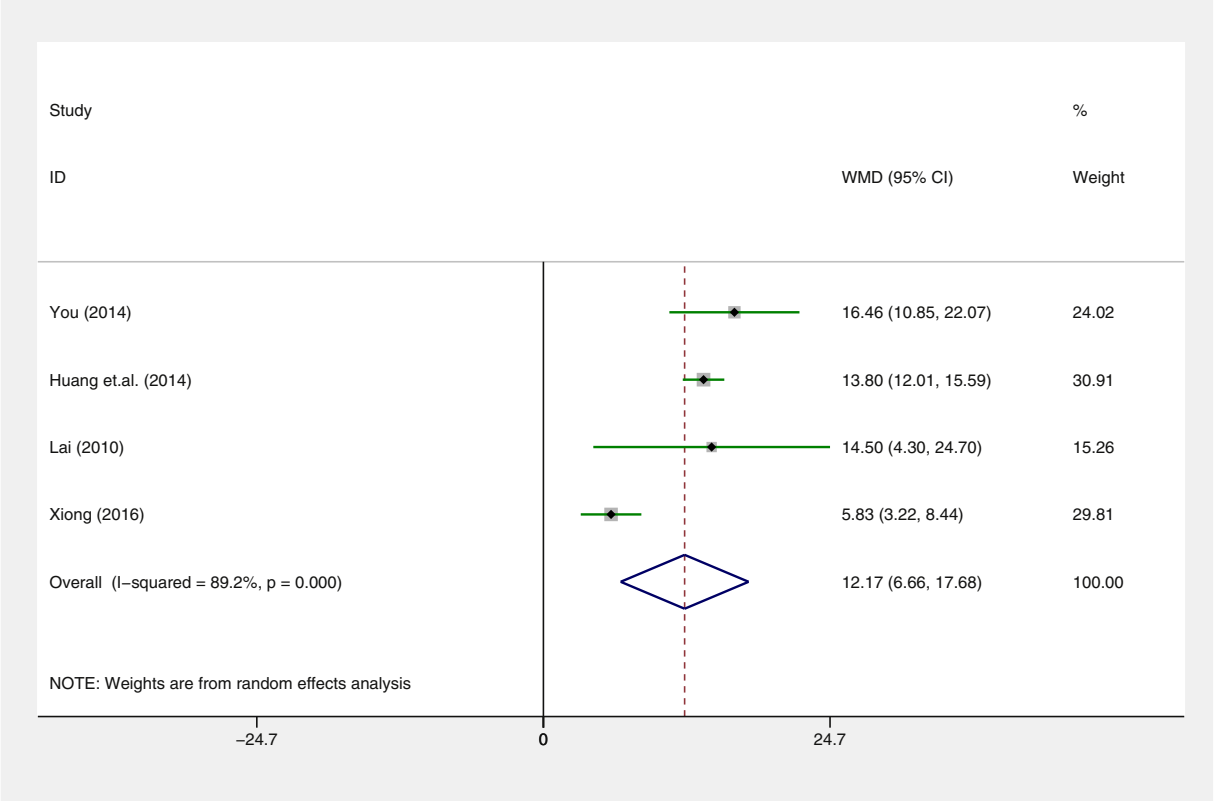

Figure 5. *Forest plot of BI.*

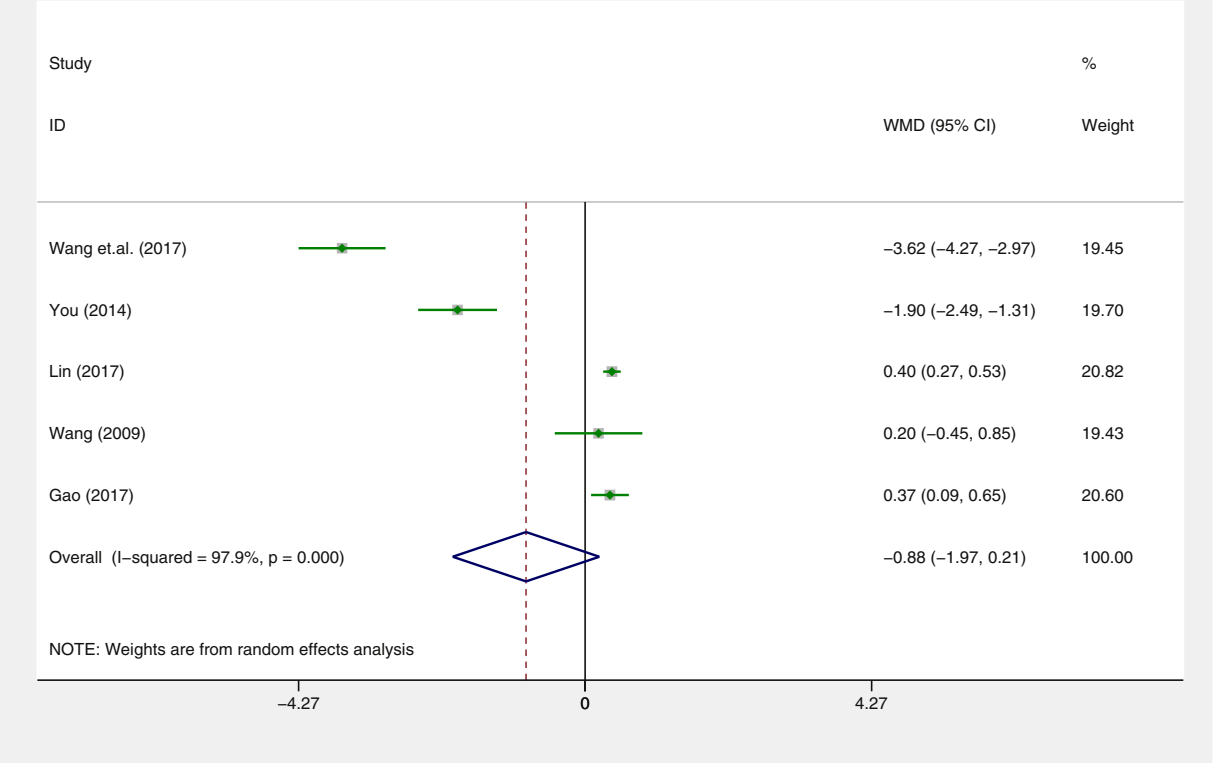

Figure 6. *Forest plot of HSS.*

Table 2. *Results of quality and relevance assessment for the included studies*

Study references	PEDro scale												Cochrane risk of bias					
	A	B	C	D	E	F	G	H	I	J	K	Total	L	M	N	O	P	Q
Gao 2017[30]	1	1	0	1	0	1	1	1	0	1	0	7	L	U	H	L	L	H
Jia et al 2012[31]	1	1	0	1	0	0	1	1	0	1	0	6	L	U	H	L	L	U
Wang et al 2017[32]	1	1	0	1	0	0	1	1	0	1	0	7	L	H	H	L	L	H
Xie et al 2016[33]	1	1	0	1	0	0	1	1	0	1	0	6	L	H	H	L	L	U
You 2014[34]	1	1	0	1	0	0	1	1	0	1	0	6	L	U	H	L	L	U
Zhang 2012[35]	1	1	1	1	0	0	1	1	0	1	0	8	L	L	H	L	L	L
Cui et al 2013[36]	1	1	1	1	0	0	1	1	0	1	0	7	L	L	H	L	L	H
Huang et al 2014[37]	1	1	0	1	0	0	1	1	0	1	0	7	L	U	H	L	L	H
Lai 2010[38]	1	1	0	1	1	0	1	1	0	1	0	7	L	H	H	L	L	L
Lin 2017[39]	1	1	0	1	0	0	1	1	0	1	0	6	L	H	H	L	L	U
Xiong 2016[40]	1	1	0	1	0	0	1	1	0	1	0	6	L	H	H	L	L	L
Wang 2009[41]	1	1	1	1	0	0	1	1	0	1	0	7	L	L	H	L	L	U
Li et al 2014[42]	1	1	1	1	0	1	1	1	1	1	0	9	L	L	H	L	L	L

PEDro scale items (each satisfied item contributes 1 point to the total PEDro score):

1 = item positive, 0 = item negative or unknown.

A = eligibility criteria; B = randomization; C = allocation concealment; D = similar at baseline; E = blinded subjects; F = blinded therapist; G = blinded assessors; H = <15% drop outs; I = ITT analysis; J = between-group comparison; K = point and variability measures;

Cochrane risk of bias:

L = random sequence generation (selection bias); M = allocation concealment (selection bias); N = blinding of patients and personnel (performance bias); O = blinding of outcome assessment (detection bias); P = incomplete outcome data (attention bias), selective reporting (reporting bias); Q = other bias.

Low risk of bias (L), high risk of bias (H), uncertain risk of bias (U).

Conclusions

In summary, Pooled data suggested that EA might be an effective therapy for RSD poststroke hemiplegia. However, the statistical power was impaired by heterogeneity and bias, the evidence strength was reduced by small sample size and intervention confounding factor. To obtain robust and convincing evidence, rigorous, standardized, multicentric, high-quality, long follow-up, multidimensional outcome measures, and good-designed RCT is indispensable.

Acknowledgments: We thank Liu Yali providing guidance for methodology and Yan Liu providing guidance for submission.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jstrokecerebrovasdis.2019.02.010.

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